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Two Essays on the Effect of Multitasking on Learning Performance

by

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Résumé

La pandémie de COVID-19 a rendu nécessaire le travail à distance et la collaboration par le biais de canaux numériques tels que la vidéoconférence, le partage d'écran et les documents partagés. Cela a entraîné une augmentation du multitâche, mais peu d'études ont examiné l'impact de ce phénomène sur la qualité du travail. Cette thèse étudie le multitâche pendant les réunions virtuelles et son impact sur les performances d'apprentissage, en utilisant à la fois des données physiologiques et des données autodéclarées. L'étude se compose d'une phase pilote et d'une seconde phase, avec respectivement 21 et 33 participants. Les participants ont regardé une vidéoconférence dans trois conditions : en regardant seulement, en regardant tout en clavardant avec une troisième partie, et en regardant, clavardant tout en jouant au Sudoku. L'étude a révélé que le fait de jongler avec deux tâches périphériques avait une relation inverse avec la performance subjective, mais n'avait pas d'impact sur la performance d'apprentissage objective. Plus les participants jonglaient avec des tâches, moins leur attention visuelle était dirigée vers la conférence, mais il n'a pas été possible de déterminer si leur attention visuelle avait une incidence sur les performances. La perception de la performance a été influencée par le multitâche, la perception du niveau d'éveil des participants étant affectée. L'étude suggère que les organisations ne doivent pas s'inquiéter du fait que les employés effectuent plusieurs tâches à la fois pendant les vidéoconférences, car la rétention des informations reste la même. Cependant, la perception de la performance à long terme peut avoir un impact sur la santé mentale. Les résultats indiquent que la perception qu'ont les individus de leurs performances ne correspond pas toujours à leurs performances réelles, peut-être en raison du partage des ressources cognitives lors du multitâche. La différence de performance entre les scénarios multitâches et non multitâches n'était pas significative, et certaines combinaisons de tâches n'entravaient pas la performance autant que d'autres. Cela suggère que les individus peuvent ne pas reconnaître pleinement l'impact du multitâche sur leurs performances dans des environnements de travail virtuels. L'étude a utilisé la technologie de suivi oculaire pour observer le multitâche en écran partagé et en changement d'onglet, mais a rencontré des difficultés pour mesurer avec précision l'attention visuelle pendant le changement d'onglet en raison des limites de la technologie actuelle de suivi oculaire. Cela souligne la nécessité de poursuivre les avancées technologiques dans ce domaine. Dans l'ensemble, l'étude souligne l'importance d'adopter des mesures pour atténuer l'impact négatif du multitâche dans les environnements de travail virtuels. De futures études pourraient porter sur l'impact psychologique du multitâche, l'impact des différents types de tâches périphériques sur les performances d'apprentissage et l'impact de la familiarité avec les environnements multitâches sur les performances. L'étude a également observé une différence significative dans la capacité des participants à se rendre compte avec précision de leurs performances et n'a pas trouvé de concordance entre les mesures subjectives et objectives de l'excitation et du plaisir. L'étude permet aux organisations d'améliorer leurs pratiques en matière de vidéoconférence.

Mots clés : Multitâche, performance, apprentissage, attention visuelle, mediation

Abstract

The COVID-19 pandemic has necessitated remote work and collaboration through digital channels such as videoconferencing, screensharing, and shared documents. This has resulted in increased multitasking, yet limited research has examined how this impacts work quality. This thesis investigates multitasking during virtual meetings and its impact on learning performance, using both physiological and self-reported data. The study consists of a pilot phase and a second phase, with 21 and 33 participants, respectively. Participants watched a video conference under three conditions: watching only, chatting while watching, and chatting while also playing Sudoku. The study found that multitasking with two peripheral tasks had an inverse relationship with subjective performance, but did not impact objective learning performance. The more tasks participants juggled, the less visual attention was directed towards the conference, but it was inconclusive if their visual attention affected performance. Perception of performance was impacted by multitasking, with participants' perception of their level of arousal being impacted. The study suggests that organizations need not be concerned about employees multitasking during video conferences as retention of information remains the same. However, the perception of performance in the long run may impact mental health. The findings indicate that individuals' perceptions of their performance do not always align with their actual performance, possibly due to shared cognitive resources when multitasking. The performance difference between multitasking and non-multitasking scenarios was not significant, and some combinations of tasks did not hinder performance as much as others. This suggests that individuals may not fully recognize the impact of multitasking on their performance in virtual work settings. The study used eye-tracking technology to observe split screen and tab switching multitasking but encountered challenges in accurately measuring visual attention during tab switching due to limitations in current eye-tracking technology. This highlights the need for further technological advancements in this area. Overall, the study emphasizes the importance of adopting measures to mitigate the adverse impact of multitasking in virtual work settings. Future studies can investigate the psychological impact of multitasking, the impact of different types of peripheral tasks on learning performance, and how familiarity with multitasking environments impacts performance. The study also observed a significant difference in participants' ability to accurately report their performance and found no concordance between subjective and objective measures of arousal and pleasure. The study provides insight for organizations to improve their video conference practices.

Keywords : Multitasking, performance, learning, visual attention, mediation.

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List of Abbreviations and Acronyms

AOIs: Areas of Interest

EDA: Electrodermal activity / conductance

HRV: Heart Rate Variability

RA: Research Assistant

Preface

The request to submit this thesis in the form of articles was approved by the administrative management of the M.Sc. program at HEC Montréal. Authorization was also provided by the Academic Affairs office. This thesis consists of two articles. The first article was published and presented at the HCI International Conference in June 2022 (HCII2022). The approval from the ethics committee at HEC Montréal was provided for this research under the 2021-4230. In addition, the agreement of all co-authors was obtained for this article to be presented in this thesis.

Acknowledgments

I would first and foremost like to express my deepest gratitude to my codirectors Pierre-Majorique Leger and Constantinos K. Coursaris for their invaluable support, help and constructive comments throughout this endeavour. This would not have been possible without your devoted participation and input.

A special thanks to Sylvain Senecal that also provided me valuable input and participating in the recording of the stimuli for this project.

I would also like to thank the operations team at Tech3Lab for their help and support in collecting data. A special thanks to Carl St-Pierre who worked patiently with me in my data analysis.

I am also very thankful to Laurie, Julie and Haroun who shared this journey with me through ups and downs.

Last but not least, I would like to thank me parents and especially Franz for your unconditional love and support.

Chapter 1: Introduction

1.1 Context of this Thesis

The COVID-19 pandemic precipitated a widespread shift to remote work, as companies gradually transitioned to digital modes of work, such as adopting digital tools and investing in videoconferencing hardware and software. To maintain productivity and collaboration, organizations rapidly adopted videoconferencing software (e.g. Teams and Zoom). Within the span of a year, from 2020 to 2021, Microsoft Teams meetings more than doubled globally (Puttaswamy and Sisson, 2022). It is certain that virtual meetings will continue to play a critical role in workers' day-to-day routines, given that many employees now prefer to work from home rather than in the office or a hybrid model where one or two days of the week is spent at the office (Mckinsey, 2022). However, while these technologies have helped to sustain productivity and collaboration during remote work, they have also presented new challenges, such as an increase in multitasking during virtual meetings.

However, while virtual meetings have helped sustain productivity and collaboration during remote work, they have also presented new challenges, such as increase multitasking during virtual meetings. When working remotely, distractions such as notifications, family members or pets, and personal tasks can often lead to multitasking, which can ultimately hinder productivity and performance.

Multitasking has been extensively researched in many different fields, but limited research has been conducted in the context of retaining information or learning while multitasking in a remote setting. Additionally, most multitasking studies use testimonial or diaries to collect data (Cao et al., 2021, Czerwinski et al., 2004, Xu, S., & Wang, Z., 2017). Therefore, this research aims to specifically collect and observe participants' physiological data and compare it to their self-reported data to better understand the impacts of new remote learning environments and related phenomena such as "zoom fatigue" on retaining information and multitasking behaviors (Riedl, R., 2021).

It is important to understand the impacts of multitasking during virtual meetings on learning performance and visual attention. The first article of this thesis investigates these effects, while the rest of the thesis explores the effect on emotion. It is crucial for companies to recognize the impact of remote work on the way people work and multitask, and how this affects their productivity and performance.

1.2 Research Questions

At the time of writing this thesis, it is forecasted by Gartner (2023) that 39% of global knowledge workers will hybrid working model by the end of 2023. Therefore, it is crucial to understand how this working model impacts the way people work or multitask and how that affects their productivity and performance.

Hence, this thesis focuses on multitasking in a virtual meeting setting where we are measuring physiological data and self-reported data. More precisely, we are looking to understand how multitasking or incrementally increasing the number of tasks performed can impact learning performance and the potential mediating effects of visual attention, arousal and valence (pleasure) on learning performance. We also aim to discover where learner attentions lie during this specific environment and if there are discrepancies between physiological and self-reported data.

In the first article, we measured learning performance and visual attention while multitasking. This allows us to answer the following research questions:
RQ1: What is the effect of an incremental number of peripheral task-based distractions on learning performance during a video conference session?

RQ2: How does a learner's attention get divided between the primary learning task and secondary peripheral tasks during a video conference session?

In the second article, we expand and measured learning performance, arousal and valence (pleasure) while multitasking. This allows us to answer the following research questions:

RQ3: How does a learner's emotional state change as the number of peripheral task-based distractions increases?

RQ4: How are self-reported data compared to physiological data in the context of multitasking in a videoconferencing setting?

RQ5: How does the use state (cognitive or emotional state) mediate the relationship between incremental number of peripheral task-based distractions and performance?

More precisely, we are looking to understand if multitasking during a video conference can affect learning performance or information retention, attention and emotional state. Moreover, we are also measuring how multitasking physiological data compare to self-reported data.

1.3 Theoretical and Practical Research Contributions

From a theoretical standpoint, this thesis aims to contribute to advancing the understanding of multitasking behaviors in remote work environments, specifically during virtual calls by exploring their physiological effects. By examining these factors, the research intends to provide insights into how remote work may affect employees' learning performance. Additionally, it aims to validate and compare whether learning performance is impacted in the same way whether subjective or objective.

From a methodological perspective, this thesis provides valuable insights into the effectiveness of conducting a multitasking study in a laboratory setting. The research explores the use of eye-tracking technology, to capture visual attention during the study. Additionally, the thesis discusses the challenges faced during the study and provides an analysis of what worked and what didn't work in the laboratory setting. This information can be helpful for future research studies that aim to investigate multitasking behaviors in similar environments. Overall, the methodological contributions of this thesis add value to the existing literature on multitasking behaviors and provide valuable insights into the practical considerations of conducting research in a laboratory setting.

1.4 Personal Contributions

This thesis was conducted at Tech3Lab, involving collaborators at different levels of contribution across different stages of the thesis. The table below identifies my personal intellectual contribution at each stage of the thesis.

Steps	Contributions
Ethics	Applying for the ethics – 80%
Research question	Development of the research questions – 50% • I developed the initial research questions • Research supervisors contributed to the development of final research questions.
Experimental Design	Development of the experimental design – 50% • I developed the experiment protocol in collaboration with team at Tech3Lab. • Research supervisors identified what was possible and helped in the development of the final experimental design. Creating the experimental stimuli and related materials – 50% • Phase 1: I built the simulated split screen using HTML • Phase 2: I built the experiment in Tobii pro • Sylvain Senecal created the content of the simulated videoconference. • Research supervisors and the team at the Tech3Lab contributed to the development of the retention test content and questions.

	Development of the questionnaire – 60% • I built the questionnaire and developed the initial questions. • Research supervisors and Tech3Lab team helped in the development of final questionnaire.
Pre-tests	Conducting pre-tests before the start of data collection – 60% • Research assistants from Tech3Lab and I conducted the pre-tests.
Recruitment	Recruitment of the participants – 30% • Phase 1 and 2: Tech3Lab research panel was used to recruit participants in addition to my personal efforts.
Data Collection	Collecting data and supervising operations - 60% • Phase 1 : The research assistants and operations team at Tech3Lab collected the entirety of phase 1 remotely. • Phase 2: Both the Tech3Lab research assistants and I oversaw the data collection of phase 2.
Analysis	Extraction and Formatting data - 80% • I extracted and cleaned the data from phase 1 and 2. • The statistician from Tech3Lab's team helped format and merge data for statistical testing. Analyzing data - 50% • I analyzed the qualitative and quantitative data from the questionnaires.

	• I determined the statistical analysis needed for the physiological data and was assisted by the statistician from Tech3Lab to extract them from the raw data.
Writing	Writing of this thesis – 75% • I wrote the initial draft for both articles and this thesis. My research co-supervisors provided feedback and edits in the text. The remaining co-authors made minor edits.

Table 1 Personal Contribution & Responsibilities in the Realization of this Thesis

1.5 Structure of this Thesis

The rest of this thesis will be structured as follows: the first chapter is an introduction of the concepts present in the two articles as well as a summary of them. Chapter two is the first article published at HCI International Conference in June 2022 (HCII 2022). After having the chance to write and present the first article at HCII, it allowed us to write a second longer article encompassing the entirety of the study which covers the effects of multitasking during a video conference on arousal and valence. The two articles investigate key concepts and explore gaps identified during this thesis. They also describe the approach used and explain the findings inferred from the results. The last chapter of this thesis will conclude with the main findings followed by limitations of the study.

Chapter 2: The Effect of Multitasking in an E-learning Video Conference on Learning Performance: A Psychophysiological Experiment[1]

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Abstract

Due to the pandemic-induced mobility restrictions, time spent in front of a device, videoconferencing or e-learning increased significantly. Zoom and other video conferencing applications will continue to be part of our everyday life as organizations decide to continue to work remotely in years to come. Multitasking has been long researched, however, due to the pandemic, it led us to investigate multitasking with the primary task being an e-learning video conference. Limited research has been done on multitasking in a remote setting and on its impact [1]. Most studies on multitasking use diaries or self-reported testimonies. In this study we use physiological data to better understand how new remote working environments and related phenomenon (e.g. zoom fatigue [2]) can alter our work behaviors, specifically multitasking. This research is important for organizations using video conferencing as the main way to communicate and collaborate, to understand multitasking behaviors and how it affects work productivity.

Keywords: Multitasking, performance, visual attention, mediation.

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[1] CHANG, Rosetta, COURSARIS, Constantinos K., LÉGER, Pierre-Majorique, et al. The Effect of Multitasking During an E-learning Video Conference on Learning Performance: A Psychophysiological Experiment. In : Learning and Collaboration Technologies. Designing the Learner and Teacher Experience: 9th International Conference, LCT 2022, Held as Part of the 24th HCI International Conference, HCII 2022, Virtual Event, June 26–July 1, 2022, Proceedings, Part I. Cham : Springer International Publishing, 2022. p. 197-208.

1 Introduction

As organizations continue to work remotely during the pandemic, to collaborate and work productively, remote meetings are crucial in the functioning of an organization. Time spent in front of devices, videoconferencing or e-learning increased significantly. Modern technology and remote work enables and amplifies [3]. For example, splitting your screen using keyboard shortcuts or having multiple monitors allows you to view and work on multiple things at the same time. Although multitasking has been well documented and researched, limited research has been done on multitasking in a remote learning setting and on its impact [1]. Most studies on multitasking use diaries or self-reported testimonies [1, 4, 5]. In this study we use physiological data to better understand how new remote learning environments and related phenomena (e.g. zoom fatigue [2]) can alter our work behaviors, specifically multitasking.

This study thus aims to investigate the effects of multitasking on learning performance, and the underlying divided attention in a videoconference or e-learning setting, to better understand the mechanism by which one gets distracted. Specifically, we examine the following research questions (RQ). More specifically:

RQ1: What is the effect of an incremental number of peripheral task-based distractions on learning performance during a video conference session?
RQ2: How does a learner's attention get divided between the primary learning task and secondary peripheral tasks during a video conference session?

The following article goes as follows: Presented in Section two, the literature review and theoretical foundation. Presented in Section three, the methodology used to test the research model looks into the effects of the volume of peripheral tasks in a video conference setting using self-reported measures and eye tracker technology. Section four will discuss the results and analysis conducted. The results suggest that multitasking between three tasks during a video conference does not affect information retention but affects your perception of your retention of information.

2 Literature Review & Theoretical Foundation

2.1 Multitasking

Originally stemming from the computer science field, multitasking is defined as doing multiple tasks at the same time [6]. Multitasking can be categorized into three different ways or strategies of multitasking, sequential, parallel and [3]. Sequential multitasking is defined as completing one task after another without overlap. It is argued that sequential strategy is not multitasking since tasks are performed one after the other. Parallel and interleaved strategies are more representative to how multitasking is defined in the context of this study. The parallel strategy is described as performing all concurrent tasks simultaneously. However, humans have limited cognitive resources to perform true parallel multitasking. When attention is divided, it has been shown that performance can be severely impacted [7, 8]. Interleaved multitasking is described as voluntarily or involuntarily stopping a task to perform another and then resume the initial task [3]. This definition of multitasking is the definition used in the context of this study.

Other researchers have examined the motivations of multitasking. It can be separated into two conditions, self and external interruptions. External interruptions are defined as interruptions from an external source that needs immediate attention [9]. Self-interruption is also described as voluntary interruption often used as a break from the current task or way to entertain oneself since the primary task is monotonous [9]. In the context of a video conference setting, people multitask by interleaving between another task and the videoconference and then only to engage again when the topic of discussion is relevant to them[10].

2.2 Dual Task Interference & Cognitive Load Theory

Prior research has suggested that, due to the limits of human cognition, each task performed during multitasking mobilizes resources involved in information processing and memory [11]. This basic principle defines the capacity-sharing model which aims to describe how similar cognitive processes triggered by different activities affect task performance [12, 13, 14]. More precisely, it has been suggested under this model that tasks carried simultaneously that involve the same area of the brain tend to have similar needs such that the allocation of resources to the cognitive processes involved is shared [14]. Many studies showed how performance suffered when multitasking such as using a laptop within a lecture [15]. The capacity-sharing is one of the two perspectives through which researchers have theorized dual task interference—the interference arising when someone attempts to complete two tasks at the same time [12]. The second perspective, cross-talk, aims to describe the interference of dissimilar cognitive processes [12]. Cross-talk theory suggests that when a person initiates tasks simultaneously, communication between areas of the brain responsible for their processing might conflict, thus affecting performance [12].

Hence we propose the following hypotheses to answer RQ1:

H1a: As the number of peripheral tasks during a video conference session increases, subjective learning performance will decrease.

H1b: As the number of peripheral tasks during a video conference session increases, objective learning performance will decrease.

2.3 Visual Attention

Visual attention is better described as a collection of cognitive mechanisms that control signals to the visual system [16]. Visual attention has four different purpose, data reduction/stimulus selection, stimulus enhancement, feature binding, and recognition [16].

Since the human brain has limited capacity in terms of cognition, visual attention serves as a filter suppressing irrelevant stimuli or to focus on what's relevant. This is called data reduction or stimulus selection [17]. This is similar to the filter theory proposed by Broadbent that our limited capability in processing information, we limit the quantity of information we can pay attention to [18]. Stimulus enhancement on the other hand is described as either focusing on a specific stimulus (e.g. space and object-based attention) or focusing on an attribute of a stimulus (e.g. feature-based attention) [16]. Feature

binding or the binding problem [19] refers to how we decompose signals to process in different areas of our brain and then resolve it through visual attention. Either by generating a representation that is not “hard-wired” in the visual system [20] or dynamically altering the selectivity or spatial extent of the receptive field of a neuron to resolve ambiguities [21]. Lastly, recognition, is the ability to identify the stimulus as well as the ability to process subsets of input for recognition that is more digestible [16].
Moreover, selective attention can also be described as the spotlight metaphor. It represents a mental beam where a specific object or space in the visual field is illuminated and the rest is ignored [22]. Also described as the attentional beam, can also be voluntarily redirected to another object or space, however relevant it might be to the task at hand. We want to investigate when given certain tasks what people choose to focus on.

Hence we propose the following hypotheses to answer RQ2:

H2: The number of peripheral tasks during a video conference session is inversely related to the visual attention fixation on the primary task video.

H3a: Visual attention fixation during the primary task video correlates with subjective learning performance.

H3b: Visual attention fixation during the primary task video correlates with objective learning performance.

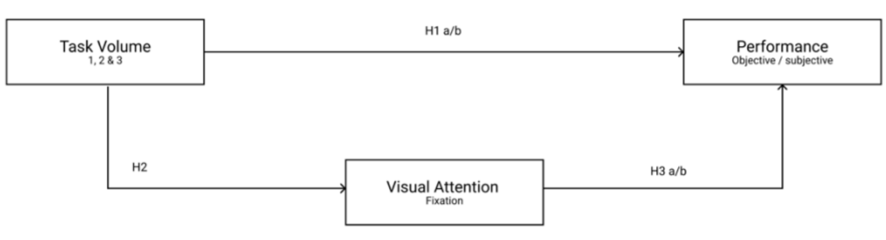

Figure 1 Research model – Article 1

3 Method

3.1 Data Collection

In this research we conducted a within-subject design experiment separated into two phases of data collection. This study was approved by the university's ethics committee (#2021-4230). The first phase was conducted in April 2021, lasted 2 weeks, and data was collected remotely from participants based in Montreal, Canada, using Lookback (a user research online platform that allows the recording of participants' facial expressions, screen and audio). The first phase's focus was to test the experimental design. The second phase of data collection was carried out in person at the authors' university laboratory, with adjustments having been made to the experimental design due to the inclusion of the eye-tracking technology to measure divided attention (a dimension not measured in Phase 1). Phase two was conducted in three waves from the summer and fall of 2021. The experiment typically involved participants multitasking by performing three desktop computer-based tasks. In phase one, participants were asked to multitask in two ways, either by having their single-screen split with dedicated screen area for each stimulus or by using multiple screens by switching between browser tabs, each containing one stimulus. In phase two, participants were only able to multitask in the split-screen condition, because the addition of eye-tracking technology did not allow accurate tracking in the tab switching condition.

3.2 Participants

A total of 54 individuals between the ages of 19 and 45 participated in this study. During the first phase, the participants (n=21) were recruited from our university research panel. The authors' laboratory research panel created and aimed at using a proprietary device named Cobalt Bluebox to enable remote physiological data collection [23]. Participants of the first phase were compensated in the form of gift cards of 25 CAN$ for their participation in a 2 hour long study. During the second phase, participants (n=33) were compensated with 30 CAN$. Eligibility requirements included participants being 18 years old or older with advanced reading and listening skills in French. All participants signed the consent form. At any moment during the experiment, participants were allowed to leave or stop if necessary. Since recruitment was more difficult over the summer, the first half of data collection in phase two was collected alongside another study and the second half was conducted alone. The first half participant would do the other study for a duration of one hour, take a 15 minute break and then participate in this study. The results were combined since there are no statistical differences between them.

3.3 Experiment

Experimental Design. We used a within-subject experimental design to assess how increasing the number of peripheral tasks while in a video conference setting affects their attention and performance in retaining information. The first factor represented their performance, subjective or self-reported and objective or actual performance. The second represented the volume of peripheral tasks (see Table 2). In condition zero (Zero_Ptask), only the primary task , the video, was present and served as the control condition. Condition one (One_Ptask) is where the primary task and one peripheral task, the chat, was present. Condition two (two_Ptask) is where the primary task and two peripheral tasks, the chat and sudoku, were present.

	Conditions		
	Zero_Ptask	One_Ptask	Two_Ptask
Subjective Performance	S_Zero_Ptask	S_One_Ptask	S_Two_Ptask
Objective Performance	O_Zero_Ptask	O_One_Ptask	O_Two_Ptask

Table 2 Experimental Conditions

Experimental Stimuli/Task. The participants interacted with up to three tasks. Each task represented a different stimulus to mimic multitasking: The video stimulus is the primary task and the chat and sudoku (a logic-based, combinatorial number-placement game) stimuli are the peripheral tasks (see Figure 2). In the video task, three different pre-recorded video conference sessions were used in each condition. Each 20-to-24-minute long video presented a different eMarketing topic and consisted of two segments. The first segment was a lecture and the second was a Q&A.

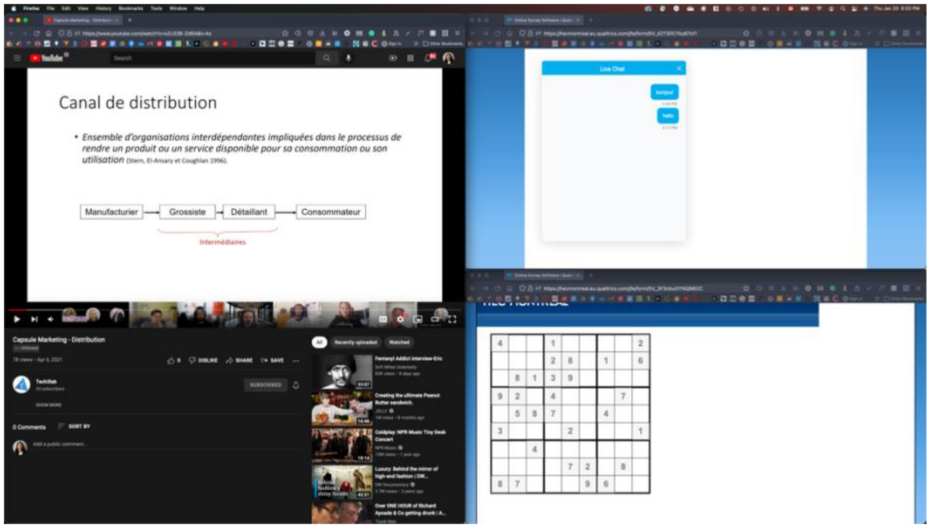

Figure 2 All three stimuli in condition two

In the conditions where the chat task was present, Social Intent's Slack Live Chat browser widget [24] was utilized to facilitate communication. Participants are prompted general questions pertaining to their origins, interests in television shows and restaurants. These questions were pre-tested and grouped into six sets of questions with similar response lengths. Participants would be prompted three times with a different set of questions within condition One_Ptask and Two_Ptask. They would also be prompted at the same time intervals (two minutes, eight minutes and 10 minutes from the start of the video) to ensure a comparable and similar experience.

The sudoku is only presented in condition Two_Ptask and was at a medium level of difficulty. To play the sudoku, requires to "fill in all the boxes in a 9×9 grid, so that each column, row, and 3×3 box have the numbers 1 through 9 without repetitions" [3]. The sudoku represented a task that required more concentration and time to imitate how people would work on other work related tasks during a video conference session.

	Video	Chat	Sudoku
Condition Zero	X		
Condition One	X	X	
Condition Two	X	X	X

Table 3 Experimental Stimuli Present in Each Condition

Experimental Protocol. An email was sent to participants 24 hours in advance to validate their candidacy as well as reminding them to complete the consent form and reiterate time and date of their participation. Once the participant is welcome and comfortably seated in the observation room the research assistant guides the participant in placing the sensors on their chest and wrist to measure physiological data using BIOPAC and Tobii Pro for eye tracker. The research assistant explains that there will be three tasks where they will be asked to multitask and between each task there will be a short questionnaire about their experience. Participants are asked to multitask by having the screen split. (see Figure 2) Before each task the research assistant uses windows shortcuts to configure the screen (e.g. Windows key + left arrow key) in order to have a consistent screen configuration across conditions. The first task is the control task, where the participant only watches the video. The second task, the participants are asked to watch a video while chatting with the research assistant. Lastly, the third task entails watching a video, chatting and completing a sudoku. The order of the video is randomized across participants. Post task questionnaires are answered immediately after each task. The following Figure 3 illustrates the experimental protocol.

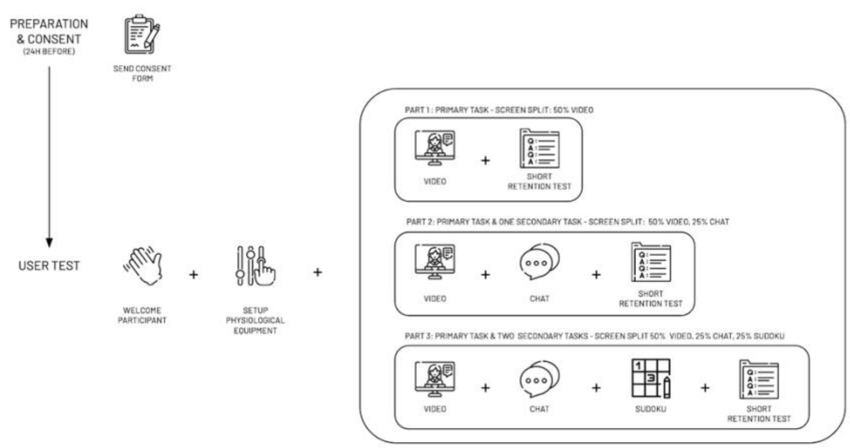

Figure 3 Experimental protocol

Adjustments From Phase One, The Pilot Phase. In phase one of study, data collection was done remotely through Lookback (a user research online platform that allows the recording of participants' facial expressions, screen and audio) and as for the physiological data, it was collected using a proprietary device named Cobalt Bluebox [23]. Adjustments were made from the pilot protocol to account for in person collection, the use of Tobii Pro Lab [25], an eye tracker technology, and the use of BIOPAC [26] to collect physiological data. The pre-experiment questionnaire was also given 24 hours before the experiment in the pilot instead of right before the experiment. The pilot study was also a between subject study where one group multitasked by switching between tabs and the other had their screen split. The tab switching scenario was removed because the eye tracker could not accurately track what they were looking at. Data from the pilot study was not included in the analysis of this study. Lastly, the split screen configuration was made larger for the main study because participants had difficulty with the third task, it was too small and many participants were scrolling and trying to change the configuration to make it more visible.

Measures. Investigating multitasking in a video conference or class setting, performance and attention, a multi-method approach was used to conduct this study. A mixture of self-reported questionnaires (explicit measures) that capture what participants remember from their experience ex post, and physiological measurements (implicit measures) that capture real time experiences before, during and after a task.

Performance. Subjective performance was measured after each task, using a five-point Likert scale adapted [27]. Objective performance was measured as the number of correct answers divided by the total number of questions for each task [3]. Since the scoring for subjective and objective performance was different, to be able to compare both the score of subjective performance was manipulated.

Divided Attention. To capture implicit attention, we used Tobii Pro, global leader in eye tracking research solutions [24], to measure visual attention. In order to do so, areas of interest (AOIs) were created for each task in each condition. From the AOIs we were able to extract the total fixation duration of each task, and the proportion of fixation duration of a task during a condition to interpret visual attention.

Materials. In this study, all questionnaires were administered through qualtrics.com, an online survey platform.

Post task questionnaire. The post-task questionnaire consisted of two parts -the retention test and the self-assessment portion - and was administered after each condition. To build the retention tests with similar difficulty for each conference video, a bank of questions was created for participants to validate and measure the level of difficulty of each question. The questions were separated into either explicit or seen information, or implicit, heard or inferred information. Some questions were excluded if the percentage of participants who answered correctly was less than 70%. A total of ten questions, five explicit and five implicit questions were chosen for each video based on their level of explicitness and accuracy/correctness. Explicitness as mentioned above is defined by the way the information is presented, seen or not seen and correctness is defined by how many participants have correctly answered the question to determine the level of difficulty. The retention test's purpose was to measure how much information the participant had retained from the video. All questions were randomized and participants were also asked to rate their level of confidence with their answers to each question.

The second portion of the post task questionnaire is the self-assessment. Participants rated their own performance on their retention test and their ability to multitask using a Likert scale from strongly disagree to agree.

4 Analysis & Results

4.1 Impact on Performance

The mean scores of subjective and objective performance are shown in .

	Peripheral Task Volume			p-value		
	Zero_Ptask	One_Ptask	Two_Ptask	Zero_Ptask vs. One_Ptask	Zero_Ptask vs. Two_Ptask	One_Ptask vs. Two_Ptask
Subjective Performance	3.6970	3.4545	2.1212	0.2154	0.0000	0.0000
Objective Performance	7.5160	6.9400	7.0910	0.1249	0.2220	0.6600

Table 4 Descriptive Statistics (Subjective and Objective Performance)

Linear regression was used to test whether the volume of peripheral tasks affects subjective learning performance. Results indicate there is a significant negative effect (F(2,32)=32.61, p<0.0001) with an R-square of .3250. Hence, results show hypothesis 1a is supported. Pairwise comparisons between the conditions were subsequently performed to investigate further. As can be seen from the results in Table 4, when participants performed only the primary task versus the primary task along with a peripheral task, there was no significant difference in the level of subjective learning performance (p=.2154). However, a significantly lower level of subjective learning performance was observed when participants performed the primary task along with two peripheral tasks compared to performing either (a) the primary task only (p<0.0001), or (b) the primary task and one peripheral task (p<0.0001).

Similarly, a linear regression was used to test whether the volume of peripheral tasks affects objective learning performance. Results indicate no significance effect F(2,32)=1.35, p=.2724) with an R-square= .0253. Hence, results show hypothesis 1b is not supported.

4.2 The Mediating Effect of Visual Attention

Using linear regression to test whether the number of peripheral tasks during a video conference session is inversely related to the visual attention fixation on the primary task video. Results indicate there is a significant negative effect (F(8,32)=266.43, p<0.0001) with an R-square=.8540. Hence, results show hypothesis 2 is supported. Pairwise comparisons between the conditions and the video stimulus were subsequently performed to investigate further. Shown in Appendix, a significantly lower fixation duration on the primary task was observed across all conditions.

Again, linear regression was used to test the correlation between visual attention fixation during the primary task video with subjective learning performance. We found that the relationship was not significant (Coef = .1752, SE=0.0936, p=.0703). Hence the Hypothesis H3a is not supported. While the number of peripheral tasks does affect visual attention and subjective performance, visual attention does not have a statistically significant effect on subjective learning performance at a confidence level of 95%. Therefore, we cannot conclude that visual attention mediates the relationship between number of peripheral tasks and subjective performance.

The third hypothesis posited that visual attention correlates with objective performance. Using linear regression we observe that there is also no correlation between them (Coef = .0794, SE=0.0939 p=.4040). Hence hypothesis 3b is not supported. We can also conclude that there is no mediation since there is no relation between number of peripheral tasks and objective performance.

The Following Table provides a summary of the hypothesis testing conducted for this study.

Hypothesis	From	To	F value	P value	Status
H1 a	Task Volume	Subjective performance	F(2,32)=32.61	0.000***	Supported
H1 b	Task Volume	Objective performance	F(2,32)=1.35	0.2724	Not Supported
H2	Task Volume	Visual attention	F(8,32)=266.43	0.000***	Supported
H3 a	Visual attention	Subjective performance		0.0703	Not Supported
H3 b	Visual attention	Objective performance		0.4040	Not Supported

Note: * significant at 0.05 level; ** significant at 0.01 level; *** significant at 0.001 level

Table 5 Hypothesis Testing

5 Discussion

5.1 Findings

This study examines the effect of secondary peripheral tasks while in a video conference setting on learning subjective and objective performance, It also looks to identify where individuals' attention is on while multitasking during a videoconference setting.

From analysis of our empirical results, we learned that there is an inverse relationship between the number of peripheral tasks and subjective performance. More precisely, when participants were asked to rate their performance, participants did not significantly rate their performance differently between the condition with zero peripheral tasks and one peripheral task. However, their rating is significantly different when comparing the two other conditions (with the one with 2 peripheral tasks). Since participants had to perform more tasks, they seem less confident in their performance and rate themselves lower. However, we found no significant difference in the actual, objective performance which is surprising and interesting since there is a relationship with subjective performance. The mismatch between subjective and objective performance in relation to the number of peripheral tasks shows that organizations should not be worried when workers multitask during video conferences. However, they should look deeper into how workers perceive their time multitasking during remote video conference settings. What would be the optimal number of tasks performed concurrently without compromising the worker's actual and perception of their performance.

In terms of visual attention, our analysis of the results showed a drastic drop in visual attention towards the primary video task. Our results show that participants were looking at the video 77.37% of the time in the control condition with only the primary task. The addition of peripheral tasks decreased visual attention on the primary task to 58.8% of the time. When two peripheral tasks are present it lowers to 11.53% of the time. Participants were mostly retaining the information auditorily by the time they reached the third condition of the experiment. Lastly from our results, we cannot conclude that spending less visual attention on the primary task affects objective and subjective performance.

While the relationship between visual attention fixation and subjective performance is non-significant, visual attention does have a positive effect on subjective learning performance. We can also conclude that in our experimental context visual attention does not mediate the effect of the number of peripheral tasks on performance, objective and subjective.

5.2 Limitations

There were several limitations from this study. The experiment was conducted at the laboratory which differs from the participants' actual condition when multitasking during a videoconference setting in terms of equipment as well as the number of devices used. However we simulated this environment for this study by pre-recording a simulated video conference. We chose not to include multiple devices when multitasking since the eye tracker, Tobii pro Lab [24] can only be set up on one device. Moreover, the testing environment varied in phase 2, as it was paired with another study during summer data collection, this may result in more or less fatigue than other participants of phase two. However, it can also be argued that it is more representative of actuality where workers can have long back to back meetings.

Conclusion

To conclude we explored the effects of the number of peripheral tasks on subjective and objective performance as well as the mediating effects of visual attention on this relationship. We found that the number of peripheral tasks influences people's subjective performance but not objective performance whether they perform one, two or three tasks. Visual attention is influenced by the number of peripheral tasks but does not influence performance. Lastly, no mediation effect was found between number of peripheral tasks, visual attention and performance.

Appendix A

Ratio TotTaskFixDur/Tottaskdur			Stimuli					
			1	**2**	**3**	**1 vs 2**	**1 vs 3**	**2 vs 3**
			Chat	**Sudoku**	**Video**			
			Means	Means	Means	p-value[1]	p-value[1]	p-value[1]
			n=99	n=99	n=99			
Task	**1**	n=99	0.0100	0.0227	0.7737	0.1637	0.0000	0.0000
	2	n=99	0.1580	0.0588	0.5880	0.0000	0.0000	0.0000
	3	n=99	0.1059	0.5021	0.1153	0.0000	0.0000	0.0000
	1 vs 2	p-value[1]	0.0000	0.2916	0.0000			
	1 vs 3	p-value[1]	0.0000	0.0000	0.0000			
	2 vs 3	p-value[1]	0.0005	0.0000	0.0000			

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Chapter 3: Multitasking in a Virtual Meeting & its Effects on Learning Performance

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Abstract

As virtual learning environments become increasingly prevalent, learners are often expected to multitask while engaging with online content. This thesis investigates the impact of multitasking on learning performance in a virtual setting by collecting self-reported and physiological data. A within-subject study was conducted in a laboratory setting and includes physiological measures such as eye tracking and electrodermal activity (EDA). The results of this study suggest that the quantity of peripheral tasks has an inverse relationship with subjective performance, but objective performance remains unchanged. Multitasking with two peripheral tasks can decrease participants' perception of their performance but not their actual performance. Additionally, multitasking affects participants' perception of their level of arousal, which impacts their perception of their learning performance. The study concludes that visual attention has a positive effect on subjective learning performance but does not mediate the effect of the number of peripheral tasks on learning performance. The research suggests that organizations should not be alarmed by employees multitasking during video conferences, but the perception of their performance may impact important factors not studied in this research such as mental health and stress. Indicating that future studies should explore mental health and stress related to multitasking behaviours. Future studies should also investigate how different types of peripheral tasks and sensory multitasking impact learning performance.

Keywords: Multitasking, performance, visual attention, arousal, pleasure, eye tracker, mediation.

3.1 Introduction

The preceding article was prepared for the HCII conference and utilized a fraction of the available data. Consequently, it provides a limited view of the research findings. The current study seeks to present a more comprehensive analysis of the collected data, building upon the previous work.

3.2 Literature review and hypothesis development

Multitasking is defined in many ways. It originated from the computer science field, which defined it as how computers can perform multiple tasks at the same time (Xu, S., & Wang, Z., 2017). Benbunan-Fich et al. (2011), argue that multitasking "occurs when a user shifts attention to perform several independent but concurrent computer-based tasks." What is important to understand is that multitasking is broken down into two key principles, independence and concurrency. Independence implies that the different tasks are separate from each other while concurrency suggests that the tasks are performed within the same period of time or, in other words, overlapping (Benbunan-Fich et al. 2011). Based on the level of concurrency, multitasking can take different forms or strategies; sequential, parallel and interleaved (Adler, R. F., & Benbunan-Fich, R., 2012). Sequential multitasking is described as completing one task after another. However it is argued that it is not really considered as multitasking (Bluedorn *et al.*, 1992) as concurrency would be zero in this strategy. Parallel multitasking is described as performing tasks concurrently or at the same time. Humans are known to have a limited cognitive resources, thus, it is hard to truly perform two tasks at the same time. Interleaved is when one performs a main task and voluntarily or involuntarily puts aside the original task to perform another task and then comes back to the original task (Adler, R. F., & Benbunan-Fich, R., 2012). Parallel and interleaved multitasking are definitions of multitasking that is used in this paper.

Using these categories, Salvucci and Taatgen (2011) frame these strategies as a continuum based on how much time is spent on the task. On one side, there is parallel multitasking where one can switch between tasks in very short amount of time usually in seconds. On the other side, there is sequential multitasking where one can switch between tasks in a longer time frame, usually in minutes or hours.

Some researchers have separated multitasking motivations into two categories; self and external interruptions. External interruptions as the name suggest are interruptions emerging from an external source that need immediate attention (Jett, Q. R., & George, J. M., 2003). Self-interruptions on the other hand are intrinsic and voluntary interruptions that take the form of breaks, like going on social media to relieve ourselves from a boring task (Jett, Q. R., & George, J. M., 2003). The context researched is when one multitasks during a video conference setting and interleave between another task to then come back and engage again when the topic of discussion is relevant to them (Iqbal, S. T., Grudin, J., & Horvitz, E. 2011).

3.2.1 Dual-Task Interference & Cognitive Load Theory

When multitasking, researchers have suggested that each task mobilizes resources within the available information processing and memory frames. (Jeong, S. H., & Hwang, Y. 2016). In its simplest form, the capacity-sharing model seeks to explain how, due to the limitations of human cognition, activities that trigger similar mental processes affect performance over time(Pashler, H., 1994, Tombu, M., & Jolicœur, P., 2003, Jenkins *et al*, 2016). Under this model of cognition, studies suggest that tasks carried out simultaneously, involving the same part of the brain are likely to have similar needs. This is because resources for the cognitive processes involved are shared (Jenkins *et al*, 2016). Studies have shown that taking on multiple tasks at once, such as using a laptop during a lecture, degrades performance (Sana, F., Weston, T., & Cepeda, N. J., 2013). Dual-task interference occurs when a person attempts to perform two tasks simultaneously. One perspective researchers have theorized dual task interference is by examining capacity-sharing (Pashler, H., 1994). Another perspective is cross-talk, cognitive processes that are dissimilar may interfere with each other (Pashler, H., 1994). According to the cross-talk theory, performing tasks simultaneously is likely to impair performance because communication between the brain areas involved in the processing might conflict (Pashler, H., 1994).

Hence we propose the following hypotheses to answer RQ1:

H1a: As the number of peripheral tasks during a video conference session increase, subjective learning performance will decrease.

H1b: As the number of peripheral tasks during a video conference session increase, objective learning performance will decrease.

3.2.2 Visual Attention

A way to define visual attention is by the group of cognitive processes that regulate signals to the visual system (Evans *et al*., 2011). Data reduction/stimulus selection, stimulus augmentation, feature binding, and recognition are the four different purposes of visual attention(Evans *et al*., 2011).

Given the cognitive limitations of the human brain, visual attention acts as a filter to either focus on important information or to block out extraneous inputs. Data reduction or stimulus selection is the term used for this (Posner, Snyder, & Davidson, 1980). This is analogous to the filter hypothesis suggested by Broadbent (2013) stating that given our limited capabilities in processing information, we restrict the quantity of information we can pay attention to. Contrarily, stimulus enhancement is defined as either focusing on a particular stimulus (for example, spatial and object-based attention) or focusing on a characteristic of a stimulus (for example, feature-based attention) (Evans *et al*., 2011). Feature binding, also known as the binding problem (Treisman, A. M., & Gelade, G., 1980), is the process by which signals are divided up for processing in various parts of the brain before being solved by visual attention. To resolve ambiguities, the visual system can either generate a representation that is not "hard-wired" (Wolfe, J. M., Cave, K. R., & Franzel, S. L., 1989) or dynamically change the selectivity or geographic range of a neuron's receptive field (Desimone, R., & Duncan, J., 1995). Finally, recognition is the capacity to both recognise the stimuli and to process subsets of data for recognition that is easier to understand (Evans *et al*., 2011).

Additionally, the spotlight metaphor may be used to describe selective attention. It symbolises a mental beam that illuminates a certain area or item in the visual field while ignoring everything else (Murphy, S. (Ed.)., 2012). Even if it is pertinent to the job at hand, the attentional beam can be consciously diverted to another item or location. When given specific tasks, we want to look at what people decide to concentrate on.

Hence, we posit the following hypotheses to answer RQ2:

H2: The number of peripheral tasks during a video conference session is inversely related to the visual attention fixation on the primary task video.

H3a: Visual attention fixation during the primary task video correlates with subjective learning performance.

H3b: Visual attention fixation during the primary task video correlates with objective learning performance.

3.2.4 Affect Arousal

In this study, the relationship between arousal and multitasking is explored (Niven, K., & Miles, E., 2012). When we speak of arousal it is typically described as an activated state, physiological or psychological. Heart rate and blood pressure increase when in an activated state of arousal. One can feel awake and susceptible to external stimuli for example (Niven, K., & Miles, E., 2012). It can also be expressed as a dimension of emotion in a Russell's circumplex of emotion along with valence (Posner, J., Russell, J. A., & Peterson, B. S., 2005). It has been found that arousal can regulate task performance. Its behaviour with performance is like inverted U-shaped, very low or very high of arousal can hinder performance and each individual has their own peak arousal state to perform well (Niven, K., & Miles, E., 2012). Researchers argue that arousal can be expressed as positive and negative (Posner, J., Russell, J. A., & Peterson, B. S., 2005). The dimension of arousal cannot only be viewed unilaterally, one can feel positive, negative or both types of arousal at the same time. Hence, arousal is strongly associated and often combined with valence. That is why we aimed to observe both arousal and valence in this study.

Some research has investigated the relationship between arousal and multitasking by measuring arousal through self-reported data such as the Self-Assessment Manikin Scale (SAM Scale, Bradley et Lang, 1994) and the Affective Sliders (Betella & Verschure, 2016). Others have investigated changes in arousal using skin conductance levels with computer multitasking environment. Notably, Wise & Reeves, 2007,Lang al., 2005, and Wise *et al.*, 2008 when watching television. However, little researched specifically looked at multitasking while in a video conference, lecture or meeting setting.

Comparing physiological data to its self-reported counterparts has been studied. Alpers & Sell (2008) and Ordoñana *et al* (2009) both found that there was a weak concordance between their self-reported and physiological measures.

Hence, we propose the following hypotheses to answer RQ3, RQ 4, RQ5:

H4a: The number of peripheral tasks during a video conference session is inversely related to the subjective arousal.

H4b: The number of peripheral tasks during a video conference session is inversely related to objective arousal.

H5a: Subjective arousal correlates with subjective learning performance.

H5b: Subjective arousal correlates with objective learning performance.

H5c: Objective arousal correlates with subjective learning performance.

H5d: Objective arousal correlates with objective learning performance.

3.2.5 Pleasure / Valence

Another dimension of emotion is through pleasure, earlier described as valence or spectrum of positive to negative emotions. Ekman & Friesen (2003) explains that humans have six main emotions (i.e. joy, sadness, surprise, fear, anger and disgust). Each emotion is deemed positive or negative. The construct created from these is valence which is the difference between the negative and positive emotions. It is also commonly used together with arousal in the Circumplex Model (Posner, J., Russell, J. A., & Peterson, B. S., 2005) where pleasure is on the x-axis from unpleasant to pleasant and arousal in the y-axis from deactivation to activation. Many studies examined the relationship between valence and multitasking. Demanet (2011) ,asked participants to categorized symbols (# and %) and the color of the symbol. Participants had to respond using one hand for the symbol and one hand for the color on a keyboard. This study showed that valence can positively affect the global performance. Other studies (Lu, Y., Jaquess, K. J., Hatfield, B. D., Zhou, C., & Li, H., 2017) also measured valence and performance but little has looked specifically at multitasking with a single device during a video conference setting and learning performance.

Hence, we propose the following hypotheses to answer RQ3, RQ4, RQ5:

H6a: The number of peripheral tasks during a video conference session is inversely related to the subjective pleasure.

H6b: The number of peripheral tasks during a video conference session is inversely related to objective pleasure.

H7a: Subjective pleasure correlates with subjective learning performance.

H7b: Subjective pleasure correlates with objective learning performance.

H7c: Objective pleasure correlates with subjective learning performance.

H7d: Objective pleasure correlates with objective learning performance.

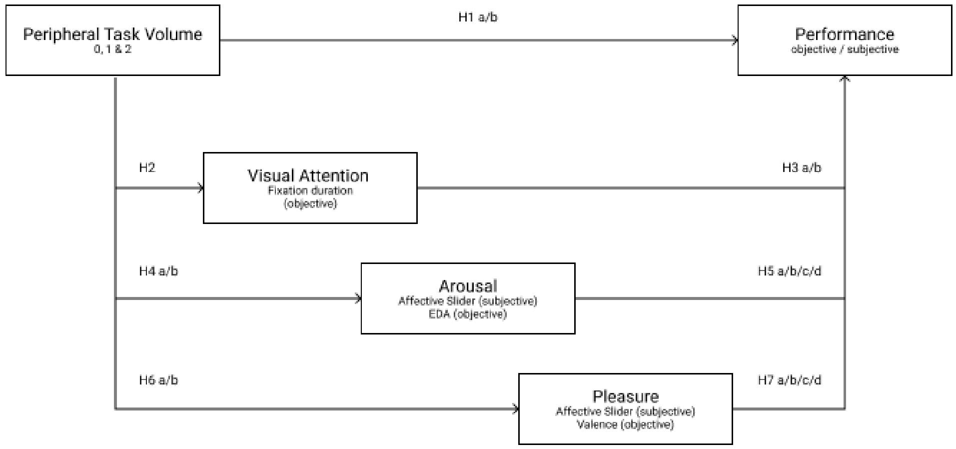

Figure 4 Research Model - Article 2

3.3 Methodology

3.3.1 Data Collection

This study was approved by the ethics committee of the university of HEC Montreal (#2021-4230) and collected two phases in Montreal, Canada. The first phase's goal was to test the experimental design and the type of measures. This phase, also referenced as the pilot phase followed a between subject design and was conducted remotely using Lookback (a user research online platform that allows the recording of participants' facial expressions, screen and audio) due to the pandemic in April 2021 and lasted 2 weeks. In the pilot phase, there were one group that multitasked between tabs and another group in a split screen manner. Modifications were made within Qualtrics, a questionnaire tool, to simulate split screen using HTML and CSS programming. However, in the second phase, participants were only exposed to split screen multitasking since eye tracking technology did not allow accurate tracking in the tab switching condition. The second phase of data collection was carried out in a laboratory setting and adjustments to the experimental design were made to include physiological measures such as eye tracking technology to measure divided attention (a dimension not measured in Phase 1), BIOPAC measuring

Electrodermal conductance or EDA (included in pilot phase but using proprietary technology, Bluebox (Courtemanche, Sénécal, Fredette, & Léger, 2022) that collected EDA). Additionally, with the inclusion of eye tracking technology, we changed the study design from a between to within subject design. For the second phase, data collection occurred in two waves between summer and fall 2021. Each participant was assigned to one of three conditions performing one or multiple computer-based tasks

3.3.2 Participants

54 people we recruited between the ages of 19 and 45. Participants (n=21) for the remote pilot phase were recruited from the university research panel. To collect physiological data remotely, a proprietary device named Cobalt Bluebox developed at Tech3lab was used (Courtemanche, Sénécal, Fredette, Léger, 2022). The pilot phase participants were compensated in the form of a gift cards worth 25 CAN$ for their participation of the 2-hour long study. For the second phase, participants (n=33) were compensated 30 CAN$ in the form of a transfer payment. Recruitment for the second phase was also done from the university research panel. The first wave of the second phase was collected alongside another study that lasted one hour. It was conducted before the other study with a 15-minute break between each study. The second wave of the second phase was collected without another study. The results from both waves were combined since no statistical difference were found between them. Unfortunately, for phase two, parity of sex could not be achieved with 10 males and 23 female participants. All participants were fluent in French and above 18 years old. Participants signed a consent form before the start of the experiment, they were informed that they could choose not to answer a question or stop the experiment at any given time during the study if they felt uncomfortable to answer a question or continue the experiment.

3.3.3 Experiment

3.3.3.1 Experimental Design

To assess how increasing the number of peripheral tasks while attending a video conference affects performance in information retention, attention and emotion, a within subject experimental design was used. The study consisted of three conditions (zero, one

& two) which describe zero, one or two peripheral tasks respectively. All participants went through conditions zero, one and two sequentially (Table 2). Performance, visual attention, arousal and valence (pleasure) were measured in each condition.

	Primary task	Peripheral tasks	
	Video	Chat	Sudoku
Condition Zero	X		
Condition One	X	X	
Condition Two	X	X	X

Table 6 Experimental Stimuli Present in Each Condition – Article 2

3.3.3.2 Experimental Tasks

In this study, participants interacted with three tasks, one primary and two peripheral tasks to mimic multitasking. Table 6 illustrates how the tasks were distributed in each condition. The primary task was watching the pre-recorded video simulating a video conference setting. The participants were exposed to three different pre-recorded videos (20-24 minutes long) about eMarketing which were randomized and counterbalanced across the three conditions. Each pre-recorded video consisted of two segments, the first segment was a lecture and the second segment was a Q&A. The peripheral tasks included the chat and sudoku. The chat task was administered through a product called Social Intent's Slack Live Chat browser widget (Live Chat [Slack Chat widget], 2014) that was embed within Qualtrics to facilitate communication. During the viewing of the pre-recorded video, the research assistant prompted the participants with three sets of questions at a three specific times (at two minutes, eight minutes and 10 minutes from the start of the video) to ensure the experience was replicated throughout the study. In addition to asking the questions at the same specific time, the questions used were predefined and pre-tested to have similar response length and time. The chat task was present in condition one and two. A sudoku (a logic-based, combinatorial number-placement game) with a medium difficulty level was used for all participants in condition two. Each task was placed at the same location across condition. A sudoku was used to replicate a task that requires more concentration and thinking. To ensure uniformity across the conditions and study, each task were placed in the same window.(see Figure 5).

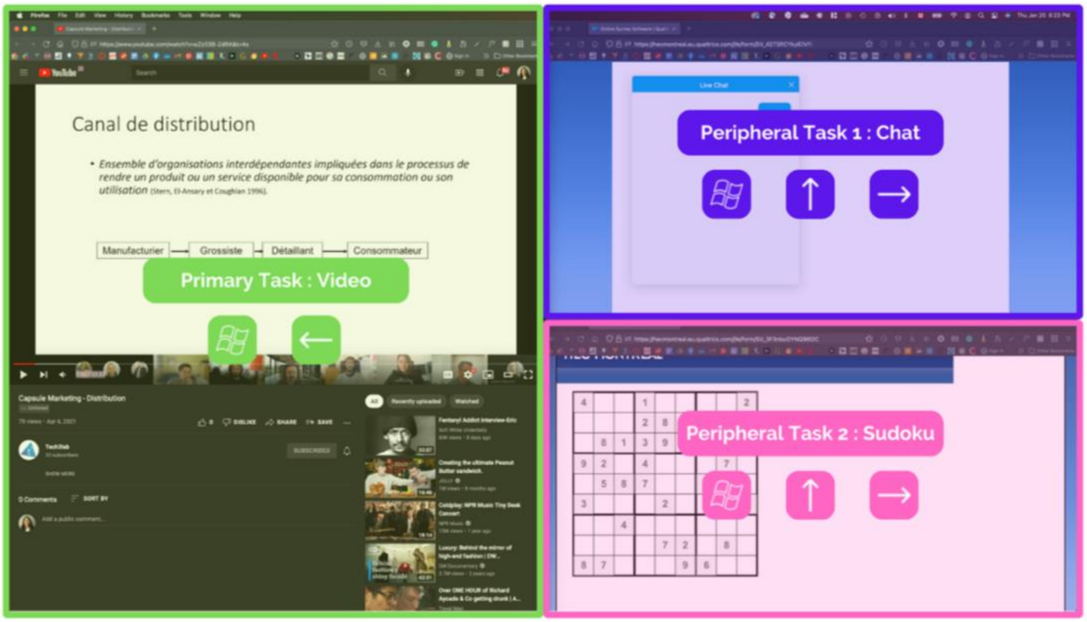

Figure 5 All three stimuli in condition two

3.3.3.3 Experimental Protocol

24 hours before the participants arrived, an email was sent to participants to remind them of the date, time and location of the study, as well as remind them to read and sign the consent form. Once the participant was welcomed and seated in the observation room, the research assistant (RA) guided the participants in placing the sensors on the chest, rib and wrist to measure physiological data using BIOPAC and Tobii Pro for eye tracker. Next, the RA explained briefly that they would be asked to perform multiple tasks on the computer and answer a short questionnaire about their experience after each condition. Before the start of each condition, the RA used keyboard shortcuts to configure the screen. The condition zero was the control condition, where participants are only watching the pre-recorded video. Condition one asked the participant to watch a pre-recorded video while chatting. Lastly, condition two asked the participant to watch a pre-recorded video while chatting and completing a sudoku. After each condition, participants had to answer a post condition questionnaire. The following figure illustrates the experimental protocol.

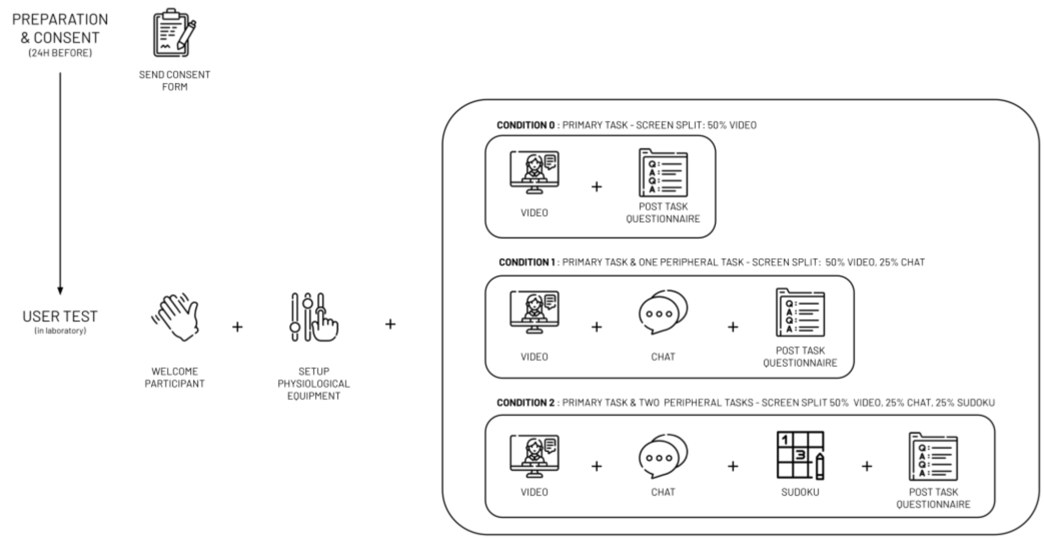

Figure 6 Experimental protocol

3.3.4 Measures

To investigate the effects of multitasking in a video conference on performance, attention, arousal and valence (pleasure), a multi-method approach was used for this study. A mixture of explicit (self-reported questionnaire) and implicit (lived: physiological data and eye tracker) measures were used (Riedl, Léger, 2016).

3.3.4.1 Performance

Subjective and objective performance was measured in this study. To capture information retention performance (objective), ten questions in each post condition questionnaire asked about the content of the video. Their correct answers were tallied for a score out of ten. Therefore, for objective performance was measured using the number of correct answers divided by the total number of retention questions. After participants had answered the retention questions, using a five-point Likert scale, participants were asked how they thought they performed (subjective). Since the subjective and objective performance captured differently, to be able to compare them, subjective performance was manipulated.

3.3.4.2 Divided Attention

To capture implicit attention, we used Tobii Pro, global leader in eye tracking research solutions (Tobii Pro [Software and Hardware], 2001), to measure visual attention. To do so, areas of interest (AOIs) were created for each task in each condition. From the AOIs we were able to extract the total fixation duration of each task, and the proportion of fixation duration of a task during a condition to interpret visual attention.

3.3.4.3 Arousal & Pleasure

Both explicit/subjective and implicit/objective arousal and pleasure were measured. An affective slider was used to capture subjective/perceived arousal and pleasure. In each affective sliders an emoticon was used at each extremities to illustrate calm versus excited and happy versus sad. As for objective arousal, skin conductance or electrodermal activity was used and captured using BIOPAC. To capture objective pleasure, we measured the valence from an automatic facial analysis software called FaceReader© version 6.0, Noldus.

3.3.5 Materials

In this study, a total of three post condition questionnaires were administered through qualtrics.com, an online survey platform.

3.3.5.1 Post Condition Questionnaire

After each condition, the post-condition questionnaire was administered. The post condition questionnaire had two segments. The first segment consisted of the ten retention questions also referred as the retention test and was followed by self-assessment questions. Each retention test segment was linked to one of the pre-recorded video, therefore the order in which the participant view and answers the retention test was randomized. Within the retention test itself, the questions were randomized as well.

To construct the retention test with similar and consistent difficulty, a bank of questions was created and tested for the level of difficulty. The level of difficulty was defined by explicitness and correctness. Explicitness of the question was measured by the way the information was given. If the information was shown visually, the question was explicit and if the information was heard or inferred than the question was implicit. The correctness of the questions was measured by the percentage of people who answered the questions correctly. Questions with less than 70% correctness were excluded. A total of ten questions were chosen for each video, five explicit and five implicit.

The second segment of the post condition questionnaire is the self-assessment. Participants were asked to rate their performance on the retention test, their level of arousal and pleasure through affective scales.

Lastly, after the last condition, additional post test questions were added to ask about their overall impression of the experiment, what their favorite and least favorite moment was and why. It was also used to ask participants to explain which task was their favorite, their multitasking habits and typical devices used.

3.4 Analysis & Results

In this study, for the statistical testing of all hypotheses, linear regressions were used.

3.4.1 The Number of Peripheral tasks' Impact on Performance

	Peripheral Task Volume			p-value		
	Zero_Ptask	One_Ptask	Two_Ptask	Zero_Ptask vs. One_Ptask	Zero_Ptask vs. Two_Ptask	One_Ptask vs. Two_Ptask
Subjective Performance	3.6970	3.4545	2.1212	0.2154	0.0000	0.0000
Objective Performance	7.5160	6.9400	7.0910	0.1249	0.2220	0.6600

Table 7 Descriptive Statistics (Subjective and Objective Performance) – Article 2

We tested if the volume of peripheral tasks affects subjective learning performance. The results show that there is a significant negative effect ($F(2,32)=32.61$, $p<0.0001$) with an R-square of 0.3250. Hence, results show hypothesis H1a is supported. To further investigate, pairwise comparisons between the conditions were performed. Shown on table 7, there is no significant difference on subjective learning performance between performing zero or one peripheral task (p=.2154). On the other hand, there is a significant lower subjective performance between multitasking with (a) zero and two peripheral tasks (p<0.0001) and between (b)one and two peripheral tasks (p<0.0001).

When testing for significance impact on objective performance by the volume of peripheral tasks, results indicate the volume of peripheral tasks does not significantly effect objective learning performance (F(2,32)=1.35, p=.2724) with an R-square= .0253. Hence, results show hypothesis H1b is not supported.

3.4.2 The Mediating Effect of Visual Attention

This study questioned whether the number of peripheral tasks during a video conference session is inversely related to the visual attention fixation on the primary task. The results show that there is a significant negative effect, (F(8,32)=266.43, p<0.0001) with an R-square=.8540, on visual attention of the primary task. Hence, results show hypothesis H2 is supported. Additionally, pairwise comparisons between the conditions were examined further. Significantly lower fixation duration on the primary task was observed as the participants went through each condition. The detailed results can be found in appendix.

This study investigated if there is a correlation between visual attention fixation during the primary task with subjective learning performance. The relationship was not significant (Coef. = 0.1752, SE=0.0936) with p-value of 0.0703. Hence the hypothesis H3a is not supported. Since the number of peripheral tasks does not affect visual attention fixation and subjective learning performance at a 95% confidence level, we cannot conclude that visual attention mediates the relationship between number of peripheral tasks and subjective learning performance.

Similarly, we also investigated if there is a correlation between visual attention fixation during the primary task with objective learning performance. There was also no significant relationship between the two (Coef. = 0.0794, SE=0.0939 p=.4040). As a result hypothesis 3b is not supported. As there is no significant relationship between the number of peripheral tasks and objective performance, it can be concluded that there is no mediating effect.

3.4.3 Impact of the Number of Peripheral Tasks on Arousal

	Peripheral Task Volume			p-value		
	Zero_Ptask	One_Ptask	Two_Ptask	Zero_Ptask vs. One_Ptask	Zero_Ptask vs. Two_Ptask	One_Ptask vs. Two_Ptask
Subjective Arousal	29.7879	58.1515	68.5455	0.0000	0.0000	0.0010
Objective Arousal	5.2641	6.4993	6.0337	0.6350	0.5046	0.1980

Table 8 Descriptive Statistics (Subjective and Objective Arousal) – Article 2

This study explored if the volume of peripheral tasks and subjective arousal have a positive relationship. The results indicate that there is positive effect ($F(2,32)=33.11$, $p<0.0001$) with an R-square of 0.4214. Hence, results show that hypothesis H4a is supported. Pairwise comparisons of the volume of peripheral tasks and subjective arousal between the conditions were subsequently performed to investigate further, illustrated in Table 8. When comparing participants who are only performing the primary task (zero peripheral tasks) to participants who are multitasking (performing one or two peripheral tasks), there is a significant statistical difference ($p<0.0000$). Moreover, there is also statistical difference between participants performing one and two peripherals tasks while watching a video ($P=0.001$) although slightly weaker than compared to no peripheral tasks.

We also explored if the volume of peripheral tasks positively affected objective arousal. The results indicate there is no positive effect ($F(2,26)=0.87$, $p=0.4293$) with an R-square of 0.0042. Hypothesis H4b is therefore not supported. Pairwise comparisons were performed to explore if there are differences between the conditions. The results of the pairwise comparisons also indicate no significant relationship.

3.4.4 Impact of Arousal on performance

Investigating the impact of subjective arousal on subjective performance. The results indicate that there is a significant negative relationship (Coef. = -0.0110, SE=0.005) with p-value of 0.0367. With this results, hypothesis H5a is supported. Following these results, we examined if there were any mediating effects on the main relationship between the number of peripheral tasks and subjective performance. Results indicate there were no mediating effects. Interestingly, when investigating the impact of subjective arousal on objective learning performance this time, the results show an insignificant relationship (Coef. = 0.0018, SE=0.0058) with a p-value of 0.7638. Therefore, hypothesis H5b is not supported.

On the other side of the coin, we wanted to see if the same results are the same with the objective measure of arousal. The relationship between objective arousal and subjective performance was not significant (Coef. = 0.1781, SE=0.1712) with a p-value of 0.3147. Hence, hypothesis H5c is not supported. The relationship between objective arousal and objective performance was found not significant Coef. = -0.4959, SE=0.3239) with a p-value of 0.1466. We can conclude that hypothesis H5d is not supported.

3.4.5 Impact of the Number of Peripheral Tasks on Pleasure

	Peripheral Task Volume			p-value		
	Zero_Ptask	One_Ptask	Two_Ptask	Zero_Ptask vs. One_Ptask	Zero_Ptask vs. Two_Ptask	One_Ptask vs. Two_Ptask
Subjective Pleasure (valence)	57.0000	65.7273	63.5455	0.0920	0.0019	0.4840
Objective Pleasure (valence)	-0.1629	-0.1720	-0.1653	0.8690	0.4237	0.6750

Table 9 Descriptive Statistics (Subjective and Objective Pleasure) – Article 2

Observing the effects of the volume of peripheral tasks on subjective pleasure (valence), the results indicates that there is positive effect ($F(2,32)=5.79$, $p< 0.05$, $p=0.0071$) with a R-square of 0.0581. Therefore, results show that hypothesis H6a is supported. Pairwise comparisons were made between the conditions, again illustrated above in Table 9. Based on the results, there is no significant difference in pleasure between performing zero and one peripheral task as well as between one and two peripheral tasks while watching a video. However, there is a significant positive difference in pleasure between performing zero and two peripheral tasks. On the other hand, we wanted to investigate if there is an inverse relationship between the volume of peripheral task and objective pleasure. The results are inconclusive, there are no significant relationship (F(2,24)=0.04, p=0.9641) with a R-square of 0.0001. We can conclude that hypothesis H6b is not supported.

3.4.6 Impact of Pleasure on performance

In this section we were interested in whether pleasure impacted performance. To begin, we will discussing the impact of subjective pleasure on subjective and objective performance. Then, we will discuss the impact of objective pleasure on subjective and objective performance.

When looking at the impact of subjective pleasure on subjective learning performance, the relationship is not significant (Coef. = -0.0067, SE=0.0102) with a p-value of 0.5170. Hence, hypothesis H7a is not supported. Similarly, the impact of subjective pleasure on objective learning performance is also not significant (Coef. =0.0152, SE=0.0110) with a p-value of 0.1761. Therefore, hypothesis H7b is not supported.

Looking at objective pleasure's impact on subjective performance, the relationship is also not significant (Coef. =0.6536, SE=0.4923) with a p-value of 0.2042. Hypothesis H7c is not supported. Lastly, results show that there is no significant relationship between objective pleasure and objective learning performance (Coef. =1.0627, SE=1.4134) with a p-value of 0.4638. Therefore, hypothesis H7d is not supported.

Hypothesis	From	To	F value	P value	Status
H1 a	Task Volume	Subjective performance	F(2,32)=32.61	0.0000***	Supported
H1 b	Task Volume	Objective performance	F(2,32)=1.35	0.2724	Not Supported
H2	Task Volume	Visual attention	F(8,32)=266.43	0.0000***	Supported
H3 a	Visual attention	Subjective performance		0.0703	Not Supported
H3 b	Visual attention	Objective performance		0.4040	Not Supported
H4 a	Task Volume	Subjective Arousal	F(2,32)=33.11	0.0000***	Supported
H4 b	Task Volume	Objective Arousal	F(2,26)=0.87	0.4293	Not Supported
H5 a	Subjective Arousal	Subjective performance		0.0367*	Supported
H5 b	Subjective Arousal	Objective performance		0.7638	Not Supported
H5 c	Objective Arousal	Subjective performance		0.3147	Not Supported
H5 d	Objective Arousal	Objective performance		0.1466	Not Supported
H6 a	Task Volume	Subjective pleasure	F(2,32)=5.79	0.0071**	Supported
H6 b	Task Volume	Objective pleasure	F(2,24)=0.04	0.9641	Not Supported
H7 a	Subjective pleasure	Subjective performance		0.5170	Not Supported
H7 b	Subjective pleasure	Objective performance		0.1761	Not Supported
H7 c	Objective pleasure	Subjective performance		0.2042	Not Supported
H7 d	Objective pleasure	Objective performance		0.4638	Not Supported

Note: * significant at 0.05 level; ** significant at 0.01 level; *** significant at 0.001 level

Table 10 Hypothesis Testing – Article 2

3.5 Discussions

3.5.1 Main Findings

To summarize, this study examined the effect that secondary peripheral tasks played within a video conference setting on both subjective and objective performance parameters. Additionally, it examined how participants' attention is divided while multitasking in a videoconference setting, and where their attention is directed.

Based on our empirical findings, we discovered that the quantity of peripheral tasks has an inverse relationship with subjective performance. To be exact, participants did not substantially rate their performance differently between the condition with zero peripheral tasks and the condition with one peripheral task. Participants did not find that their performance was affected when multitasking with one addition peripheral task. However, when multitasking with two peripheral tasks, participants were more likely to rate their performance lower than when they performed zero or one peripheral task. Interestingly, the impact of multitasking did not impact objective performance or actual learning performance. Multitasking with two peripheral tasks significantly decreases their perception of their performance but in reality their performance remains similar whether they are multitasking or not.

Similarly, we also observed that multitasking affects how people perceive their level of arousal, which affects their perception of their learning performance. This mean that the perception of how they performed and how they felt is as important or more important than their actual performance or physiological reaction. This opens the door for future studies on the psychological impact of multitasking.

Organizations should not be alarmed of employees multitasking when in a video conference setting since the retention of the information remains the same. However, their perception of their own performance might impact their mental health in the long run. It would be interesting for future research to investigate how different types of peripheral tasks might affect learning performance as well as testing different types of performance measures. It would also be interesting to investigate how familiarity of multitasking environments impacts performance.

Based on this study, we can conclude that as the number of tasks being managed increases, the level of visual attention directed towards the videoconference decreases. Instead, the individual tend to prioritize their visual attention towards peripheral tasks while still being able to process the audio content of the videoconference simultaneously. It would be interesting to do more studies on cross sensory multitasking and investigate how it impacts people.

According to our findings, under the control condition where the primary task was the only thing participants were doing, they watched the conference 77.37% of the time. When participants were exposed to one peripheral task were present, only 58.8% of the time was spent paying visual focus to the primary activity. When participants were exposed to two peripheral tasks, the percentage drops to 11.53%. Since this study was designed to incrementally increase the number of peripheral tasks, by the time they reached the third condition where they multitasked with two peripheral tasks, we can assume that participants were mostly remembering the information auditorily.

When observing the results, we cannot say that spending less visual attention on the primary task affects objective and subjective performance. Although the relationship between visual attention and subjective learning performance is inconclusive, visual attention does have a positive effect on subjective learning performance. Visual attention in our experimental context does not mediate the effect of the number of peripheral tasks on subjective and objective learning performance.

Lastly, in this study we aimed to observe if self-reported measures concorded with their physiological counterpart. When discussing about performance in our experimental context, the difference was significant. Participants were not able to accurately report their performance. As for the arousal and pleasure, there were no concordance between subjective and objective measure.

3.6 Conclusion

To conclude, this research explored how the number of peripheral tasks impact performance of learning. The results show that multitaskers' actual learning potential is not impacted by multitasking although they believe so.

Chapter 4 : Conclusion

4.1 Questions & Objectives

This thesis is focused on understanding the impact of hybrid working models on productivity and performance, particularly in relation to multitasking in a virtual meeting setting. The thesis aims to measure physiological and self-reported data to understand how multitasking affects learning performance and the potential mediating effects of visual attention, arousal and valence (pleasure) on learning performance. Additionally, the thesis aims to discover where learner attention lies during a virtual meeting and to determine whether there are any discrepancies between physiological and self-reported data. We used physiological and self-reported data to measure learning performance, arousal and pleasure.

4.2 Summary of the Results

To summarize, this thesis aimed to investigate the effect of secondary peripheral tasks on learning performance in a video conference setting, as well as the impact of multitasking on participants' attention and perception of their performance. The empirical findings revealed that the number of peripheral tasks had an inverse relationship with subjective performance, with participants rating their performance lower when multitasking with two peripheral tasks. However, objective performance and actual learning performance were not impacted by multitasking. Additionally, multitasking affected participants' perception of their level of arousal, indicating that the perception of performance is as important as actual performance.

Based on the results, organizations should not be concerned about employees multitasking during video conferences since retention of information remains the same. However, the perception of performance in the long run may impact mental health. Future studies can explore the psychological impact of multitasking, investigate the impact of different types of peripheral tasks on learning performance, and examine how familiarity with multitasking environments impacts performance.

The study also found that the more tasks participants juggled, the less visual attention was directed towards the video conference. However, it was inconclusive if spending less visual attention on the primary task affects objective and subjective performance. Visual attention had a positive effect on subjective learning performance, but did not mediate the effect of the number of peripheral tasks on learning performance.

Lastly, the study aimed to observe if self-reported measures concorded with their physiological counterpart. The results revealed a significant difference in participants' ability to accurately report their performance. Additionally, there was no concordance between subjective and objective measures of arousal and pleasure.

Overall, this study sheds light on the impact of multitasking on learning performance and the importance of perception in performance evaluation. Further research can continue to explore these topics and provide insight for organizations to improve their video conference practices.

4.3 Contributions

From a theoretical perspective, the primary objective of this thesis is to make a meaningful contribution towards enhancing the comprehension of multitasking behaviors in remote work environments, particularly during virtual calls, by investigating their self-reported and physiological effects. The findings from this study suggest that there is a substantial discrepancy between individuals' perceptions of their performance and their actual performance, which may be attributed to shared cognitive resources when multitasking. It is worth noting, however, that the difference in performance between multitasking and non-multitasking scenarios was not particularly pronounced. Familiarity of certain combination of tasks while multitasking did not hinder as much as other tasks that require more cognitive resources. This finding has significant implications for remote work environments, as it suggests that individuals may not be fully aware of the extent to which multitasking can impact their performance. Therefore, this study highlights the importance of adopting measures to mitigate the adverse impact of multitasking in virtual work settings.

From a methodological standpoint, the present study collected physiological data through the use of eye-tracking technology to observe two types of multitasking: split screen multitasking and tab switching multitasking. Split screen multitasking involves dividing the screen into two or more sections to perform different tasks, while tab switching multitasking involves having a single window open and switching between tabs to perform various tasks. The study encountered methodological challenges in accurately measuring visual attention during tab switching multitasking. The Tobii Pro eye-tracking technology was unable to map fixation points every time a participant switched tabs, as it only recognized a screen change when a new page was loaded. To address this issue, the study was designed to only use stimuli that did not require scrolling in both split screen and tab switching multitasking. Conversely, the study was able to observe split screen multitasking by recording the entire screen and utilizing keyboard shortcuts, such as the windows key + arrow right, to capture fixation points. Therefore we were able to accurately represent and study eye tracking data for split screen multitasking while in a virtual meeting.

Another challenge encountered by the study during both multitasking styles was differentiating fixation points during scrolling. This difficulty highlights the limitations of current eye-tracking technology in capturing dynamic screens or scenes, emphasizing the need for further technological advancements in this area.

In conclusion, this study underscores the methodological challenges associated with collecting physiological data using eye-tracking technology to observe split screen multitasking and tab switching multitasking. The findings suggest that split screen multitasking is more compatible with eye-tracking technology, while tab switching multitasking requires further methodological refinement. Moreover, the study highlights the limitations of current eye-tracking technology in capturing dynamic screens or scenes, signaling the need for continued technological advancements in this area.

4.4 Limits

The results of this study on the effects of multitasking in a videoconferencing setting could be due to some limiting factors. The study conducted the experiment in a laboratory setting which differs from the participant's normal setting. Normally, participants would be in their own home with their own devices and distractors. It was necessary to sacrifice some ecological validity in order to record physiological data in a laboratory. However, we simulated this environment as much as possible all while controlling the variables needed for this study. We pre-recorded videos of a conference to simulate a video conference during the experiment. We also decided not to include more than one device as the eye tracker, Tobii pro Lab (Tobii, 2001), can only be set up for one device and would not be able to identify when the participant would be switching their focus or if they are simply looking off screen. Due to the limitations of eye tracking technology, we were not able to capture visual attention from the tab switching multitasking environment.

Additionally, we encountered recruitment difficulties over the summer, with lower rates of students coming to the campus, the recruitment of this study was paired with another study named Athena, from Tech3Lab. Recruited participants would do the Athena study first and then this study with a 15 min break in between. We were able to recruit 12 participants over the summer and 21 participants during September. The rest of the participants were recruited only for this study during the month of September. The results of this study may have varied between participants recruited over the summer and participants recruited during in September. The participants recruited during the summer may have more fatigue than the other participants. Although some participants were more fatigued than others, it can be argued that it is even more representative to a real work or school day with back-to-back meetings or classes. Results from both were tested and were found not statistically different.

4.5 Future Studies

When eye tracking technologies improve, comparing different styles of multitasking can be a future avenue to understand different ways of work and determine which methods are most effective. Specifically, observing new features such as picture-in-picture video while multitasking could provide valuable insight into the benefits and drawbacks of this technique compared to other forms of multitasking. Future studies could also explore the impact of individual differences such as age, cognitive ability, and personality traits on multitasking performance in remote work environments. Additionally, incorporating other physiological measures beyond eye tracking and electrodermal activity, such as heart rate variability (HRV) and brain imaging, could offer a more comprehensive understanding of the underlying mechanisms of multitasking in remote work settings. Overall, there is a great deal of potential for future research to advance our understanding of multitasking behaviors in remote work environments and inform the development of effective strategies and tools for improving productivity and performance.

Future research could explore the long-term effects of multitasking in remote work environments and the impact of technology and work design on individual performance and well-being. Additionally, studying the effects of multitasking on different age groups and personality types could provide insights into how individuals can better manage their tasks in remote work environments. Overall, this study contributes to the growing body of literature on remote work and highlights the importance of understanding multitasking behaviors in virtual work environments.

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Appendices

Appendix A : Fixation Table

Ratio TotTaskFixDur/Tottaskdur			Stimuli					
			1	**2**	**3**	**1 vs 2**	**1 vs 3**	**2 vs 3**
			Chat	**Sudoku**	**Video**			
			Means	Means	Means	p-value[1]	p-value[1]	p-value[1]
			n=99	n=99	n=99			
Task	**1**	n=99	0.0100	0.0227	0.7737	0.1637	0.0000	0.0000
	2	n=99	0.1580	0.0588	0.5880	0.0000	0.0000	0.0000
	3	n=99	0.1059	0.5021	0.1153	0.0000	0.0000	0.0000
	1 vs 2	p-value[1]	0.0000	0.2916	0.0000			
	1 vs 3	p-value[1]	0.0000	0.0000	0.0000			
	2 vs 3	p-value[1]	0.0005	0.0000	0.0000			

Appendix B: Questionnaire

Tâche 1

Pour la première tâche, vous devrez visionner une vidéo. Lorsque vous êtes prêts à débuter, passez à la page suivante du questionnaire à l'aide de la flèche bleue. Cliquez ensuite sur "jouer" pour débuter la tâche.

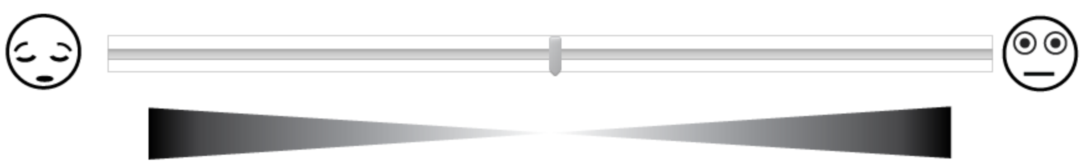
Veuillez démarrer la lecture de cette vidéo et l'écouter complètement.

En vous référant à la vidéo que vous venez de visionner, veuillez lire attentivement les énoncés suivants et répondre par vrai ou faux.

	Vrai ou Faux?	
	Vrai	Faux
C'est la production qui détermine les produits à fabriquer, et non le marketing.		
Un programme sport-études offert dans une école privée est un exemple de positionnement.		
Le positionnement d'une entreprise dépend aussi du positionnement de ses concurrents.		
Selon le conférencier, les entreprises à but non lucratif n'ont pas souvent besoin de segmenter, de cibler et de se positionner.		
Segmenter un marché en fonction de l'endroit où les gens font leurs courses en est un exemple de segmentation socio-démographique.		
Parmi les participantes de sexe féminin, une seule a posé une question à la fin de la présentation.		
Un marché est un groupe de clients potentiels disposés à échanger quelque chose de valeur avec des vendeurs proposant divers produits et/ou services.		
La segmentation, le ciblage et le positionnement doivent se faire en séquence.		
Sur le site web de la compagnie Hatley, un enfant porte un chandail avec un bateau.		
Une entreprise devrait avoir autant de positionnements que de segments cibles.		

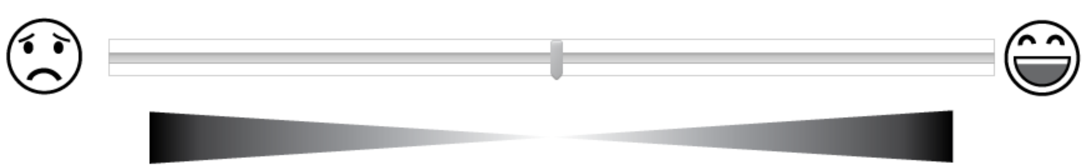
Pour cette première échelle, l'excitation fait référence à l'intensité de vos émotions. Cette échelle va de calme/tranquille/endormi à excité/stimulé/éveillé.

Par rapport à la première tâche, déplacez le curseur afin de représenter le niveau d'intensité de votre émotion (calme-excité).



Pour cette deuxième échelle, le plaisir fait référence à la nature de vos émotions. Cette échelle va de triste à joyeux.

Par rapport à la première tâche, déplacez le curseur afin de représenter votre niveau de plaisir (triste-joyeux).



Tâche 2

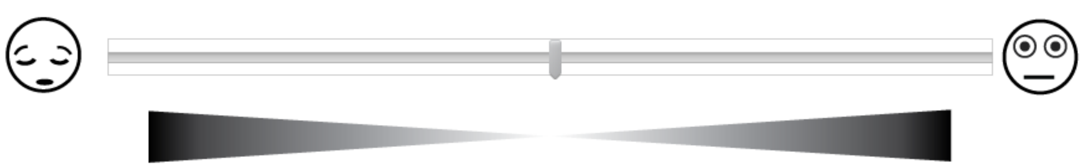
La seconde tâche consiste à visionner une vidéo et à répondre à un clavardage.

S'il vous plaît, répondez le plus vite possible au clavardage. Écrivez des phrases complètes. Lorsque vous êtes prêt à débuter la tâche, cliquez sur "jouer" sur la vidéo.

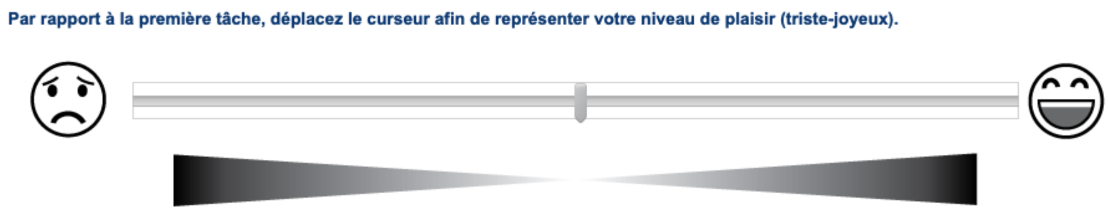
	Vrai ou Faux?	
	Vrai	Faux
Wal-Mart est un exemple de manufacturier.	○	○
Casper est un exemple d'entreprise vendant directement aux consommateurs.	○	○
Il est toujours plus avantageux pour un fabricant de prendre en charge la distribution de ses produits.	○	○
Avoir des salles de montre (showrooms) est un exemple d'une adaptation à la croissance du commerce électronique.	○	○
Levis a créé sa propre boutique en ligne en 2002 malgré les menaces de ses intermédiaires.	○	○
La marque UBER EATS apparait sur le sac à dos du cycliste à la fin de la présentation.	○	○
Les intermédiaires facilitent l'accès aux produits.	○	○
Nous n'utilisons pas d'intermédiaires pour accroître l'efficacité et la couverture du marché.	○	○
Le conférencier utilise l'exemple de Disney+ durant la présentation.	○	○
De nos jours, les consommateurs ont des attentes "multi-canales".	○	○

Pour cette première échelle, l'excitation fait référence à l'intensité de vos émotions. Cette échelle va de calme/tranquille/endormi à excité/stimulé/éveillé.

Par rapport à la première tâche, déplacez le curseur afin de représenter le niveau d'intensité de votre émotion (calme-excité).



Pour cette deuxième échelle, le plaisir fait référence à la nature de vos émotions. Cette échelle va de triste à joyeux.



Tâche 3

La troisième tâche consiste à visionner une vidéo, répondre à un clavardage et compléter un sudoku.

Voici les instructions du sudoku:

Un sudoku classique contient neuf lignes et neuf colonnes, donc 81 cases au total. Le but du jeu est de remplir ces cases avec des chiffres allant de 1 à 9 en veillant toujours à ce qu'un même chiffre ne figure qu'une seule fois par colonne, une seule fois par ligne, et une seule fois par carré de neuf cases. Une grille initiale de sudoku correctement constituée ne peut aboutir qu'à une et une seule solution.

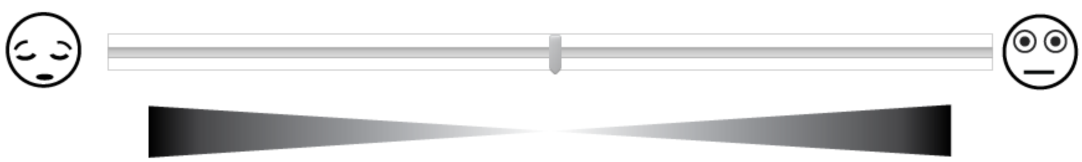
Répondez le plus rapidement possible au clavardage. Écrivez des phrases complètes. Complétez le sudoku du mieux que vous le pouvez. Nous vous poserons des questions sur le jeu à la fin de l'expérience.

Vous pouvez changer d’onglet autant que vous avez besoin.

	Vrai ou Faux?	
	Vrai	Faux
Zara fait du marketing de contenu ayant pour but d'amener les utilisateurs sur leur application.		
Le marketing de contenu et le marketing sur les médias sociaux sont deux types de marketing différents		
Une entreprise qui fait du bon marketing de contenu suscite l'attachement des consommateurs à sa marque.		
Le marketing de contenu se concentre sur la création de contenu selon les besoins de vos clients, quelle que soit l'étape à laquelle ils se trouvent dans le cycle d'achat ou le parcours client.		
La photo avec le cheval provient du compte Instagram d'Expedia.		
Le « Up-selling » consiste en la vente de produits à valeur ajoutée.		
Le guide Michelin est rouge.		
"L'art de communiquer sans vendre" est une citation présentée dans les diapositives.		
Dans le graphique de Google Trends, « influencer marketing » est représenté par la couleur verte.		
Le marketing de contenu réduit le coût d'acquisition des clients pour les startups.		

Pour cette première échelle, l'excitation fait référence à l'intensité de vos émotions. Cette échelle va de calme/tranquille/endormi à excité/stimulé/éveillé.

Par rapport à la première tâche, déplacez le curseur afin de représenter le niveau d'intensité de votre émotion (calme-excité).



Pour cette deuxième échelle, le plaisir fait référence à la nature de vos émotions. Cette échelle va de triste à joyeux.

Par rapport à la première tâche, déplacez le curseur afin de représenter votre niveau de plaisir (triste-joyeux).