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Five Essays on Joint Use of Information Technology Systems

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Five Essays on Joint Use of Information Technology Systems

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Résumé

Cette thèse, composée de cinq essais, est motivée par l'ampleur du phénomène d’utilisation multi-utilisateur de systèmes d’information (SI). Alors que la plupart de ces systèmes sont conçus pour être utilisés en mode mono-utilisateur, dans la pratique, ils sont couramment utilisés par deux ou plusieurs utilisateurs de manière conjointe, c'est-à-dire que les utilisateurs interagissent de manière collaborative avec un système à travers le même écran ou des écrans partageant un affichage unique. Cependant, cette perspective multi-utilisateur est rarement abordée dans la littérature actuelle en SI. Ainsi, cette thèse vise à développer des connaissances pour améliorer la compréhension des antécédents, des mécanismes et des conséquences liés au phénomène d’utilisation multi-utilisateur de systèmes par interface partagée, que nous appelons *utilisation conjointe des SI*.

Afin de fournir une base théorique pour de futures recherches sur le phénomène d’étude, le premier essai examine conceptuellement le construit d'utilisation conjointe des SI. Il propose une typologie des conceptualisations de ce construit se proposant d’orienter les perspectives dans lesquelles ce concept est étudié. En outre, ce premier essai propose un cadre d’analyse de l'utilisation conjointe des SI qui présente un réseau nomologique du concept. Le deuxième essai est axé sur le contexte spécifique des achats en ligne effectués conjointement par des couples. Il étudie les conditions et l’ampleur des activités d’achat en ligne en couple en Amérique du Nord. Ce faisant, l'essai met en lumière de manière empirique l’importance du phénomène d'utilisation conjointe des systèmes de commerce électronique. Il lance ainsi un appel aux chercheurs à s'intéresser davantage à la perspective d'utilisation conjointe des SI. Le troisième essai, également axé sur les achats en ligne conjoints par des couples, étudie les antécédents de l'utilisation conjointe dyadique des SI, la manière dont ces derniers influencent des mécanismes d'utilisation conjointe dyadique (c'est-à-dire un ensemble de construits interreliés caractérisant l'activité) et les impacts associés. L'essai met en œuvre une approche expérimentale et fournit des recommandations concrètes aux praticiens des SI pour une meilleure conception des systèmes informatiques qui anticipe des utilisations en contexte multi-utilisateur. Le quatrième essai mobilise une méthodologie basée sur les neurosciences, à savoir l'oculométrie, pour étudier l'utilisation conjointe des SI. Il explore la faisabilité de la collecte simultanée et synchrone de données sur les regards de dyades d'utilisateurs – une méthodologie appelée *oculométrie double* – interagissant conjointement avec une interface système partagée. L'essai développe un nouvel indice indiquant dans quelle mesure les membres d'une dyade regardent les mêmes endroits à l'écran pendant une utilisation conjointe de SI, un construit que nous appelons *convergence des regards*. En outre, l'essai développe et, à travers une expérience de laboratoire, teste un modèle suggérant de quelle manière la convergence des regards peut influencer la performance dyadique et la charge cognitive. Le cinquième essai quant à lui examine en contexte de laboratoire et dans une approche exploratoire l'utilisation conjointe d'interfaces de commerce électronique. Il utilise une méthode mixte combinant des mesures psychométriques et des mesures psychophysiologiques, y-compris l'analyse faciale automatique, la galvanométrie, et l'oculométrie double synchrone dont une technique est illustrée par le quatrième essai. Ce dernier essai identifie des liens émergents entre construits relatifs à l'expérience utilisateur en utilisation dyadique, base sur laquelle nous faisons plusieurs recommandations pour la recherche et la conception des SI utilisés conjointement par plusieurs utilisateurs.

Mots clés: utilisation conjointe, mécanismes d'utilisation, interface partagée, interaction humain-machine multiutilisateur, dyade, processus dyadique, convergence des regards, magasinage en ligne en couple, conflit, revue de littérature, enquête, expérience en ligne, expérience en laboratoire, oculométrie double synchronisée, analyse faciale automatique.

Méthodes de recherche: revue de littérature, élaboration de théorie, enquête, expérience en ligne, expérience en laboratoire, oculométrie double synchronisée, analyse faciale automatique, activité électrodermale, NeuroIS.

Abstract

This thesis, composed of five essays, is motivated by the importance of the phenomenon of multiuser interaction with information technology (IT) system interfaces. While most IT systems are designed to be used in single-user mode, in practice, they are commonly used by two or more users together in a joint manner, that is, the users interacting collaboratively with a single shared system display. However, the latter perspective is seldom addressed in the current literature in information systems (IS). Hence, this thesis aims at developing insights to increase understanding of antecedents, mechanisms, and consequences related to the phenomenon of multiuser system use through shared system interface, which we refer to as *joint IT use* or *joint system use*.

To provide a theoretical ground for future research on the phenomenon of study, the first essay conceptually examines the joint IT use construct. It proposes a typology of conceptualizations of this construct that may drive perspectives in which this construct is investigated. Moreover, the essay proposes a joint IT use framework exhibiting a nomological network of the construct. The second essay is focused on the specific context of joint online shopping by couples. It investigates the settings and the extent to which couples shop online together in North America. In doing so, the essay provides empirical evidence confirming that the joint IT use phenomenon is important and calls for greater interest from IS researchers on this perspective of IT use. The third essay, also focused joint online shopping by couples, investigates antecedents of dyadic joint IT use, how these antecedents trigger mechanisms of dyadic joint IT use (i.e., assembly of constructs emerging from the activity), and the impacts associated with dyadic joint IT use. The essay takes an experimental approach and provides actionable recommendations to IT practitioners for better system design that anticipates multiuser settings. The fourth essay focusses on a neuroscience-based methodology for investigating joint IT use, namely, eye-tracking. It explores feasibility of simultaneously and synchronously collecting gaze data of user dyads – a methodology called *dual eye-tracking* – jointly interacting with a shared IT system interface. The essay develops a new index for measuring the extent to which dyad members look at the same locations on the system interface, a construct we

call *gaze convergence*. In addition, the essay develops and, through a laboratory experiment, tests a model suggesting how gaze convergence may influence dyadic performance and cognitive load. The fifth essay examines joint use of e-commerce interfaces in a laboratory context and in an exploratory approach. It uses a mixed method combining psychometric and psychophysiological measures, including automatic facial analysis, galvanometry, and synchronous dual eye tracking, a technique which is illustrated in the fourth essay. This final essay identifies emerging relationships to user experience in dyadic use, upon which we make several recommendations for research and computer system design that considers joint use by multiple users.

Keywords: joint IT use, joint system use, IT use mechanisms, display sharing, multiuser human-computer interaction, dyad, dyadic process, online shopping in couple, conflict, literature review, survey, online field experiment, laboratory experiment, synchronized dual eye-tracking, gaze convergence.

Research methods: literature review, theory building, survey, field experiment, laboratory experiment, synchronized dual eye-tracking, automatic facial analysis, electrodermal activity, NeuroIS.

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List of acronyms

AFA	Automatic facial analysis
Aff	Affective conflict
ANCOVA	Analysis of covariance
ANOVA	Analysis of variance
AOI	Area of interest
Beh	Behavioral conflict
C.I.	Confidence interval
Cog	Cognitive conflict
CPU	Central processing unit
DC	Dyadic conflict
df	Degrees of freedom
DPA	Dyad pre-agreement
DSH	Display sharing
DV	Dependent variable
EDA	Electrodermal activity
ERP	Entreprise resource planner
GC	Gaze convergence
HCI	Human-computer interaction
IDC	Input device control
IDE	Integrated development environment
IMOI	Inputs–mediators–outputs–inputs
IPO	Input-process-output
IS	Information system(s)

IT	Information technology / Information technologies
IV	Independent variable
JITU	Joint information technology use
MGC	Mutual gaze convergence
MISC	Post-acceptance model of information system continuance
MSE	Mean squared error
NTP	Network time protocol
OFD	Overall fixation distance
PN	Partner controls
PP	Participant controls
PreA	Pre-agreement
RQ	Research question
RTGD	Real-time gaze distance
SCM	Supply chain management system
SDG	Single-display groupware
SepDis	Separate displays
ShdDis	Shared display
SOGC	System-oriented gaze convergence
TI	Technologie(s) de l'information

Dedicated to my mother, Yvonne, who is now gone, for having built my path,

To Lydiane, my precious wife, thank you for your love and support along the way,

To Kenia Zenou, Dansi Nelann, and Loussi Shanna, thank you for your daily happiness,

To my parents, for your unconditional support and for guiding me on the right path,

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Preface

The present research projects were funded by the Natural Sciences and Engineering Research Council of Canada, grant number RGPIN-2019-06602, and by the Social Sciences and Humanities Research Council of Canada.

Essay 1 was co-authored with Dr. Pierre-Majorique Léger and Dr. Marc Fredette. I was responsible of literature review, ideation, conceptual development, and manuscript writing. Dr. Pierre-Majorique Léger and Dr. Marc Fredette supervised the manuscript development process.

Essay 2 has been published in the proceedings of the 22nd Human-Computer Interaction International conference. I co-authored it with Dr. Pierre-Majorique Léger, Dr. Marc Fredette, Dr. Sylvain Senecal, Dr. Constantinos K. Coursaris, and Laurie Charmichael. I was the main author, responsible of ideation, methodological design and execution, data analysis, manuscript writing, and paper publication process. Dr. Pierre-Majorique Léger, the supervisor on this project, was involved throughout. Dr. Marc Fredette was involved in the methodology design of the study. Dr. Sylvain Senecal and Dr. Constantinos K. Coursaris provided guidance on methodology execution and manuscript editing. Laurie Charmichael, master student at HEC Montréal, assisted me on operational tasks.

Dr. Pierre-Majorique Léger, Dr. Marc Fredette, and Dr. Sylvain Senecal are my co-authors of Essay 3. I was the main author, responsible for literature review, theoretical development, methodology design and execution, data analysis, and manuscript writing. Dr. Pierre-Majorique Léger and Dr. Marc Fredette supervised the project throughout its development. Dr. Sylvain Senecal provided guidance on ideation and methodology execution.

Essay 4 has been published in the Applied Sciences journal. The essay was co-authored with Dr. Pierre-Majorique Léger, Dr. Marc Fredette, Dr. Jared Boasen, Dr. Sylvain Senecal, and Jad Adam Taher, a master student at HEC Montréal. I was the principal researcher and main author in this project, responsible for literature review, conceptual developments, methodological design, data collection, manuscript writing and editing, and paper publication process. Dr. Pierre-Majorique Léger provided financial and infrastructure resources and supervised the project throughout its development. Dr. Marc Fredette supervised the project throughout its development. Dr. Jared Boasen provided guidance on conceptual design, methodological design, and paper review. Dr. Sylvain Senecal provided guidance on paper review. Jad Adam Taher assisted me on infrastructure setups. Dr. François Courtemanche provided engineering services for technical system setups.

Dr. Pierre-Majorique Léger, Dr. Marc Fredette, and Dr. Sylvain Senecal are my co-authors of Essay 5. I was the principal researcher in this project, responsible for ideation, experimental design, execution of the laboratory study, data analysis, and manuscript writing and revision. Dr. Pierre-Majorique Léger provided financial and infrastructural resources and performed the end-to-end project supervision. Dr. Marc Fredette supervised project design, data analysis, and manuscript writing. Dr. Sylvain Senecal provided guidance on ideation and data analysis. Besides, our experimental study benefited from engineering services of Dr. François Courtemanche on technical system setups.

Introduction

The present thesis is circumscribed in the study of joint use of information technologies (IT) systems through shared interface by multiple users, herein referred to in the following ways interchangeably: joint use, collaborative joint use of information systems (IS), joint IS use, collaborative joint use of IT, joint IT use, and multiuser single-interface use. For several decades, organizations have been increasingly relying on groups of workers to reach organizational goals (Gibson et al., 2007; Mehta and Mehta, 2018). A rationale for this still ongoing trend resides in the nature of business processes. A large amount of business processes require coordinated actions by groups of workers not only at process level but also at task level (Mehta and Mehta, 2018), including tasks requiring IT use. Besides, hedonic tasks may also require coordinated activities by two or more individuals. Example of such systems include multiplayer video games and e-commerce platforms targeting couples or families. Such IT-enabled group tasks (i.e., pieces of group work that are performed using an IT system) are often executed by two or more users interacting in a collaborative way with separate or shared software interfaces. Separate software interfaces include collaborative or workflow systems such as enterprise IT (e.g., Supply Chain Management – SCM – software or Enterprise Resource Planner – ERP – software) or network IT (e.g., Email and instant messaging software) (McAfee, 2006). Likewise, group tasks are usually executed through joint interactions with single IT interface, a setting in which the IT interface can be physically shared (using the same computer monitor) or logically shared (using the same software interface) among users. This latter configuration is prevailing in professional environments as well as in hedonic contexts. Besides, joint use of system interfaces can generally be differentiable as common-view interface use and different-view interface use. Examples illustrating joint use of system interfaces include the following: a business analyst providing a training on a newly developed IT system to an end user through a shared display, sitting in the same physical room or in separate remote locations (using a screen sharing or a shared navigation software); two software developers working together in an integrated development environment (IDE) to figure out how to adapt an existing source code to build new software modules; two IT consultants working simultaneously to build slides for a presentation to a client on a project planning, through a shared online office document. Besides, examples in hedonic context include the following: couples shopping online together to buy a new gazebo for their home; a dyad of friends browsing the internet together to find information about their common hobby; and a dyad of friends playing a video game involving joint dyadic actions. Hence, the notion of multiuser single-interface system includes interfaces used synchronously by a user group and promoting shared mental model (e.g., a couple jointly interacting with a website through the same laptop) and interfaces used jointly asynchronously (e.g., two professionals working together on an online office document, each on a different part of it). Besides, joint use of systems commonly involves collaboration among two or more users for task performance. However, these systems are generally designed with a single-user approach, that is, they do not consider possible interactions among users or cooperation scenarios (Stiemerling and Cremers, 1998). Consequently, accounting for this important gap in system design practice, research on IS use may be extensively enriched through the perspective of single-interface collaborative IS use, to widen contributions to system design.

In the IS field, IS use is a central construct, as it denotes IS effectiveness and is generally accepted as an indicator of IS success (DeLone and McLean, 1992; Goodhue and Thompson, 1995; DeLone and McLean, 2003; Burton-Jones and Straub, 2006). Research suggests that more as well as better IS use contributes to organizational performance (e.g., Fadel, 2007; Fadel, 2012). Understanding individuals' experience during the actual use of an IS (that is, while they use a system) is important to organizations, because not only it can inform the development and use of IT systems in a way that promotes effective and efficient IS use (Dimoka et al., 2012; De Guinea and Markus, 2009; De Guinea et al., 2014), but also it can be instrumental to the development of IS policies and IS strategy (Dimoka et al., 2012; Gisonti, 2015). Actually, negative user experience during system use can be related to losses in productivity (e.g., through IT unexpected harmful events such as disruptions) and bad decision making (Dimoka et al., 2012), and it can create technostress (i.e., stress incurred by the use of IT systems (Riedl, 2013)). Such outcome may ultimately influence individuals' intention to continue to use an IT (e.g., Bhattacherjee, 2001) or breadth of system feature use (e.g., Bagayogo et al., 2014).

Several limitations can be raised concerning past research perspectives on technology use. First, they typically do not consider collaborative system use in the context of shared interfaces, that is, system interfaces used simultaneously (either co-located or remotely from each other) and collaboratively by multiple users through single interface. Individual-level IS use literature is generally limited to scenarios involving one user interacting with the system in an isolated way; it seldom addresses factors relating to simultaneous use of IT system by two or more users, resulting in unnatural and incomplete views of how IT systems are used by individuals (Burton-Jones and Gallivan, 2007). Second, the extant literature on group-level IS use is mostly limited to collective use of systems originally designed for group use and whose primary function is to support collaboration in the workplace. Collaboration through such systems typically involves collective use, including processual use (i.e., lowly interdependent users using tightly dependent modules to perform sequential tasks respectively) and network use (i.e., highly inter-dependent users using tightly dependent modules to perform complex collaboration task) (Negoita et al., 2018). Examples of such systems include group support systems (e.g., Dennis et al., 2001) and collaborative systems (e.g., Easley et al., 2003). These systems do not include systems originally designed for individual use (which are commonly used collaboratively though). Third, most of past research works on IS use, empirical as well as theoretical, rely on theories and conceptualizations of IS use that are grounded in the planned behavior and reasoned action paradigm (De Guinea and Markus, 2009; Venkatesh et al., 2016). As such, these studies address IS use through core constructs such as intention to use, intention to continue to use, and amount of use (e.g., frequency of use, use amount of time, amount of use of the basket of features: Burton-Jones and Straub, 2006; De Guinea and Webster, 2013). Hence, these conceptualizations are not able to explain users' dynamic experience of system use, that is, users' emotions, cognitions, and behaviors happening while they use a system. Finally, based on the previous limitation, most of past research works have relied on users' perception towards system use outside their actual use experience (De Guinea et al., 2014). Hence, this perspective mostly relies on explicit (e.g., self-reported) measures to assess system use experience, and it cannot allow to measure users' automatic use states (Kim et al., 2005) and patterns emerging without individuals' awareness (Riedl and Léger, 2016; De Guinea and Webster, 2013; Dimoka et al., 2011).

Accounting for the foregoing limitations in the extant literature, the present thesis aims at studying the phenomenon of joint IT use through a physically or logically shared system interface. In this regard, the objectives of this thesis are (1) to propose avenues for conceptualizing and a framework for examining joint IT use, (2) to highlight and evidence the importance of the joint IT use phenomenon, and (3) to empirically investigate mechanisms of joint IT use (i.e., ways or means by which constructs involved during joint IT use are inter-related at individual and group levels) and how they influence outcome constructs. We will start by developing a framework for studying this phenomenon, then we will provide some evidence of the phenomenon and empirically examine specific related research questions. This work is delineated into five essays.

The first essay is dedicated to the development of a theoretical foundation for our research. We conceptualize joint IT use as a collective multilevel construct involving individual-level as well as group-level manifestations (Burton-Jones and Gallivan, 2007). Based on the nomological network of team adaptation proposed by Maynard et al. (2015) as a starting point, we identify constructs that may act as antecedents of joint IT use processes. Moreover, we explore how joint IT use patterns are shaped as well as their outcomes. This essay answers three research questions: (1) What are defining characteristics of joint IT use? (2) What are important constituents of joint IT use mechanisms? (3) What important factors serve as antecedents or outcomes of joint IT use mechanisms? By drawing upon past seminal works on collaborative use, and in conjunction with literature on individual and team adaptation, this essay contributes by proposing a rich multilevel conceptualization of joint IT use (Burton-Jones and Gallivan, 2007), a typology of joint IT use, as well as a framework for studying joint IT use mechanisms in the context of shared system interface.

The second essay contributes to the state of the art of research on the scant studied phenomenon of joint IT use. Focused on the context of e-commerce systems, the essay provides evidence of the extent of online shopping habits by couples, answering two research questions: (1) To what extent do couples jointly use online shopping platforms; (2) In what settings do couples shop together using online platforms? This study is a call to practitioners for accounting for dynamics and influences spawn by multiuser contexts of IS use.

The third essay, illustrating the first essay's proposed framework, investigates joint IT use settings, along with associated mechanisms and their influence on joint task performance. Focused on user dyads, the essay addresses three research questions in an e-commerce context: (1) What are mechanisms undelying joint IT use and their impact? (2) What is the role of system setup in the context of joint IT use? (3) What initial dyad states play an important role in the formation of joint IT use mechanisms? Based on the research framework we propose in the first essay, the study develops a multilevel model of emotions and cognitions generated by system setting, pre-task agreement state, and on-screen action control, as well as associated task performance-related constructs. The model is empirically tested through an online experiment about online shopping by couples. Based on findings, the essay discusses theoretical and practical implications, including system design considerations.

The fourth essay tests a model derived from the first essay's proposed framework to illustrate feasibility of detecting patterns of joint IT use. The study focuses on the role of users' gaze patterns, which illustrate how users effectively use a shared interface during joint IT use. We propose a new construct, gaze convergence, that is, the extent to which partner users look at same visual objects and user controls on the shared system interface within a period of time. Research suggests that mutual gaze convergence between two individuals is an indicator of communication effectiveness (Thepsoonthorn et al., 2016), and miscoordination incidents may be reduced when a user dyad looks at the same visual objects in system interface (Kwok et al., 2012; Zhu et al., 2010). Moreover, it has been suggested that user awareness of partner user's gaze improves collaboration (Zhang et al., 2017). The essay develops and proposes an index for measuring gaze convergence. This new operationalization of gaze convergence is used to investigate outcomes of this construct at dyad-level and answer the following research questions: (1) How can the degree of gaze convergence of a dyad collaborating simultaneously on a shared system interface be measured? (2) To what extent does gaze convergence relate to dyad cognitive states and dyad performance? This essay contributes by bringing new insights about how visual cues in an IT interface can foster effective collaborative use of a shared system interface. Besides, this essay is a methodological validation of gaze convergence construct and a feasibility study of the methodology we later employ in the fifth essay of the present thesis.

The fifth essay, like the third one, investigates joint IT use in a context of e-commerce systems. It addresses three research questions: (1) What difference in user experience does it make to share same synchronized system interface display, compared to using asynchronous system interface displays during joint IT task performance by user dyads? (2) What are antecedents of joint IT use experience? (3) What are system characteristics fostering optimal joint IT use experience? We examine these questions through an exploratory laboratory experiment involving couples jointly shopping in different complementary conditions. In the mixed-method study, in addition to self-reported measurement instruments, we leverage psychophysiological tools to explain the phenomenon of study. Specifically, we exploit automatic facial analysis, electrodermal activity, and synchronized dual eye-tracking, a technique exemplified in the fourth essay. Several relationships emerging among our constructs, this essay represents a ground to future theoretical or empirical research on joint IT use. Based on our results, we make recommendations for research and IT system design practice.

In developing theoretical grounds and empirically examining the joint IT use phenomenon, the present thesis contributes to advancing knowledge about IT use. Past IS research works have called for more interest in conceptualizations of IT use-related constructs that are not limited to user's individual and direct interactions with system interface. Barki et al. (2007) proposed that IT use be studied by considering individual-level activities surrounding IT use. Other researchers have proposed that the construct be studied in a multilevel fashion, to provide a more complete understanding of system use (e.g., Zhang and Gable, 2017; Burton-Jones and Gallivan, 2007). This thesis answers these calls by examining multilevel IT use mechanisms related not only to user-system interactions but also to collaboration during shared use of system interface. This research complements the perspective of collective use of systems designed for group use, which has been examined by recent major research on collective use (e.g., Negoita et al., 2018). Moreover, this thesis generates numerous insights that may help pave the way to several research avenues. Besides, the present research works also have several practical contributions. Our empirical studies bring about recommendations to IS professionals regarding system design considerations with the aim of improving dyadic system use experience in different conditions.

We briefly outline the status of the thesis' essays in Table 0.1. We also mention co-authors of each paper at the beginning of each chapter. Figure 0.1 outlines the thesis structure.

Table 0.1. The thesis' essays.

	Type of study	**Publication status**	**Outlet**
Chapter 1- Essay 1	Theoretical development	Working paper	In preparation for Journal of the Association for Information Systems
Chapter 2 - Essay 2	Empirical (survey)	Published[1]	22nd Human-Computer Interaction International conference
Chapter 3 - Essay 3	Empirical (field experiment)	Working paper	In preparation for Journal of Management Information Systems
Chapter 4 - Essay 4	Empirical (laboratory experiment, synchronized dual-eye tracking)	Published[2]	Applied Sciences journal
Chapter 5 - Essay 5	Empirical, Inductive (laboratory experiment, synchronized dual-eye tracking, automatic facial analysis, galvanometry)	Working paper	In preparation for Cyberpsychology, Behavior, and Social Networking journal

[1] Tchanou, A. Q., Léger, P.-M., Senecal, S., Carmichael, L., & Fredette, M. (2020, 19–24 July 2020). Multiuser Human-Computer Interaction Settings: Preliminary Evidence of Online Shopping Platform Use by Couples. *In proceedings of the Human-Computer Interaction International Conference 2020, Copenhagen, Denmark*.
[2] Tchanou, A. Q., Léger, P.-M., Boasen, J., Senecal, S., Taher, J. A., & Fredette, M. (2020). Collaborative Use of a Shared System Interface: The Role of User Gaze—Gaze Convergence Index Based on Synchronous Dual-Eyetracking. *Applied sciences*, 10(13), 4508. https://doi.org/10.3390/app10134508

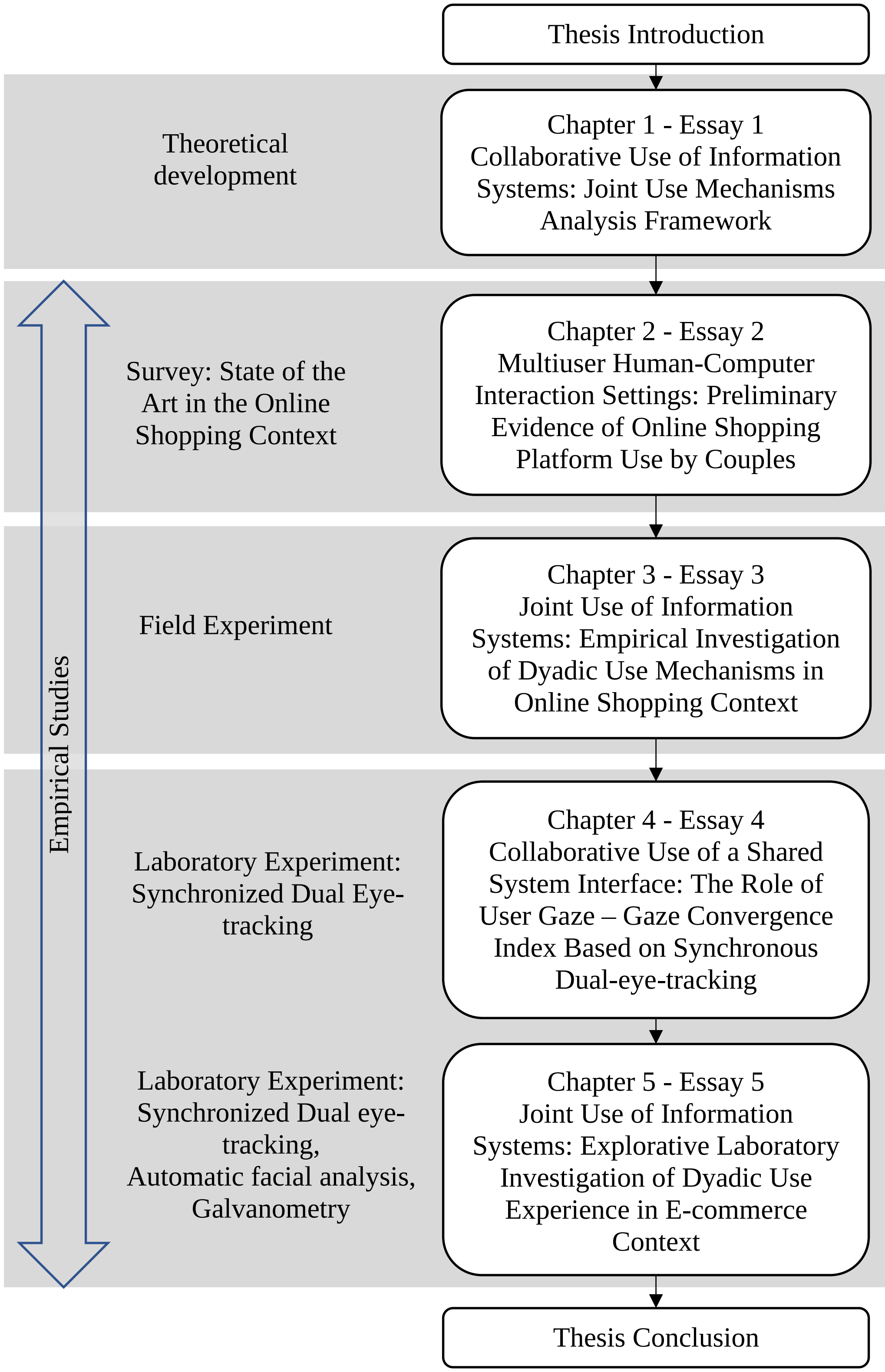

Figure 0.1. Thesis structure overview.

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Chapter 1 - Essay 1

Collaborative Use of Information Systems: Joint Use Mechanisms Analysis Framework[3]

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Abstract

Information systems (IS) are commonly used simultaneously by two or more users sharing an information technology (IT) interface, a phenomenon we refer to as *joint IT use*. Yet the IS literature seldom addresses this perspective, leading to a lack of understanding of how group-level joint IT use patterns emerge, that is, what are antecedents of joint IT use, their consequences, and their mechanisms. This first essay aims at proposing a holistic framework of joint IT use. Based on a rich and multilevel view of IS use, we propose a typology of conceptualizations of joint IT use, hinging on technical elements (i.e., system and task) and action levels (i.e., user and user group). Moreover, we develop a framework made of three layers and based on the Input-Mediators-Output-Input (IMOI) model borrowed from the group dynamics literature. The framework's *Inputs* layer is made of (1) characteristics at system, task, individual, group, and organization levels, and (2) IS events we call triggers. The *Mediators* layer is composed of (1) individual-level, group-level, and cross-level configurations of emotions, cognitions, and behaviors, (2) system attributes, and (3) task configurations. The *Outcomes* layer is made of consequences of the Mediator layer and in turn influences the Inputs layer. The proposed framework allows for future research in IS acceptance not only in the perspective of the traditional paradigm of reasoned action at group level, but also in perspectives promoting capture of system use patterns during real-time use of IT system.

Keywords. IMOI model, Input-Mediator-Output model, Collaborative use, Shared system interface, Multilevel construct, Joint IS use, Joint IT use, Joint system use, Joint use mechanism, IS event, IS trigger.

1.1 Introduction

Groups have been increasingly important in professional environments as well as in non-professional contexts, as they are among the most common settings for people's expression (O'Neill and Salas, 2018; Korsgaard et al., 2008; Rousseau et al., 2006; Gersick and Hackman, 1998). In line with this trend, a significant majority of employers (75% - Vardhman, 2020) consider collaborative work very important. In hedonic contexts, research as demonstrated that group activities based on information technology (IT) systems are common and often essential. Examples include couple online shopping and team gaming (Tchanou et al., 2020a; Keith et al., 2018). The phenomenon of study addressed in this essay is that of multiple users interacting together (i.e., collaboratively) with a single shared system interface to perform a task. We refer to it interchangeably *joint IT use*. This perspective is seldom seen in the literature on group-level or individual-level information systems (IS) use. Collaborative work has been addressed in the IS literature essentially through studies of group-level use of systems originally designed for group use, such as group support systems and collaborative systems (e.g., Negoita et al., 2018; Kang et al., 2012; Doll and Deng, 2001; Dennis et al., 2001). Very few studies on group-level system use address collaborative interactions through a single shared system interface. One such exception is Sarker et al. (2005), who propose a model of group-level adoption of an information technology and whose scope includes collaborative use of IT originally designed for group collaboration (e.g., professional social networks) or originally designed for individual use (e.g., word processing software). But the authors simply allude to the latter and do not explicitly address joint IT use by a user group. Moreover, past research on IS use generally conceptualizes IS use at a single level of analysis (e.g., individual or group), without explicitly considering possible influences from or to other levels of analysis (Negoita et al., 2018; Burton-Jones and Gallivan, 2007).

Collaborative use entails two or more people working together to support one another by sharing knowledge, ideas, competencies and information, and/or by coordinating their activities to accomplish a task, using an IT (adapted from Doll and Deng (2001) and Hargrove (1998)). Trivially, collaborative use is group work. Group work can be automatic (routinized) or non-routinized (Gersick and Hackman, 1990). Non-routinized work typically invokes adaptations, as it typically engages active cognitive processing (Kim et al., 2005). The concept of adaptation is prominent in technology adoption literature. It has been proposed that user adaptation needs to be considered for better understanding and capturing of a person's use of IT (Barki et al., 2007). Based on this premise, we contend that considering group adaptation along with individual adaptation during collaborative IT use is important for a comprehensive understanding of the phenomenon of study. Yet, research on the concept of group adaptation in the IS field is lacking. Hence, to the best of our knowledge, we know very little about how user groups adapt to events related to collaborative use of IT, namely dynamic group configurations of behaviors, cognitions, and emotions. This essay contributes to the understanding of group adaptation during collaborative use of IT and is specifically focused on collaborative joint use of IT, that is, user group collaborative interactions with same system interface.

Our study aims at (1) conceptualizing collaborative IT use in the context of use of shared IT interface, that is, joint IT use, and (2) proposing a framework for further IS research on joint IT use. The extant literature on post-adoptive individual adaptations essentially examines IT use mechanisms and adaptations by focusing on contexts in which users perform their IT tasks using IT system interfaces in an isolated way, that is, users do not work jointly on the same interface with other users at a given moment when environment triggers are raised. Yet, user adaptations may be influenced by partner users when they use single IT interface collaboratively. An illustration is a couple using together an e-commerce platform to shop for household articles. The way each partner adapts to related triggers can be influenced by the other couple member's adaptation. For example, in such online shopping context, research suggests that female couple members are more expressive when their spouse controls input devices, with higher relative influence over decision making (e.g., Mekki Berrada, 2011). Another illustration is a junior user working together with a senior colleague (who is an expert user) on the same shared interface display of a system such as inventory management module of an enterprise resource planner (ERP). The junior user's adaptation to system-related triggers may be influenced by collaboration with the helping expert user; a discrepancy in the system (i.e., an unexpected system behavior) may be better fixed by a user with the help of the expert user; this factor may then be expected to have direct impact on user's emotional coping, cognition, and behavior, altering individual IT use patterns as described by De Guinea and Webster (2013) and adaptive system use as described by Sun (2012). For example, a user may react to IT discrepancies with more positive emotions due to his/her partner's help in fixing the discrepancies. Moreover, the user may be more able to adopt new ways of using system features or to increase his/her basket of features in use, inspired by a partner user's use behavior. Taking into account possibly intertwining constructs between group level and individual level would provide a more complete picture of the IT use phenomenon, not only at individual level but also at group level. Hence, this essay addresses the following research questions in the context of users using together a shared interface.

RQ1: *What are defining characteristics of joint IT use?*

RQ2: *What are important constituents of joint IT use mechanisms?*

RQ3: *What important factors serve as antecedents or outcomes of joint IT use mechanisms?*

Our proposed framework of joint IT use mechanisms is based on a rich multilevel conceptualization of IT use (Burton-Jones and Gallivan, 2007). We call it the *joint IT use framework* (JITU framework). In the remainder of this essay, we present the different constituents of the proposed JITU framework and discuss related relationships. We start by discussing settings relevant to our phenomenon of study. We then discuss background knowledge about collaborative IT use, as well as team adaptation, a concept from which we draw to examine user group adaptation. Moreover, we propose a seven-type typology of joint IT use as a base for the conceptualization of the construct. Besides, we present the proposed JITU framework and end with a discussion about how this framework can be used for the study of joint IT use.

1.2 Theoretical background

1.2.1 Multiuser IT use settings

We conducted a literature review to identify settings in which collaborative joint use of a single interface is usually investigated. Our review was based on the following keywords[5]: multiuser, shared screen, single display, shared display, collaborative use. We considered major scientific databases relevant to the IS field, including Web of Science, Proquest, JSTOR, AIS Library, and Google Scholar. Findings suggest the existence of two types settings: si*ngle interface physically shared*, and *single interface physically separate*. The "single interface physically shared" type generally includes software designed for single-user use but, as is usually the case, used collaboratively (Burton-Jones and Gallivan, 2007; Sarker et al., 2005). Examples include e-commerce platforms, used by couples to shop together (Mekki Berrada, 2011); individual productivity tools such as software diagramming application (e.g., Sarker et al., 2005); or integrated software development environments (IDE) used by two software programmers doing pair programming, with one user (called the *driver*) writing source code and the other (called the *observer* or *navigator*) reviewing the written code, considering strategic directions of the programming and bringing new ideas (Williams, 2001). The "single interface physically separate" type includes systems that are typically used collaboratively with shared interface by remote or physically co-located users, with one or more users having control of the input devices. This type of setting is made of two subtypes. *Single interface with synchronous display* refers to system interfaces that allow joint inputs or interactions only through an identical display to users. Examples include screen-sharing software, shared web navigation systems (e.g., Zhu et al., 2010), and single-display groupware (SDG) systems (Stewart et al., 1999). Screen-sharing systems are very often used for helpdesk activities. It is usual that support teams gain access to user's computer for troubleshooting through the sharing of user's display. Besides, the SDG model was introduced by Stewart et al. (1999) to support collaborative work of several individuals in settings in which they are physically close to one another. An SDG system has been defined as a software

[5] Because this search is not the focus of our research question, we briefly present the review process.

allowing users physically close to one another to collaborate via a computer with a single display shared across multiple devices – of same or different types – and simultaneous control of multiple input devices by users (Stewart et al., 1999, p. 286). Examples of such systems include co-located web search systems (e.g., Amershi and Morris, 2010) and educational video gaming with multi-user control (e.g., Infante et al., 2010). To the best of our knowledge, SDG systems have scarcely or not been investigated in the literature on IS use. The second subtype of single interface physically separate is *single interface with asynchronous display*. It refers to system interfaces that allow joint inputs or interactions through identical or different display to the participating users. Examples include video-conferencing software, which may display the same interface differently to participating users. Video-conferencing systems are typically used for online group activities, including remote training, online meeting, and virtual team work sessions (e.g., Caya et al., 2013). Another example of single interface with asynchronous display is online office software (e.g., online word processing software), which may allow multiple users to work together at the same time on a document, with each user working on a different section or page of the document (e.g., Krishnan et al., 2018; George et al., 2013).

1.2.2 Collaborative use

In the remainder of this essay, the terms “IT use”, “system use” and “system usage” will be used interchangeably. System use has been generally conceptualized at single levels of analysis (Negoita et al., 2018; Zhang and Gable, 2017; Burton-Jones and Gallivan, 2007). A resulting limitation is that most published studies on system use do not consider cross-boundary change, that is, upward influence and downward influences (Markus and Rowe, 2018; Burton-Jones and Gallivan, 2007; Zhang and Gable, 2017). Upward influence relates to influence of constructs at lower levels (e.g., individual level) on higher-level constructs (e.g., group-level), while downward influence relates to influence of constructs at higher levels on lower-level constructs (Markus and Rowe, 2018). To address this limitation, in their seminal paper, Burton-Jones and Gallivan (2007) proposed that IT use be conceived of as a multilevel construct, each level comprising three elements: a *user* (i.e., the subject using the IT), a *system* (i.e., the IT used), and a *task* (i.e., the IT-related function being performed). As the authors suggest, considering these three components of system use allows to measure system use in several ways including *user*-centered fashion (e.g., user's cognition and emotions during system use), *system*-centered fashion (e.g., system features and characteristics), and *task*-centered fashion (e.g., variety of system use or number of subtasks, and task complexity). Furthermore, as Burton-Jones and Gallivan suggest, this view allows to investigate system use by a group of users in which some users indirectly interact with a system and rely on other group members. Based on this view, Burton-Jones and Gallivan defined system usage as "*a user's employment of a system to perform a task*" (p. 659). Besides, they argue that this definition encompasses not only *direct* interaction with IT, but also *indirect* interaction with IT by users working collaboratively by relying on other partner users who directly interact with IT. Hence, this view of IT use addresses the phenomenon of study in this essay, that is, two or more users using IT together to perform a task, whether all users have control of input devices (e.g., mouse, or keyboard) or not.

Another reference work relevant to this essay's multilevel view of IS use is that from Zhang and Gable (2017), who propose a process framework for multilevel theorizing in IS. They recommend four main activities for multilevel theorizing. The first step is to consider single-level theories that may help explain the phenomenon of interest. A rational for this activity is that multilevel theories may emerge from single-level theories (Kozlowski and Klein 2000). The second step is to identify candidate constructs that may be relevant to the single-level theory, considering larger contexts and narrowing down. A rationale given is that constructs are almost always encompassed in larger contexts or composed of smaller components, or both. The third step is to zoom-in (considering internal structures of) and zoom-out (considering external contexts of) the focal entity (in the present case, the individual) to identify possible top-down and bottom-up effects. The final step is to specify top-down and bottom-up effects, analyzing whether the top-down influence equally applies to lower-level entities (in the present case, the individual), whether bottom-up effect applies equally from all lower-level entities, and whether these effects concern construct or relationships between constructs (separately at each level). This framework represents valuable guidelines for the development of our proposed framework.

1.2.3 The Input-Process-Output-Input model

1.2.3.1 Teams vs groups

Although the present essay is centered on the notion of user groups, the notion of teams is interesting because of close similarities with the former, as discussed below. The concept of *team* has been extensively examined in the literature. Generally, a team is viewed as having certain defining characteristics. First, trivially, a team is made of two or more individuals, the team members. Second, individuals composing a team must share a common goal or objective (Whitley, 2018; Rousseau et al., 2006). Third, team members must be interdependent (Uitdewilligen, 2011; Rousseau et al., 2006). Finally, there must be collaboration among team members (Whitley, 2018). A team is generally considered a particular case of group, based on considerations that a group may also be made of individuals with different goals (Whitley, 2018) and with low or no interdependence (Uitdewilligen, 2011). However, in our context, a user group jointly using an IT interface is made of interdependent users, and although it may be a team in the sense of a professional working group, it may also refer to a set of individuals jointly performing a task in non-professional contexts (e.g., a couple shopping online together). But this user group construct is very similar to the team construct, since it shares all above-mentioned characteristics of a team. In other words, user group members jointly using an IT interface share common goals, are interdependent, and collaborate to achieve their common goals. Clearly, the literature on group dynamics, including team dynamics, is instrumental to studying user groups in the present context.

1.2.3.2 Team adaptation

Team adaptation has been a prominent topic within the group dynamics literature (Maynard et al, 2015). However, unlike the concept of user adaptation, which has drawn increasing interest for the past two decades in the IS field, team adaptation or more generally, user group adaptation, is still seldom investigated in the IS literature. Yet, research suggests that team adaptation is related to team performance (Christian et al., 2017; Uitdewilligen et al., 2013).

Team adaptation has been generally defined in the literature in relationship with the notion of change in the team environment. As teams operate and acquire experience in their task (during stable and expected situations), they develop habitual patterns of behaviors, often called *routines* (Gersick and Hackman, 1990), which contribute to increased team efficiency for three reasons: team members learn to anticipate their own (Kim et al., 2005) and other members' actions (LePine, 2003); the mechanism of processing inputs is not actively managed; less cognitive activation is required after learning (Kim et al., 2005); and the routines reduce uncertainty among the team (LePine, 2003). However, teams usually face multiple changes in their task processing and have to adjust their configuration in terms of behavior and cognition (Uitdewilligen et al., 2013). Hence, team adaptation is focused on change and is considered a process by which a team alters in response to some stimuli or trigger (Maynard et al., 2015). Different elements take part in the adaptation process. First, a team adapts in response to change such as novel situations or unexpected events (LePine, 2003). Second, team adaptation is considered a process (Uitdewilligen, 2011). Finally, it involves changes in team structure, behaviors, cognitions (Uitdewilligen, 2011), and emotions.

Recent advances in neuroscience have made it possible to assess team adaptation in real time (Stevens et al., 2018). Such question is tackled by the emerging field of team neurodynamics. Team neurodynamics is referred to in literature as the study of the changing rhythms and organizations (i.e., dynamics) of teams from the perspective of neurophysiology (Stevens, 2015). It consists in leveraging the measurement of neurophysiological indicators in the modeling of teamwork. Studies in team neurodynamics suggest opportunities for better modeling of team processes (Waldman et al., 2015). For instance, the team neurodynamics view may help model team macrocognition, which is defined as internalized and externalized mental processes employed by teams (Stevens et al., 2012); external processes are those associated with observable actions, while internalized processes are those non-observable and are indirectly captured through qualitative metrics such as "think-aloud" protocols and quantitative proxy metrics such as pupil size, electroencephalogram brain waves, and psychophysiological measures such as electrodermal activity (EDA) and heart rate provided by electrocardiograms (EKG) (Stevens and Galloway, 2014; Stevens et al., 2012). Likewise, studying team neurodynamics may help understand team emotions through neurophysiological correlates of individual emotions and associations with team processes. Hence, team neurodynamics represent a significant perspective in studying team adaptations in the IS field, especially as it provides opportunities for better understanding of team adaptation processes as well as team mediators such as team cognition and emotions, including in real time during collaborative use of an information system.

1.2.3.3 Input-mediators-output-input (IMOI) model

The IMOI model in the group dynamics literature was introduced by Ilgen et al. (2005) in an effort to address some limitations exposed by the input-process-output (IPO) model, which is a prominent framework in the same literature. The IPO model is based on the principle that team inputs lead to processes, which in turn lead to outcomes (Hackman, 1987). However, two limitations of the IPO model (among others) were raised. First, the "process" layer fails to capture several mediation factors that explain mechanisms through which inputs lead to outcomes (Ilgen et al., 2005) and that cannot be considered adaptation team processes. For example, team inputs can lead to emerging cognitive and affective states, which are not processes but can lead to team adaptive outcomes (Ilgen et al., 2005; Hackman, 1987). Finally, the IPO model does not account for possible feedback loops, that is, it does not capture possible influences of outputs on inputs (Ilgen et al., 2005). The IMOI model addresses these limitations by incorporating emergent states in the mediation layer, enriching the variance perspective of team dynamics. The model also considers possible feedback influences of the outcomes layer on the inputs.

Based on the IMOI model, a synthesis of fifteen-year research on team adaptation is proposed by Maynard et al. (2015), leading to a framework, depicted in Figure 1.2. However, this framework does not exhibit the above-mentioned feedback loop. The input layer is made of starting conditions at the individual, the team, and the organizational levels. The mediator layer contains team processes as well as other types of mediators that are not processes, that is, team emergent states. Based on this synthesized model, Maynard et al. (2015) further developed the "team adaptation process" entity, proposing a model representing its content domain and links with types of triggers throwing adaptation processes, as depicted in Figure 1.3. This model is based on Marks et al. (2001)'s team process framework, which suggests that team processes are of three types, namely, action, transition, and interpersonal. Marks et al. (2001)'s framework proposes that the *action* team processes relate to actual task carrying out such as system monitoring or interactions, coordinating with team members, or monitoring or backing up teammates; *transition* team processes relate to team activities such as mission analysis, goal specification, planning, and strategy elaboration; and *interpersonal* processes relate to team management activities such as conflict management, confidence building, and affect management among team members. The model showcases the role of triggers of adaptation, differentiating two types of triggers: *task-based triggers* (e.g., a change of task requirement), and *team-based triggers* (e.g., a change in team structure). Besides, the model posits that task-based triggers prompt teams to alter their action processes, while team-based triggers prompt teams to alter their interpersonal processes. Finally, the model posits that the higher the trigger's severity, the more apt teams are to initially adjust their transition processes and then turn to either their action or interpersonal processes in function of the type of adaptation trigger the team faces.

Several other studies in the group dynamics literature propose models of team process, which has often been considered under the "team behaviors" umbrella. Such models were integrated into a team behavior framework by Rousseau et al. (2006). However, unlike Maynard et al. (2015)'s, Rousseau et al.'s integrative framework focuses on team behaviors and does not highlight triggers that may bring about the behaviors. Thus, the present essay considers Maynard et al. (2015)'s work as a starting ground.

1.3 Theoretical development

Because of the nature of the phenomenon of study (users jointly interacting with an IT interface), user groups in the present context are essentially made of interdependent individuals sharing the same overarching goal (e.g., task performance such as getting a user issue with an IT fixed), although these users may have the same subgoal (e.g., two software programmers modifying together a source code) or not (e.g., a trainer and a user sharing a screen display). Other than these characteristics of a user group, joint IT use involves collaboration, although collaboration levels may vary depending on the nature of the joint task. Hence, we define a user group in this essay as a group of two or more individuals jointly interacting with a shared system interface to perform a task. Examples of such user groups include a dyad (e.g., a couple) or a triad using a system interface together and groups or teams of coworkers collaborating through a shared interface.

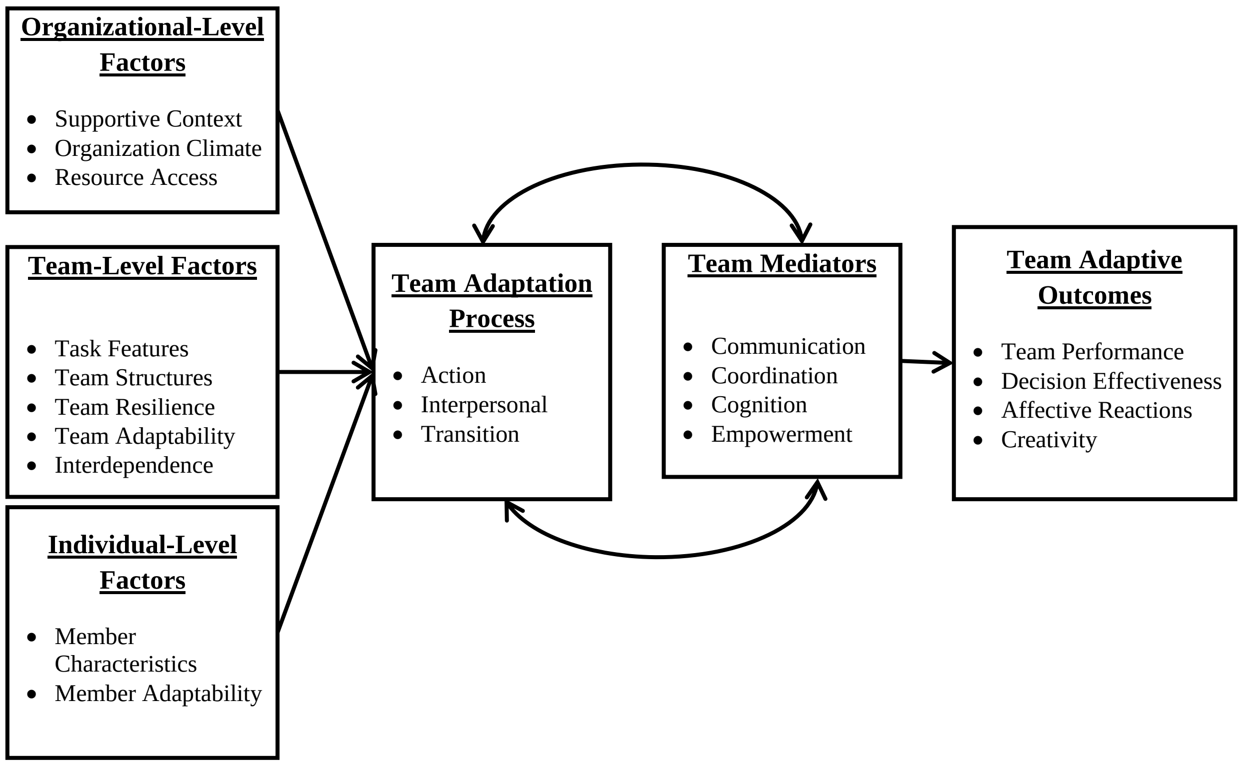


Figure 1.2. Team adaptation nomological network (Maynard et al, 2015).

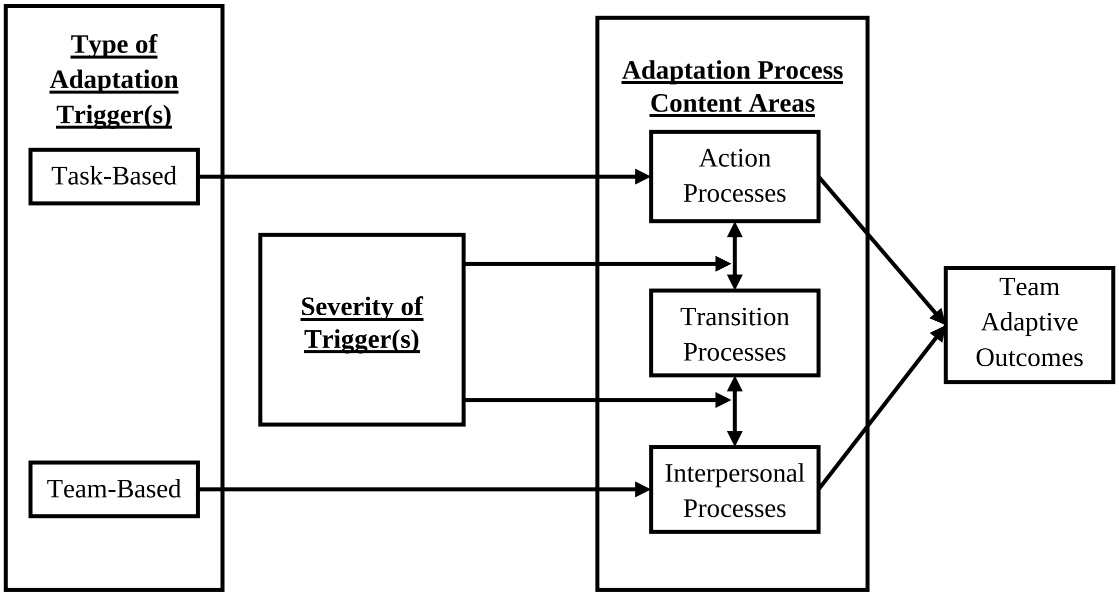


Figure 1.3. Team adaptation process content area (Maynard et al, 2015).

1.3.1 A typology of joint IT use conceptualizations

We build on the seminal paper from Burton-Jones and Gallivan (2007) to propose multilevel view of joint IT use, based on three pillars: system (i.e., technology being used), task (i.e., work being performed through joint use of the IT), and user (actor performing a task by using IT directly or indirectly through collaboration). Our conceptualization comprises two levers: technical elements, and action level. The *technical elements* dimension is made of the first two pillars, that is, it includes the *system* and the *task*. *The action level* is defined as the level of analysis and includes *individual* and *group* (collective of users). This dimension hinges on the third pillar of the proposed conceptualization of joint IT use, that is, user. At individual level, the focus is on individual-level constructs, that is, those that manifest and can be captured at individual level (e.g., affect). At group level, the focus is on constructs that manifest as not related to specific individuals but to a collective of users as a whole (e.g., emergent states such as group harmony). Breaking the "user" pillar into two different levels allows to conceptually separate the *user group* construct from the *user* construct and to better clarify associated outcomes at each level of analysis as well as top-down and bottom-up influences. Table 1.2 summarizes different dimensions of joint IT use covered by the proposed conceptualization. In the first line of the table (i.e., individual action level), the system use of interest is that by a group member: direct or indirect use of a system by a user, with or without collaboration with other group members. In the task perspective the focus is on the task performed by individuals (which may represent subtasks of the group task), with or without coordination with other group members. Here, a "zoom-in" is done from group level (i.e., the focal entity) to individual level (the internal structure of a user group) to identify constructs and relationships that may contribute to group-level states (Zhang and Gable, 2017) – for example, when group task performance is assessed as some combination of individual task performance, examining this construct at the individual level may be useful or required. In the second line of the table (i.e., group action level), the interest is on coordinated system use: the system is collaboratively used – including directly or indirectly – by a user group. Task-wise, a task is performed collaboratively by a user group through action, transition, and interpersonal processes (Maynard et al., 2015). A "zoom-out" is performed from group level to identify and specify influences within the external context of the group – for example, it can be examined how organizational or societal factors come into play to influence user group behavior during joint IT use.

The above conceptualization of joint IT use allows for future research using several perspectives of capturing IT use, which may hinge on either of the seven combinations of system, task, and user pillars, as presented in Table 1.3. These perspectives all involve a system, but they can be used depending on the nature of the phenomenon of study related to IT use. Researchers may be interested in capturing the extent to which a system originally designed for individual use is used by single users or by groups of users collaboratively, without focusing on users or group characteristics (model type 1). Other researchers may focus on the extent to which a user employs a system during joint use of a system (model type 2). In this same context, others may go farther by capturing specificities related to the task a user performs as part of collaborative joint use of a system (model type 3). Besides, researchers may examine the extent to which a system is used to carry out individual task (Burton-Jones and Straub, 2006) in the context of collaborative joint use (model type 4). Regarding group-level elements, future research works may consider examining joint use of a system interface as the extent to which a collective of users simultaneously employ the system (model type 5). Joint IT use can also be conceptualized as the extent to which a collective of users employ a system to perform a group task, with an interest on group-level, system, and task characteristics (model type 6). Finally, an alternative conceptualization may focus on the system and the group task by investigating the extent to which a system is employed to perform group tasks (model type 7).

Combining all these possibilities would allow investigations of joint IT use as a multilevel construct, whose characteristics could be studied both at individual level and at group level, unlike isolated (single-level) investigation. Hence, for the remainder of the present essay, we propose a rich and more general definition of Joint IT use as *the combination of group members' individual and collaborative joint employment of a system to perform a group task*. This conceptualization acknowledges mutual influences between levels of action elements (user and group) and between levels and/or sublevels of technical elements (e.g., system, system feature, team task, or subtasks). An example of research illustrating such cross-level influence is Burton-Jones (2005)'s study, which presents an experiment in which teams of students used Microsoft Excel to perform a business analysis task in which individuals relied on their team's coordination. Burton-Jones found that team collaborative use of the system influenced individual performance. A rationale was that poor coordination among teams jeopardized team members' ability to perform well.

Table 1.2. Dimensions of joint IT use and cross-definitions.

Technical elements → **Action level ↓**	**System**	**Task**
Individual level (user)	A system is used directly or indirectly by a user with or without coordination with the group	A task is performed by a user, with or without coordination with the group
Group level (collective of users)	A system is collaboratively used (direct or indirect use) by the group	A task is collaboratively performed by the group through group actions and interpersonal processes

Table 1.3. Typology of “rich” joint IT use perspectives.

Model type	System use pillars	Joint IT use definition	Type of conceptualization
1	System	Individual or collaborative employment of a system, in a joint use context.	Extent to which a system is used by a single user directly and/or indirectly or by a collective of users. E.g., Frequency of joint interactions with an information system (Trice and Treacy, 1988).
2	User, system	User’s direct and/or indirect employment of a system during collaborative joint tasks.	Extent to which a user directly and/or indirectly employs a system (Burton-Jones and Straub, 2006) during joint system use with other users. E.g., Cognitive load (De Guinea et al., 2014); Cognitive absorption (Agarwal and Karahanna, 2000).
3	User, system, task	A user’s direct and/or indirect employment of one or more features of a system to perform a task (Burton-Jones and Straub, 2006) during collaborative joint use.	Extent to which a user employs system features directly and/or indirectly to perform a task during joint system use with other users. E.g., Adaptive system use (Sun, 2012; Kwok et al., 2012); Variety of use (number of computers supported business tasks) (Igbaria et al., 1997).
4	System, individual-level task	The direct, indirect, or joint employment of a system to perform a task during system collaborative use (e.g., in organizations, in houses).	Extent to which a system is used directly, indirectly, or jointly, to perform an individual task (Burton-Jones and Straub, 2006) during joint system use with other users. E.g., User’s variety of use (number of computer-supported business tasks, by a user) (Igbaria et al., 1997).
5	Collective of users, system	User group’s collaborative employment of a system.	Extent to which a collective of users jointly employ the system with other users. E.g., Group-level score (Burton-Jones, 2005); Set of system features used collaboratively and jointly (adapted from Sun, 2012).
6	Collective of users, system, task	A group’s collaborative and joint employment of a system to perform a group task.	Extent to which a collective of users employ a system to perform a group task. E.g., Team cognition; Task modularizability (Mithas and Whitaker, 2007) using a system.
7	System, group-level task	The employment of a system to perform a group task (e.g., in organizations, in houses).	Extent to which a system is employed to perform group tasks. E.g., Set of system features used collaboratively (from Sun, 2012); Task modularizability (Mithas and Whitaker, 2007) using a system.

1.3.2 Joint IT use framework

IT use has been conceptualized as behaviors (i.e., what users do), cognitions (i.e., what a user thinks, or the extent of cognitive resources mobilized during system use), and affect (i.e., what users feel, that is, emotions) (Burton-Jones and Gallivan 2007; De Guinea and Webster, 2013). Besides, group-level IT use has generally been conceptualized as the aggregation of individual use-related constructs (e.g., average group members' frequency of use and average group members' depth of use (Easley et al., 2003)) or as complex patterns of cognitions, affects, and behaviors emerging in a group (Burton-Jones and Gallivan 2007). In addition, it has been suggested that group adaptation can be assessed through behaviors, cognitions, and affect (Pearsall et al., 2009; Ilgen et al., 2005).

Consistent with these views, we propose the use of three constructs to investigate joint IT use mechanisms, namely, behaviors, cognitions, and emotions. We use the term *emotions* rather than *affect* because recent IS literature examines emotions as made of two dimensions, namely, affect (often referred to as *emotional valence*), and arousal (often measured through physiological activation) (e.g., Tchanou et al., 2021; Giroux et al., 2019; Tchanou et al., 2018; Riedl and Léger, 2016; De Guinea et al., 2014; De Guinea et al., 2013). Hence, we define joint IT use mechanisms as configurations of group members' behaviors, cognitions, and emotions, and group-level emerging states and behaviors during collaborative joint use of a shared system interface. These mechanisms may include structural relationships as well as process flows involving their foregoing three constituents.

Based on the proposed multilevel conceptualization of joint IT use construct and borrowing from previous work on team adaptation (Maynard et al., 2015; Ilgen et al., 2005), we propose a framework of collaborative joint IT use, which is depicted in Figure 1.4, Figure 1.5, and Figure 1.6. This framework hinges on the three foregoing pillars, that is, system, task, and user as building blocks of joint IT use. Figure 1.4 presents an overview of the research framework, which is based on the IMOI model. The framework is made of three layers, namely, the *Inputs*, the *Mechanisms*, and the *Outcomes* layers. Figure 1.5 presents a more detailed view of the model in Figure 1.4 with the main higher order constructs; and Figure 1.6 presents the detailed research framework, which is a zoom-in of the model in Figure 1.5 with higher-order as well as lower-order constructs.

Collaborative IT use entails group adaptations, which happen in response to changes in collaborative use environment (including in socio-technical system involving the group, the system, and the task). Such changes can be internal to the group-system-task system (e.g., changing power structure within the group, system interruptions, or changed task requirement) or external to it (e.g., new application support service). The proposed framework considers both types of changes and their influences on individual-level and group-level configurations of emotions, cognitions, and behaviors. We call such changes *IS-related triggers* (or *triggers* for simplicity), defined as changes internal or external to the group-system-task system that influence characteristics or behavior of one or several of its elements (i.e., of the group, the system, or the task).

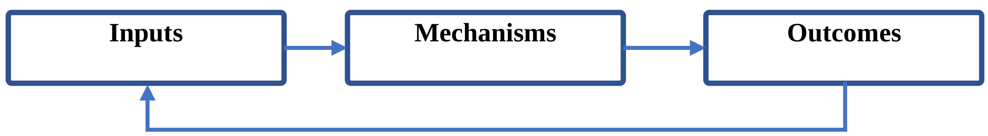
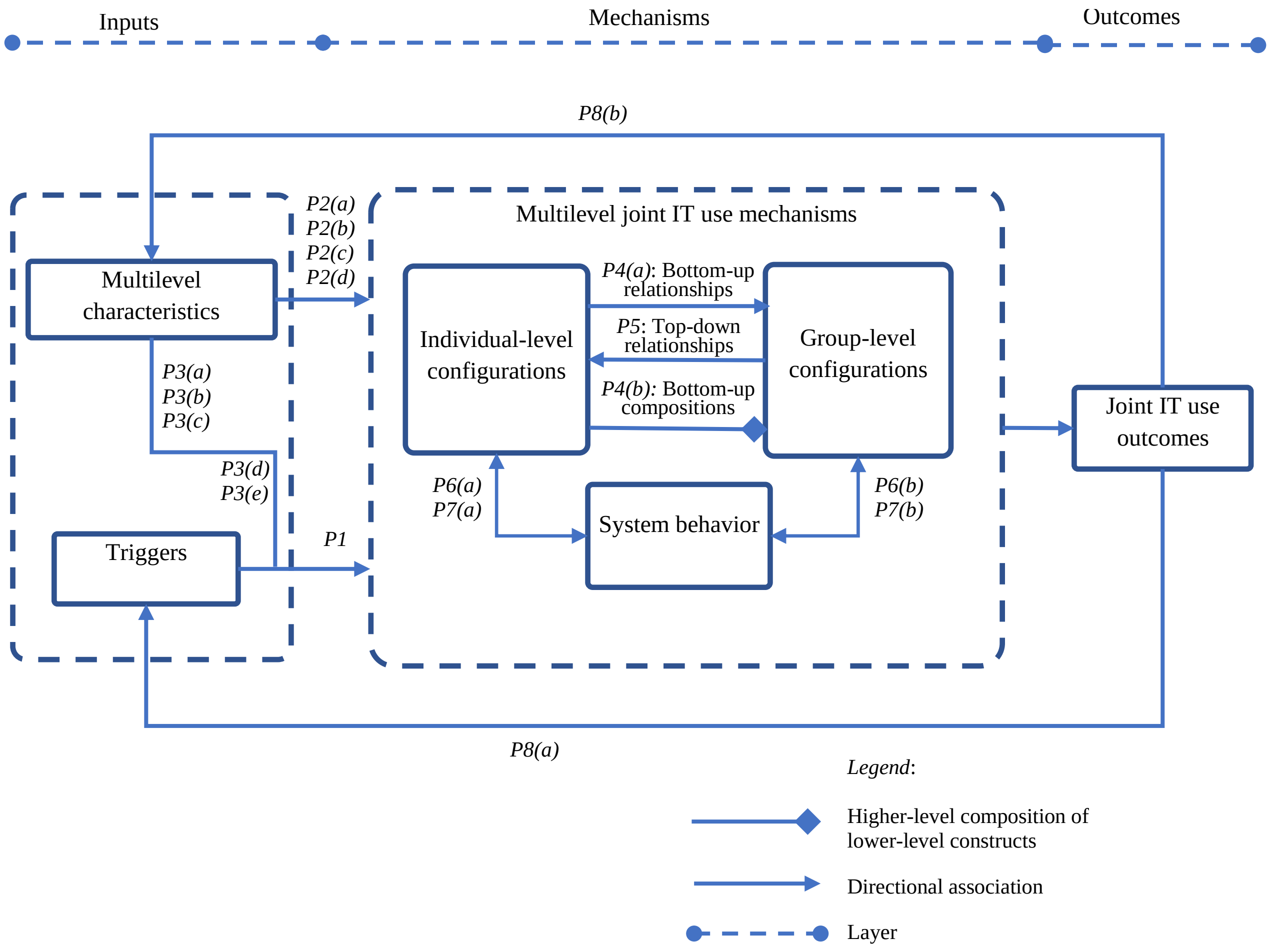


Figure 1.4. JITU framework overview.



Note. P = Proposition.

Figure 1.5. Intermediate view of is the JITU Framework.

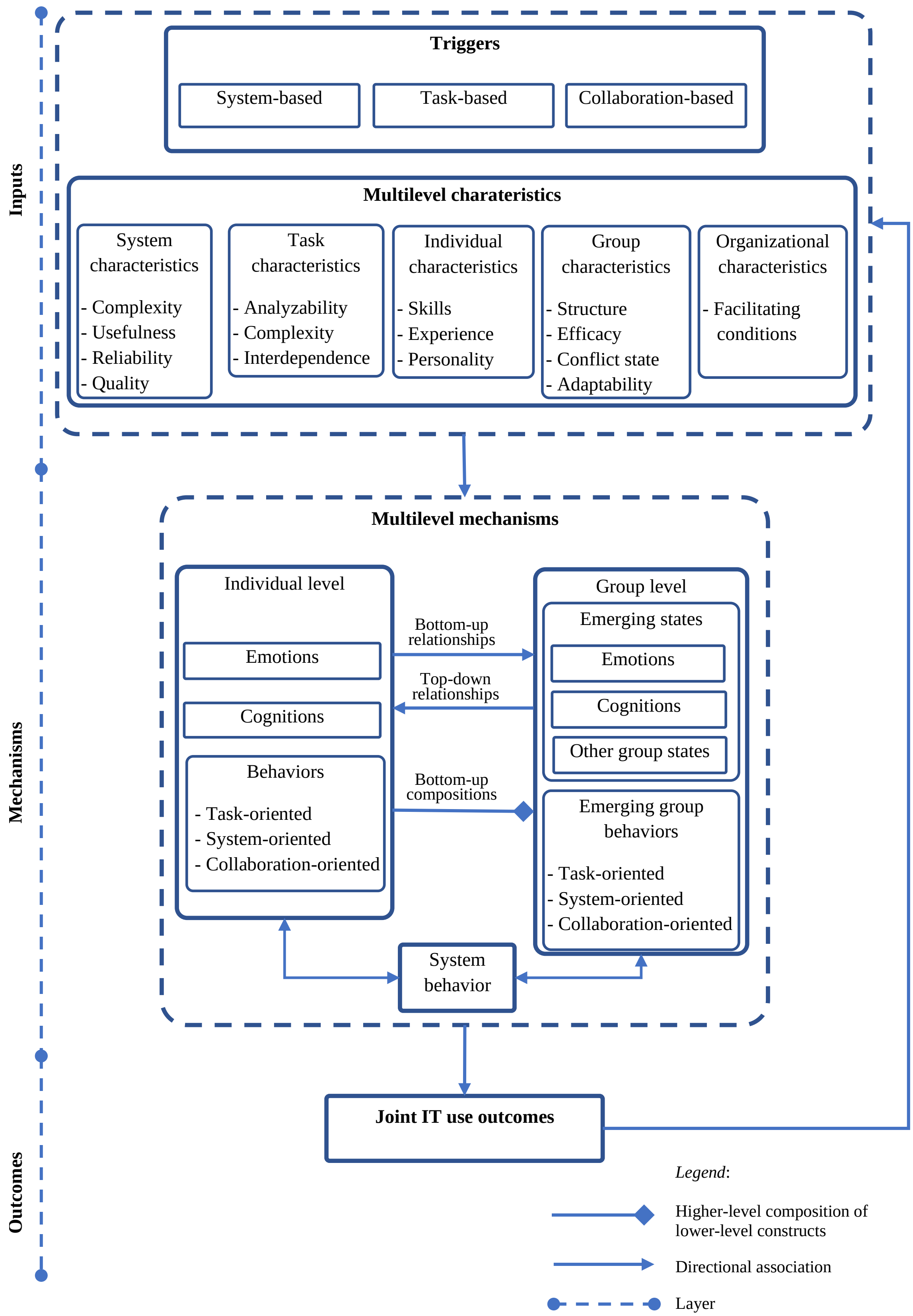


Figure 1.6. Detailed JITU framework.

1.3.2.1 Inputs

We consider *triggers* part of the Input layer, since they are the starting points of group adaptation processes and antecedents of group emerging states (Maynard et al., 2015). We group triggers into three categories, namely, system-based, task-based, and collaboration-based triggers. Past research suggests the existence of two types of triggers: expected events, and unexpected events (Gersick and Hackman, 1990; LePine, 2003). Hence, each category of triggers can be separated into expected and unexpected. *System-based triggers* refer to events raised within a system, which include expected and unexpected IT events. Expected IT events are happenings related to normal course of IT use and are characterized by a match between group's expectation and system behavior. Unexpected IT events can be discrepant IT events (which are unwanted) or discovery IT events (i.e., positive unexpected IT event materialized by the discovery of a new functionality or a new way to use system features) (De Guinea, 2016; De Guinea and Webster, 2013). *Task-based triggers* are changes in task characteristics (e.g., task requirement, instructions, and procedure) and new task attribution. Finally, *collaboration-based triggers* are related to group interactions (i.e., collaboration) in the purpose of performing a task at hand using a system. Unexpected triggers in this category (i.e., collaboration discrepancies) include such factors as uncoupling incident (i.e., loss in coordination among group members (Zhu and Benbasat, 2010)), conflicts, miscommunication, and group member role change (Maynard et al., 2015) or empowerment (e.g., a user controlling the mouse hands over control to partner user indirectly interacting with the system).

In the input layer we also include characteristics at system, task, individual, team, and organizational levels. System characteristics include elements such as system usability constructs (Ayyagari et al., 2011), namely, *complexity* (i.e., the degree to which IT use is free of effort), *usefulness* (i.e., the degree to which system characteristics enhance job performance), and *reliability* (i.e., the degree to which system features and capabilities are dependable), or *system quality* (DeLone and McLean, 2003). We suggest that system characteristics may influence the ability to adapt to environmental triggers. For example, system complexity and system reliability have been found to influence team members' work overload (Ayyagari et al., 2011). Hence, as depicted in Figure 1.5, system characteristics may directly influence joint IT use mechanisms and moderate the impact of triggers on the latter.

Task characteristics include analyzability, complexity, and interdependence (Bagayogo et al., 2014). *Task analyzability* represents the extent to which a task has formal, well-defined procedures (Karimi et al., 2004); *task complexity* is defined by the number of distinct acts that must be completed and the amount of information that need to be processed (Bagayogo et al., 2014); *task interdependence* is the extent of output exchange among group members (Bagayogo et al., 2014; Karimi et al., 2004) to accomplish a group task. We propose that these task characteristics may influence group adaptability. Higher task analyzability (clear procedures) may help a user group better allocate subtasks to its members, which may facilitate adaptation to changes. Furthermore, research suggests that task complexity may be associated with group emerging states such as group cohesion, depending on group composition (Higgs et al., 2005). Besides, research suggests that task characteristics are associated with patterns of IT use. For instance, Bagayogo et al. (2014) suggest that task characteristics influence locus of innovation, extent of substantive use (i.e., reflective engagement – such as cognitive effort – involved in system use), and user adaptation during manifestation of different patterns of IT use. Yet, user adaptation contributes to group-level adaptability (Maynard et al., 2015). Clearly, task characteristics may influence the way user groups adapt to IS-related triggers.

Past group dynamics research suggests that individual characteristics play an important role in group members' capacity to adapt to environmental triggers (Maynard et al., 2015). Examples include team member's *skills*, *experience*, and *personality* (e.g., open-mindedness, enthusiasm for learning, flexibility, and ability to remain composed and calm) (Maynard et al., 2015; Pulakos et al., 2000; Pulakos et al., 2006). Likewise, how groups adapt to disruptions has been found to be influenced by group characteristics, including group structure, extent of shared mental models (i.e., group members' mental representations of a system and related knowledge and relationships), collective efficacy, and conflict state (i.e., the extent to which group members are in conflict with one another) (Maynard et al., 2015; Uitdewilligen et al., 2013). Moreover, how a user group adapts during joint IT use may be influenced by organizational factors, including facilitating conditions, defined as the degree to which an organizational and technical infrastructure exists to support the use of a system (adapted from Venkatesh et al. 2003). Finally, research suggests that individual traits such as tolerance, and group composition such as diversity, influence group cohesion (Higgs et al., 2005), suggesting possible influence of individual characteristics on group emerging states, which is part of group-level mechanisms in our JITU framework.

Based on above developments, we make the following propositions.

Proposition 1: *IS-related triggers may directly influence joint IT use mechanisms.*

Proposition 2: (a) *System, (b) task, (c) individual, and (d) group characteristics, respectively, may directly influence joint IT use mechanisms.*

Proposition 3: (a) *System, (b) task, (c) individual, (d) group, and (e) organizational characteristics, respectively, may moderate the influence of IS-related triggers on joint IT use mechanisms.*

1.3.2.2 Mechanisms

This second layer of our JITU framework encompasses mechanisms of joint IT use. They include group adaptation processes and group emergent states, all emerging from individual-level patterns. They also include system behaviors inter-related with individual-level or group-level mechanisms. For example, as demonstrated in the human-computer interaction literature involving bioadaptative systems paradigms, systems may adapt their behavior to account for user emotional and cognitive states, which in turn may be influenced by system behaviors (e.g., Karran et al., 2019; Demazure et al., 2019).

Group adaptation processes include processes of actions, that is, behaviors (Uitdewilligen et al., 2013). We propose that these actions are of three categories, namely, task-oriented, system-oriented, and collaboration-oriented, which respectively correspond to transition, action, and interpersonal types of team processes proposed by Marks et al. (2001). *Task-oriented actions* aim at modifying procedures of task execution, elaborating a common strategy, and planning for task execution. *System-oriented actions* refer to actual interactions with an IT in order to perform a task or modify the system or the way it is used, in the normal course of the IT use or to cope with an unexpected event (Barki et al., 2007; Sun, 2012). Interactions with a system aiming at direct task performance have been referred to as *exploitive system use*, since they entail straightforward system exploitation to perform a task at hand (Burton-Jones and Straub, 2006). System interactions aiming at altering the system or the way it is used have been referred to as *adaptive system use* (Sun, 2012; Barki et al., 2007; Burton-Jones and Straub, 2006). Examples of system-oriented actions include modifying the functional configuration of a program, or collectively looking at system visual interface components to align group members' mental models (i.e., individuals' mental representations of the system). *Collaboration-oriented actions* represent means by which a group fulfills tasks together and are directed to interactions among group members, including for coordination, communication, conflict management, confidence building, and affect management.

Mechanisms of IT use also include emergent states, which are group-level configurations of emotional and cognitive states. Cognition has been investigated in the IS literature through constructs such as thoughts (De Guinea and Webster, 2013), cognitive load (e.g., Mirhoseini, 2018), cognitive absorption (e.g., Léger et al., 2014; Agarwal and Karahanna, 2000), attention (e.g., Lee and Ahn, 2012; Labonté-LeMoyne et al., 2015), and engagement (Riedl and Léger, 2016; Léger et al., 2014). Besides, emotions have been investigated using a categorial perspective focused on discrete emotions (e.g., happiness, anger, and disgust: Ekman and Friesen, 1978) or a dimensional perspective suggesting a three-dimension view of emotions made of emotional valence (i.e., affect), emotional arousal (i.e., physiological activation), and dominance (i.e., feeling in control) (Grimm and Kroschel, 2005). Group configurations of behaviors, cognitions and emotions emerge from individual cognitions and emotions (Maynard et al., 2015; Burton-Jones and Gallivan 2007). They have been conceptualized through aggregation of group members' behaviors, cognitions, and emotions respectively (e.g., Tchanou et al., 2020b). We refer to this multilevel relationship as *bottom-up composition*. Group-level configurations have also been conceptualized through emerging states not necessarily captured based on individual-level constructs, including group cohesion, conflict, communication (e.g., Higgs et al., 2005). However, calls have been made for considering other ways of assessing multilevel influences, such as examining bottom-up as well as top-down influences between team level and individual level constructs (e.g., Markus and Rowe, 2018; Zhang and Gable, 2017). An illustration of bottom-up influence is the relationship between group members' attitude and group harmony. For example, Higgs et al. (2005) suggest that group member's tolerance attitude positively influences group cohesion. A top-down influence illustration is that of a group harmony on individual emotions. For example, Burton-Jones (2005) found that poor coordination among teams adversely influences team members' individual performance. Moreover, Higgs et al. (2005) suggest that increasing the level of diversity in a group's composition positively influences group members' tolerance attitude. Finally, just as we suggested reciprocal relationship between individual-level configurations and system behavior, we suggest that the latter may impact collaboration dynamics during joint system use. For instance, system information feedback and processing may drive discussions and decision process among user partners.

Above developments leads us to make the following propositions.

Proposition 4. *Individual-level mechanisms may (a) influence or (b) compose group-level mechanisms during joint IT use.*

Proposition 5: *Group-level mechanisms may influence individual-level mechanisms during joint IT use.*

Proposition 6: *(a) Individual-level and (b) group-level mechanisms, respectively, may influence system behavior during joint IT use.*

Proposition 7: *System behavior may influence (a) individual-level and (b) group-level mechanisms, respectively, during joint IT use.*

1.3.2.3 Outcomes

The third layer of the proposed JITU framework is concerned with consequences (outcomes) of joint IT use mechanisms. Collective IT use outcomes investigated in the literature include group performance (e.g., group effectiveness and efficiency), decision effectiveness, emotional reactions (Maynard et al., 2015), group flow states (e.g., Borderie and Michinov, 2017; Labonté-Lemoyne et al., 2016), and creativity (e.g., Cirella et al., 2014). These group-level outcomes are relant to joint IT use, a specific case of collective

IT use. Individual IT use outcomes include user satisfaction (Sun et al., 2016), behavioral intention (e.g., Polites and Karahanna, 2012; Venkatesh et al., 2003), performance (e.g., Burton-Jones and Grange, 2013). These individual-level outcomes can be influenced not only by direct interactions with IT but also by IT-related activities including group collaboration during joint IT use (Barki et al., 2007) .

We propose that joint use outcomes in turn may influence constructs at the Inputs layer. For example, it is possible to imagine plausible scenarios in which group poor intermediate performance would lead to more frustration among the team and ultimately to greater or lesser conflict state at group level. This conflict state may act as a group-level characteristic that may influence constructs or processes in the mediator layer such as team coordination behaviors. Moreover, individual satisfaction may cause individual actions that would act as trigger to further individual-level or group-level mechanisms. For example, past research suggests that couples jointly shopping tend to clash over input device control (Mekki Berrada, 2011), denoting some degree of related user dissatisfaction as possible source of conflict. Such clashes are triggers for subsequent IT use mechanisms. Moreover, such clashes may reasonably cause change in individual roles during the joint activity or in the power structure related to input device control. Consequently, we make the following proposition.

Proposition 8. *Joint IT use outcomes may influence (a) IS-related triggers and (b) multilevel characteristics.*

1.4 Discussion

As a ground for the present work, we raised the need for more research on joint IT use. Such perspective lacking in IS, the present work leverages the group dynamics literature and seminal works on collective IT use to develop and propose a framework and a typology for increasing understanding of the phenomenon of study. Joint IT use is conceptualized using two levers, namely, technical elements (i.e., the system and the task) and action elements (i.e., user and team using the system together). Based on these levers we developed a typology of seven perspectives of Joint IT use. Researchers may use this typology to develop conceptualizations of joint IT use that capture essential elements of their phenomenon of interest. Researchers may also use the typology as a significant ground for clarifying conceptualization of the broader collective IT use construct as they apply to their specific research context. Furthermore, this research proposes a framework of joint IT use, with the IMOI model of team adaptation proposed by Ilgen et al. (2005) and the team adaptation process framework proposed by Marks et al. (2001) as background concepts. The framework depicts influences from triggers of three types (system-based, task-based, and collaboration-based) and from system, task, individual, group, and organizational characteristics, on joint IT use-related mechanisms at individual, group and system levels. Individual and group mechanisms, that is, associations of emotions, cognitions, and behaviors, participate in cross-level relationships, including top-down associations as well as bottom-up associations and compositions. The joint IT use mechanisms influence joint IT use outcomes, which in turn may influence back constructs in the input layer, including IS-related triggers and multilevel characteristics.

1.4.1 Contributions

This research makes several theoretical contributions. First, we propose a holistic construct of joint IT use through which mechanisms of IT use can be examined based on building blocks that have been used in the literature, that is, emotions, cognitions, and behaviors (e.g., Burton-Jones and Gallivan 2007; De Guinea and Webster, 2013). Our proposed multilevel typology of joint IT use responds to calls for richer conceptualizations of IT use (e.g., Burton-Jones and Straub, 2006) and avails a very diverse set of perspectives. For example, this typology can be used to examine the joint IT use phenomenon by focusing on individual users, collectives of users, group-level or individual-level tasks, and/or the system.

Second, the present work answers past calls to consider the multilevel nature of IT use (e.g., Burton-Jones and Gallivan, 2007; Zhang and Gable, 2017) and to examine cross-boundary change between upper and lower levels, that is upward and downward influences (Markus and Rowe, 2018). For example, the framework allows for the investigation of how group cognition emerges from individual user cognition, or how group harmony during joint use of a system emerges from individual user emotions.

Third, the proposed multilevel framework allows for the investigation of IT use not only in the dominant fashion grounded in theories of reasoned action but also in more "real-time" fashions, that is, during the actual use of the IT. Traditional IT use or IT continuance theories help explain why individuals will use a new system or why they continue using a system they already experienced (Bhattacherjee, 2001). These theories are mainly based on users' behavioral beliefs about a system and their intention to use or continue to use the system (e.g., Venkatesh et al., 2016). However, these theories do not help explain variance in factors that come into play during the actual utilization of a system, especially, emotional, cognitive, and behavioral factors experienced by users or collectives of users (De Guinea and Webster, 2013). The present work addresses this gap by considering influences and antecedents of multilevel configurations of emotions, cognitions, and behaviors during the real-time use of a system, based on different types of IS-related event and multilevel characteristics. Hence, based on the proposed framework, research on joint use of shared system interfaces, which is embryonic, can be done based on the reasoned action paradigm or based on the "real-time" assessment of IT use mechanisms (e.g., De Guinea and Webster, 2013), both at individual and group levels.

Fourth, our proposed framework allows for investigation of optimal configurations of individual or group factors, system characteristics, and task characteristics for better outcomes in two ways. First, based on the quality of outcomes, ideal patterns of individual and group emotions, cognitions, and behaviors could be linked to specific system and tasks characteristics. Second, it could be investigated what IS triggers generate ideal individual or group IT use patterns for better performance. Hence, our framework could contribute to the task-technology fit (Goodhue and Thompson, 1995) paradigm through theoretical extensions to group level by allowing for investigations of user group, group task, and technology characteristics and the relationship between group task, technology fit, and IT use-related group performance constructs.

Fifth, our JITU framework is not focused on a specific context of IT use. It is generic and can be adapted in diverse settings, as it provides a broad perspective for investigation of joint use of systems. Consequently, it can be used by researcher not only in professional settings but also in hedonic settings.

Finally, the typology of conceptualizations of joint IT use and the framework we propose can apply to user groups made of two or more users. Hence, our study allows for a variety of system use setups. For example, it can be instrumental for the study of dyadic or triadic decision-making processes during joint interaction with shared system interfaces. It may also be useful to investigate learning processes in group training settings relying on technologies.

1.5 Conclusion

1.5.1 Research avenues

Like most research works, the present study presents rooms for different extensions. One of them resides in the fact that it does not provide illustrations of possible instantiation of the proposed framework. Future research may develop a theoretical or an empirical model based on the JITU framework. Moreover, the framework does not clearly discriminate between process modeling and variance modeling. Future research could specifically address how joint IT use processes may form. Other research works may focus on the variance perspective for investigating IT use mechanisms. Such conceptual separation of joint IT use process view and variance view may bring more clarity to the framework as well as ease its exemplification in process-oriented and in variance-oriented research.

Through the present study, we intended to propose a holistic approach to conceptualizing and studying joint IT use. Future research may examine approaches focused on each type of multiuser setting we identified in section 1.2.1. Such approaches may bring light on differences in joint use mechanisms related to specific contexts including system configuration.

1.5.2 Concluding remarks

Research on joint use of shared interfaces being lacking in IS research, this essay can be considered an initial effort to formally define a framework for investigating the phenomenon of multiple users interacting together with a system interface. The framework allows for both variance and process theorizing, as it incorporates not only individual constructs and group-level emergent states but also processes of actions. Moreover, it suggests rooms for extending IS use literature not only through the traditional paradigm based on the theory of reasoned action, but also through perspectives focused on real-time assessment of group system use. In addition, our proposed framework addresses joint IT use not only by user dyads (made of two users) but also by user groups made of more than two persons. Besides, it applies to not only to instrumental, professional context but also to hedonic contexts. Furthermore, future research will benefit our typology of conceptualizations of group-level IT use by suggesting a diverse set of views of collaborative IT use.

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Chapter 2 - Essay 2

Multiuser Human-Computer Interaction Settings: Preliminary Evidence of Online Shopping Platform Use by Couples[6]

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Abstract.

The phenomenon of multiple users interacting together with a single shared system interface to perform a task (i.e., a multiuser human-computer interaction) is under-investigated in the Human-Computer Interaction (HCI) literature, yet it shows promising avenues for research. For example, little is known about cross-level influences driving collaborative use of a shared system interface, and the literature lacks knowledge about collective adaptation of users to triggers in this setting. The present work contributes to contemporary research on multiuser HCI with system interfaces. As an initial effort, it focusses on the joint use of online shopping platforms by couples. A survey is conducted with 390 respondents in the USA about couples' habits regarding joint online shopping. Results suggest that joint online shopping is overwhelmingly common among couples and that they engage in such activity in a wide variety of ergonomic layouts. Our findings constitute preliminary evidence and intrinsically call for more researchers' interest in investigating emotional, cognitive and behavioral dynamics taking place when multiple users jointly use system interfaces. Such research endeavors may ultimately inform and optimize multiuser system designs and corresponding products and services.

Keywords: Multiuser Human-Computer Interaction, Shared System Interface, Collaborative Use, Joint Online Shopping, Couples' Online Shopping, Joint System Use.

2.1 Introduction

The phenomenon of study addressed in this paper is that of multiple users interacting together with a single shared system interface to perform a task. This perspective is important for several reasons. Although most computer systems are designed for use by a single user, they are frequently used in multiuser settings. Examples include individual shopping systems such as e-commerce platforms (e.g., Mekki Berrada & Montréal, 2011; Yue et al.; Zhu et al., 2006). To illustrate further, a recent study revealed that 53% of online purchases by households are operated by two or more users shopping online together (Briggs, 2018). Hence, it is common that individuals use information technologies collaboratively with other users by interacting with a single system interface (Burton-Jones & Gallivan, 2007).

Despite its importance, this perspective of multiuser interaction with a shared system interface is scant within the human-computer interaction (HCI) literature. Introducing this perspective may contribute to addressing several limitations in extant literature. First, the HCI literature on collaborative system use has been examined mostly through studies focused on group-level use of systems made to be used by groups of users separately, such as with group support systems (e.g., Dennis et al., 2001) and collaborative systems (e.g., Doll & Deng, 2001). Very few studies on group-level system use focus on collaborative task processing jointly performed through a shared system interface. Second, past research has essentially conceptualized system use at a single level of analysis (e.g., individual level or group level), without explicitly addressing cross-level associations, that is, possible influences from or to other lower or higher levels of analysis (Markus & Rowe, 2018). Third, the literature on user adaptations during interactions with a system addresses the question of patterns of user coping with triggers (e.g., De Guinea and Webster, 2013); however, this literature only considers single-user system use. Hence, little is known about how multiple users, both collectively and individually, adapt to triggers while they jointly interact with a system.

The objective of the present paper is to contribute to contemporary research on multiuser interaction with system interfaces. As an initial study, this research focuses on the collaborative use of online shopping platforms by couples. Two research questions (RQ) are investigated:

RQ1: *To what extent do couples jointly use online shopping platforms?*

RQ2: *In what settings do couples shop together using online platforms?*

To answer these questions, an online survey was conducted on couples' habits of joint online shopping. Based on a sample of 390 responses, detailed results are presented on a variety of perspectives showing the extent to which, as well as settings in which, couples jointly use online shopping platforms. Findings suggest that couples spend a significant amount of time jointly navigating the Internet, with 43.95% of couples spending more than 3 hours/week in this activity. Findings also suggest that couples shop together in different ways. During this activity, they use a wide variety of ergonomic layouts and are significantly more physically co-located than remote from each other. Analyses revealed that during joint online shopping couples most frequently use two separate smartphones, followed by comparable frequencies of using either the same computer or two separate computers. In terms of screen layout, during joint online shopping, couples mostly use the same website window when they use the same screen, whereas they mostly use different website windows when they use separate screens. Regarding the location of this joint activity, couples engage in it mostly from home, and specifically either in the living room or the bedroom, and tend to do so physically separated (i.e., remotely) from each other, with men maintaining control of the mouse significantly more than women. Finally, couples engage in joint online shopping mostly on websites related to travel and tourism, computers and electronics, and classified ads.

The remainder of this paper is structured as follows: the study's methodology is presented first, followed by the results, and ending with a discussion of emergent implications.

2.2 Methodology

To answer the above-mentioned research questions, a survey in the U.S.A. was conducted regarding couples' habits of joint online shopping (note: participants were asked to report on their habits under normal times/conditions). Participants were randomly recruited from a general online population through Amazon Mechanical Turk (MTurk), a crowd sourcing online platform having a United States user base of approximately 85,000 “Turkers” (Robinson et al., 2019). Participants were required to be in a relationship, without taking into account their marital status or whether they lived with their partner. The survey had to be completed by a single respondent. Finally, the study was approved by the ethics committee of the authors’ institution (ethical certificate number: 2021-3978), and each participant provided informed consent.

A total of 490 respondents participated to the study. Excluded from the analysis were responses from participants, who: (i) reported not being in a relationship, (ii) failed one of the attention check questions on MTurk, (iii) completed the survey multiple times, or (iv) completed the survey in an extremely fast pace that would not allow for meaningful processing of the questions and answer options (i.e., 3 seconds per question, on average). After this meticulous review and cleansing of the questionnaire data collected, the final dataset comprised 390 usable responses.

In addition to demographic information, participants reported on various aspects of their joint online shopping habits, including the extent to which: they buy certain categories of products together; shop together in different types of locations; use different device setups; use different types of screen layouts, in terms of device screen(s) (i.e, same or separate) and website window(s) (i.e, same or different); and each partner controls the mouse during joint shopping. The product categories chosen based on existing product categories that were investigated in the literature in the context of online shopping by couples (Mekki Berrada, 2011), which were refined and extended following working sessions with two marketing experts. The added product categories are Real Estate, Clothing and Fashion, Leisure Activities, And Cars. The questionnaire was administered through the Qualtrics.com platform. Table 2.4 presents the participants’ demographics.

Several visualizations of various aspects of the collected data and analyses were produced. Significance tests on differences observed were performed using linear regression with random intercept, at $\alpha = 0.05$ significance level and using two-tailed p-value adjusted for multiple testing using the Holm-Bonferroni method. The analyses were performed using the SAS statistical software.

2.3 Results

Results are presented in Figure 2.7 to Figure 2.22. Differences observed in bar charts are generally statistically significant. The statistics related to the pairwise comparisons are presented in Table 2.A40, Table 2.A.41, Table 2.A.42, Table 2.A.43, Table 2.A.44, and Table 2.A.44 of Appendix A.

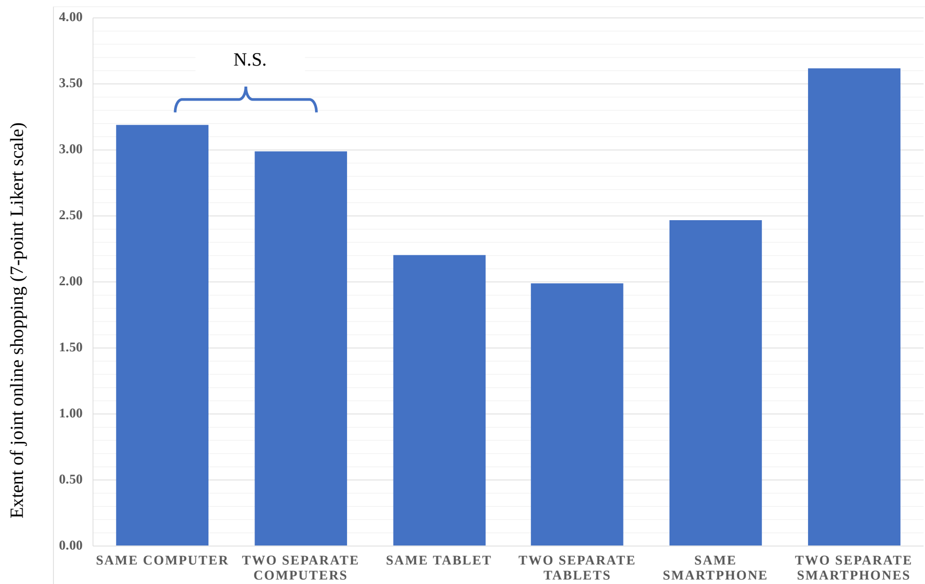
Regarding which device setup – smartphone, tablet, or computer, and whether single or multiple devices were used – couples used when they jointly shop online, Figure 2.7 shows that couples use two separate smartphones significantly more than using the same smartphone; in fact, the former is the most frequently used of all device setups. Regarding the use of computers, couples reported using the same computer more frequently than separate computers but not to a statistically significant different level. Finally, the least used device setups by couples during joint online shopping were the use of the same smartphone, the same tablet, and two separate tablets. In terms of response data distribution, Figure 2.8 shows that the same trend as in Figure 2.7 was observed, except for the two most used setups. A total of 93.59% of couples appear to jointly shop together at least occasionally using the same computer, while 92.05% use two smartphone occasionally, 86.67% use two separate computers, 82.56% use the same smartphone, 68.97% use the same tablet, and 61.28% use two separate tablets. Figure 2.9 shows relative frequencies per device setup, suggesting higher frequencies for the use of two smartphones or the same computer.

Concerning which screen layouts couples use when they jointly shop online, Figure 2.10 shows that when they use the same screen, they mostly use the same website window. Also, using the same window within the same screen appears to be the most used of all four screen layout options. On the other hand, when couples use separate screens to jointly shop online, they tend to use multiple windows as opposed to using the same window. The next most used layout is the use of multiple website windows within separate screens. The least popular setups reported were the use of the same shared window within separate screens and finally the use of different website windows within the same screen. The same trend was observed with the data distribution as shown in Figure 2.11. A total of 93.33% of couples appear to at least occasionally use the same website window when they use the same screen for joint online shopping, while 71.03% use different websites windows. Finally, 87.69% use different website windows when they use separate screens, while 78.72% use a same shared website window. Figure 2.12 shows relative frequencies per screen layout, suggesting higher frequencies for the use of a shared window when using the same screen and the use of different windows when using separate screens.

Table 2.4. Participants' demographics.

Demographics variables		Frequency	Percentage
Participant's Gender	Male	218	55.90%
	Female	170	43.59%
	Other	2	0.51%
Partner's Gender	Male	174	44.62%
	Female	215	55.13%
	Other	1	0.26%
Participant's Age	18-25 years	41	10.51%
	26-35 years	197	50.51%
	36-45 years	87	22.31%
	46-55 years	43	11.03%
	Greater than 55	22	5.64%
Participant's Education Level	High school	61	15.64%
	College	69	17.69%
	Undergrad	104	26.67%
	Graduate	115	29.49%
	Post-graduate	41	10.51%
Household Income	< $30,000	29	7.44%
	$30,000-$49,999	73	18.72%
	$50,000-$69,999	102	26.15%
	$70,000-$89,999	86	22.05%
	> $90,000	100	25.64%

Regarding the physical location from where couples shop online together, as shown in Figure 2.13, results show that couples do so mostly being physically co-located, specifically in their living room, followed by their bedroom. The third most common location to jointly shop online is to be physically remote from each other and in different rooms. This setting' reported value was not statistically significantly different from those from joint shopping in the kitchen, in separate rooms at home, and at the same location out of the home. Lastly, joint shopping in the yard or in the garage were also reported albeit at the lowest frequencies.



N.S. = Non-Significant at $\alpha = 0.05$.

Figure 2.7. Extent to which couples use each device setup during joint online shopping.

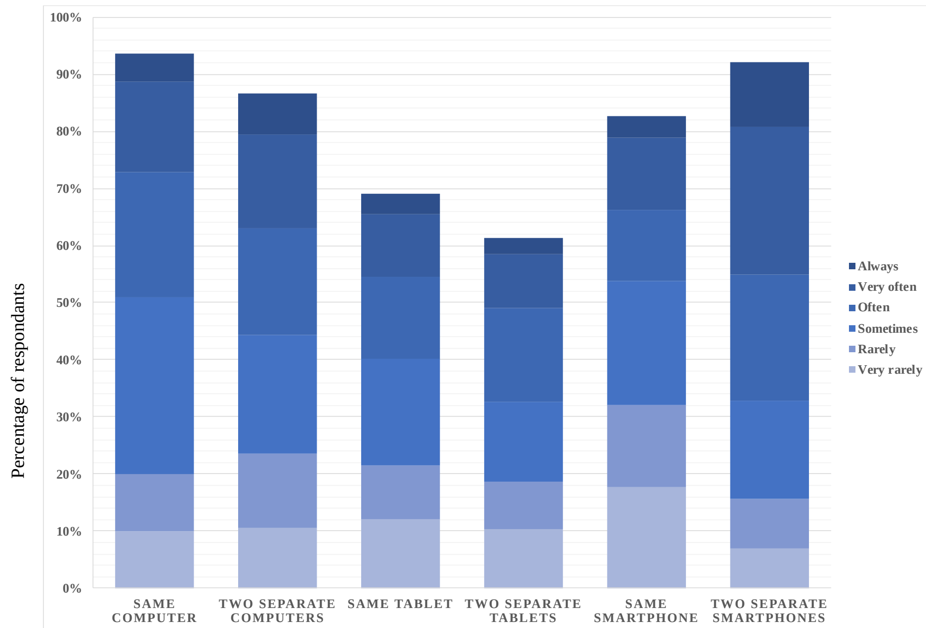


Figure 2.8. Proportions of respondants per device setup use during couples' joint online shopping.

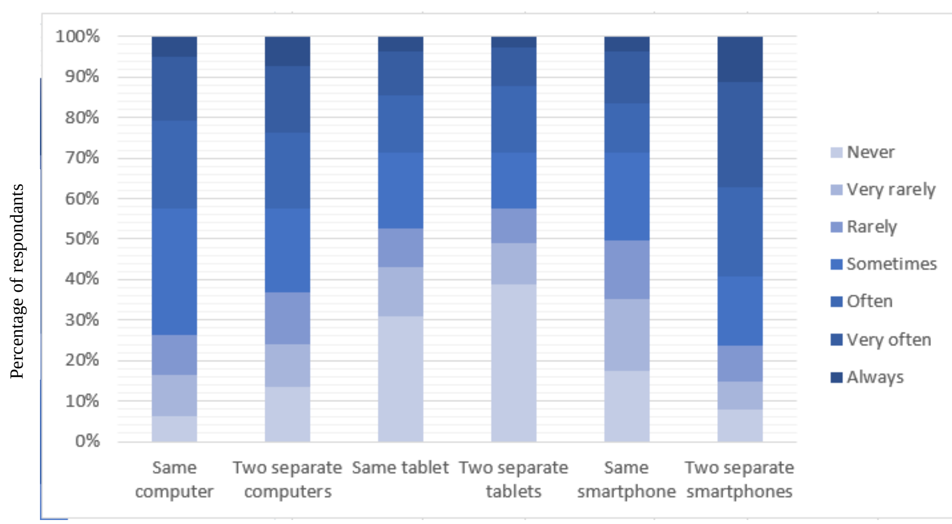


Figure 2.9. Relative proportions of respondants per device setup and per frequency of use during couples' joint online shopping.

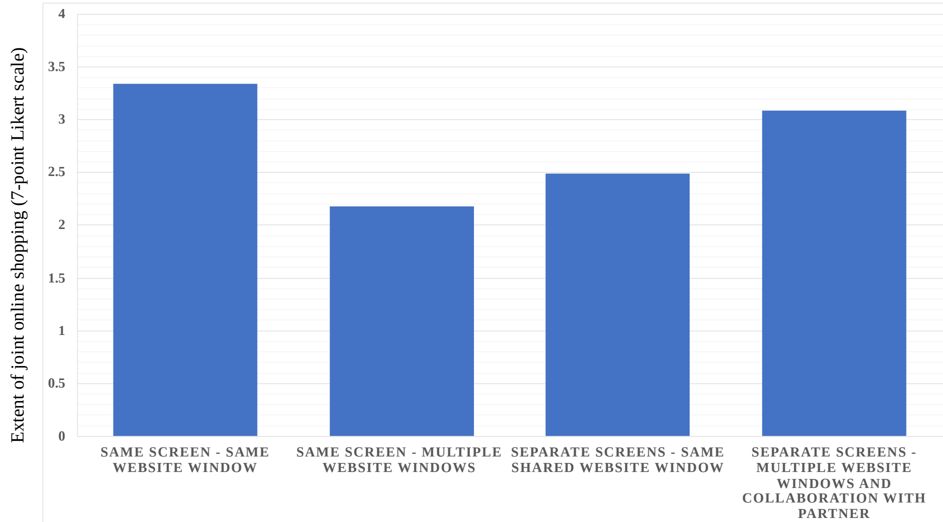


Figure 2.10. Extent to which couples use each screen layout during joint online shopping.

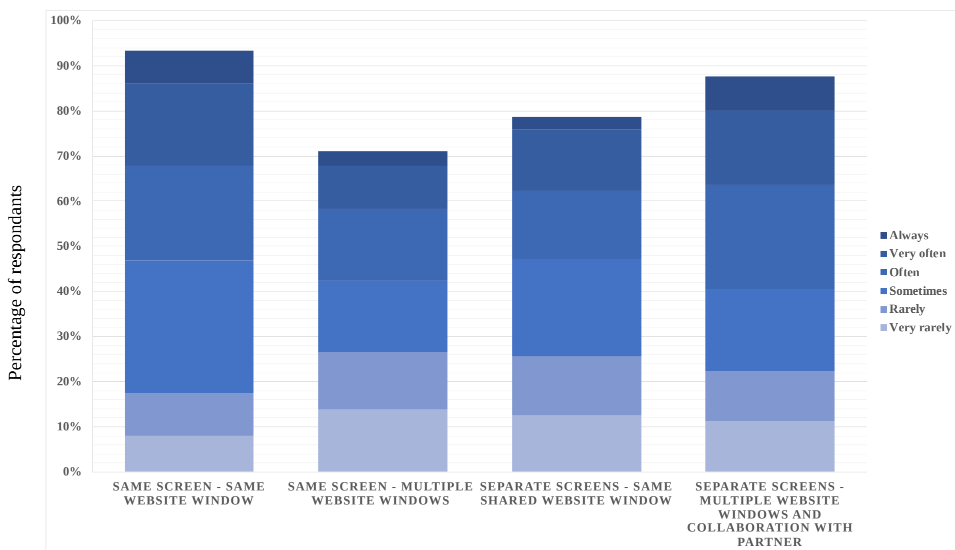


Figure 2.11. Proportion of respondants per screen layout use during couples' joint online shopping.

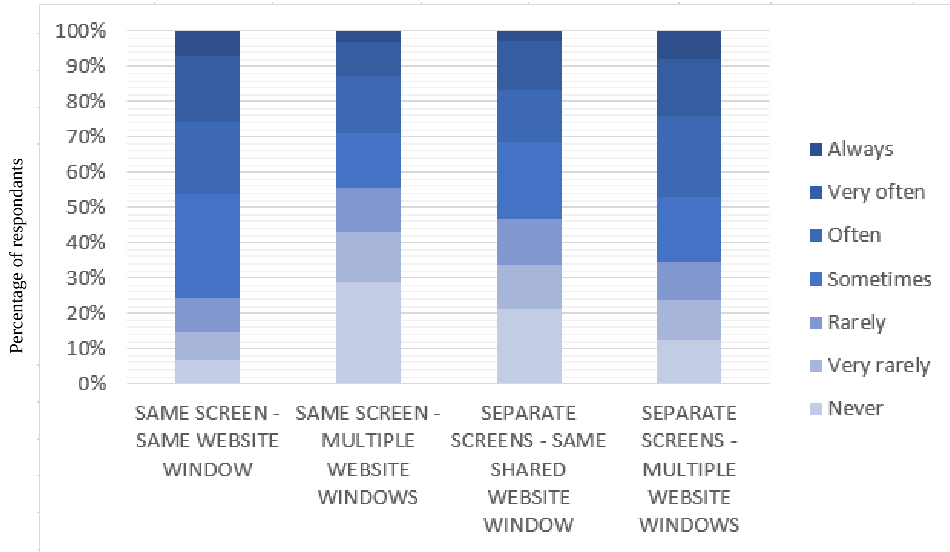
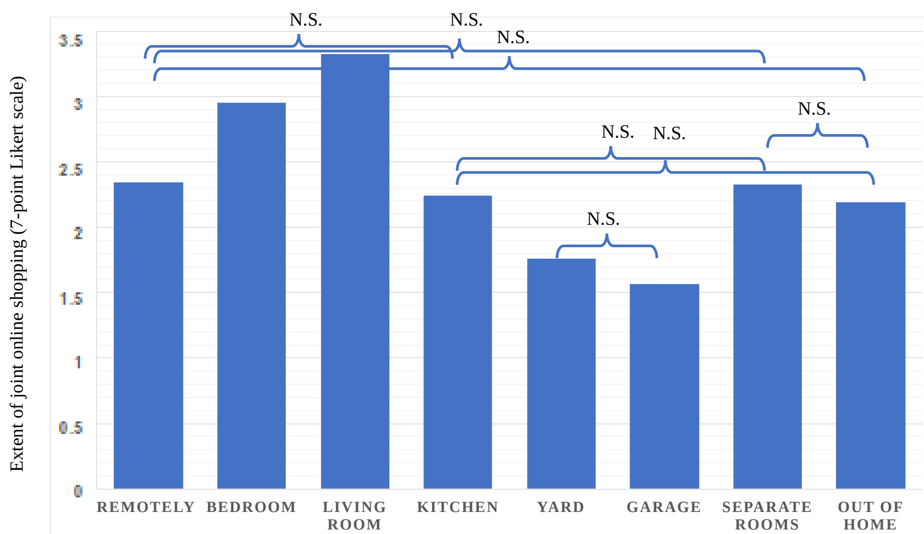
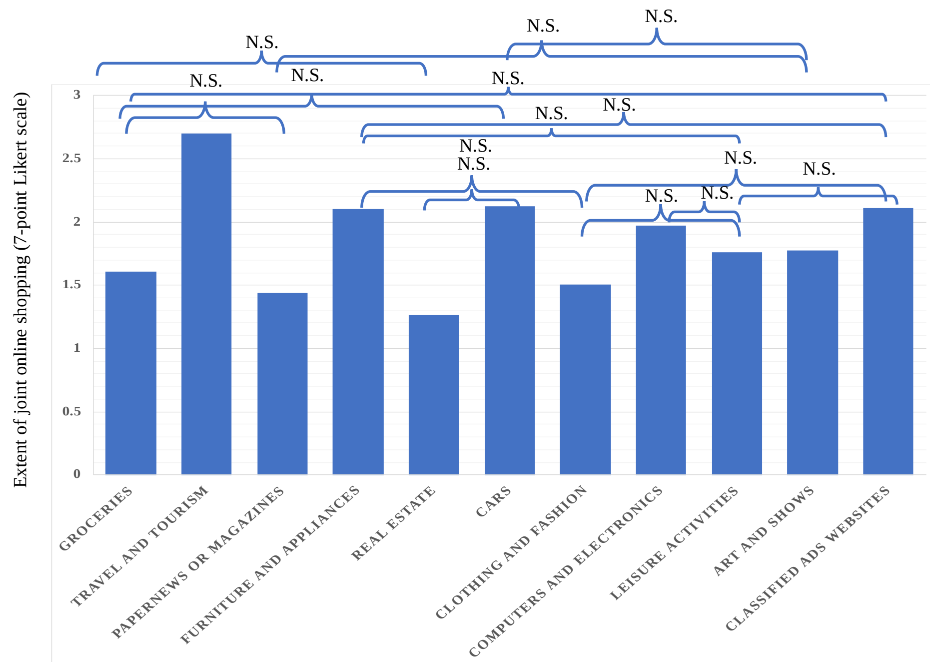


Figure 2.12. Relative proportions of respondants per screen layout and per frequency of use during couples' joint online shopping.



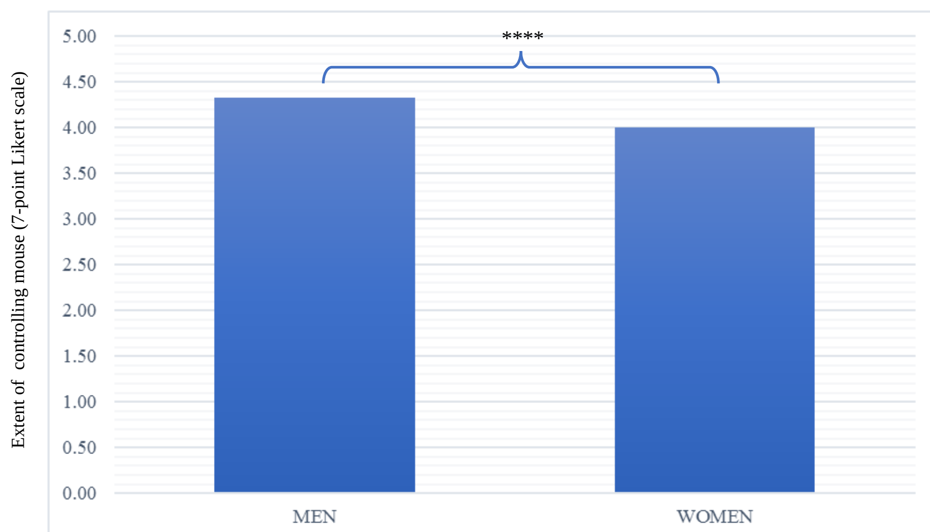
N.S. = Non-Significant at α = 0.05.

Figure 2.13. Extent to which couples jointly shop online by location.



N.S. = Non-significant at α = 0.05.

Figure 2.14. Extent to which couples jointly shop online by product category.



**** = statistically significant at α = .0001

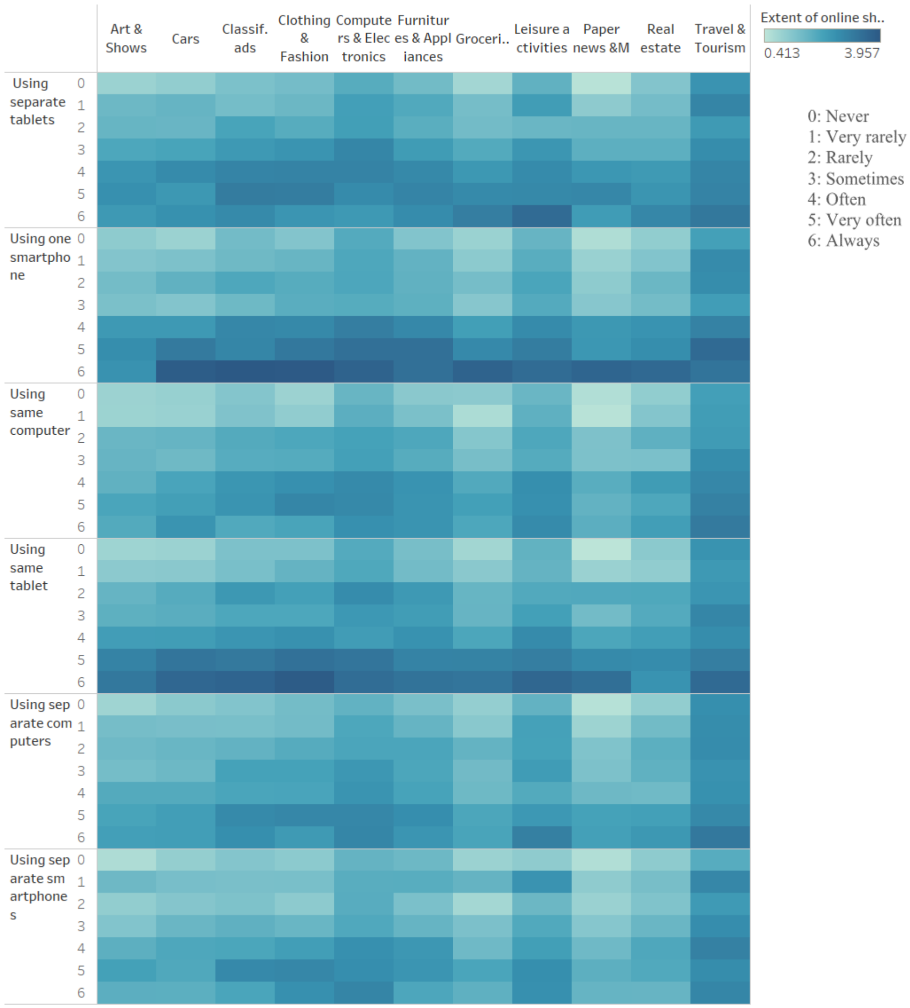
Figure 2.15. Extent to which partners keep control of the mouse, by gender.

Regarding what categories of products are shopped for online by couples (or in other words, the categories of online shopping platforms accessed), as depicted in Figure 2.14, Travel and Tourism appears to be most shopped for online. The Cars category follows, with no significant difference with Art and Shows, Groceries, and Real Estate. Leisure Activities and Clothing and Fashion. The Cars category is followed by the Furnitures and Appliances category, which shows no statistically significant difference with Classified Ads, Leisure Activities, and Clothing and Fashion. The Furnitures and Appliances category is followed by the Computers and Electronics category, with no statistically significant difference with Leisure Activities. The Computers and Electronics category is followed by Art and Shows, with no statistically significant difference with the Paper Magazine category.

Also answered was the question as to what extent each partner by gender keeps control of the mouse during the couple's joint online shopping. As shown in Figure 2.15, men reported to keep control of the mouse during the activity to a significantly greater extent than women do.

The remaining results are provided against more than one dimension. Figure 2.16 presents a heatmap representing the extent to which couples were reported to jointly shop online for each product category. This information is reported by the extent to which they use each device to conduct the activity. The heatmap suggests that couples which jointly shop the most for Art and Show are those who always use the same tablet to do so. On the other hand, couples who jointly shop the most for Cars are those which always use the same smartphone to do so, followed by those who always use the same tablet. The result for Cars also applies for the Classified Ads, Clothing and Fashion, Computers and Electronics, Furnitures and Appliances, Groceries, and Paper and News categories. Moreover, it appears that couples which shop the most for Leisure Activities are those which very often use either separate tablets, the same tablet, or the same smartphone to jointly shop online. Those couples which jointly shop online most often for Real Estate are those which always use the same smartphone to shop online. Finally, those couples which shop most often for Travel and Tourism are those which either most often use the same smartphone or always use the same tablet.

The next view is provided in Figure 2.17, which shows the extent to which couples jointly shop online for the different product categories, reported according to the extent to which they jointly shop online in various location settings. It appears that the Art and Shows category is mostly shopped for jointly when the couple tends to do joint shopping very often in separate rooms at or when they are co-located out of home. As for Cars, couples who jointly shop online for this category are those who tend to do joint shopping very often in the yard or out of home at the same location. Moreover, couples jointly shopping very often in the garage are those mostly shopping for Clothing and Fashion. As for Computers and Electronics, couples who jointly shop for this category are those who tend to do joint shopping very often in the yard or in the kitchen or in the garage at home. As for Furnitures and Appliance, couples who jointly shop for this category tend to engage in joint shopping very often in the garage, in the kitchen, or at the same location out of their home. As for Groceries, they are mostly jointly shopped by couples which tend to shop together very often in the yard or in the garage. Leisure Activities are most shopped for by couples which shop together online very often remotely from each other or co-located in the garage or in the kitchen. Paper and News are most shopped for by couples which shop together online very often in the garage or in the same location out of home, or in separate rooms at home. Couples mostly shopping for Real Estate together are those which tend to shop together online very often in the yard. Finally, couples mostly shopping together for Travel and Tourism are those which tend to shop together online very often in the yard.

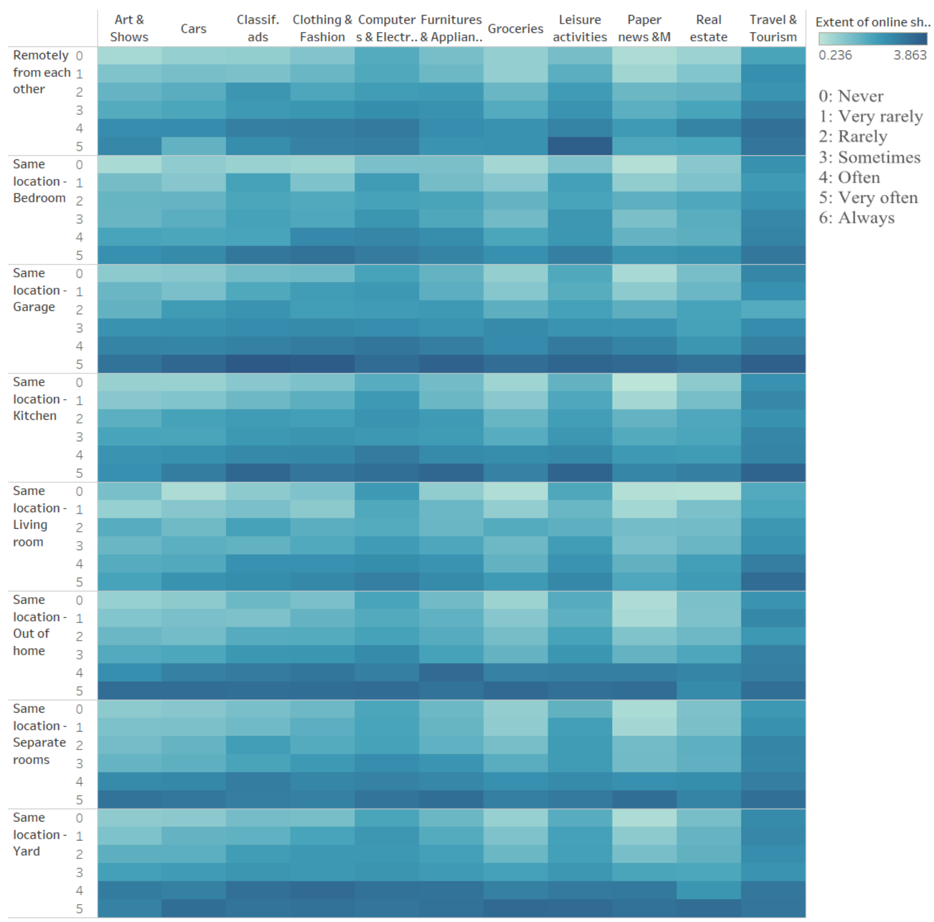


Vertical axis: Extent to which couples jointly shop online using each device setup.

Horizontal axis: Product categories.

Figure 2.16. Extent of joint shopping per product category and by device setup.

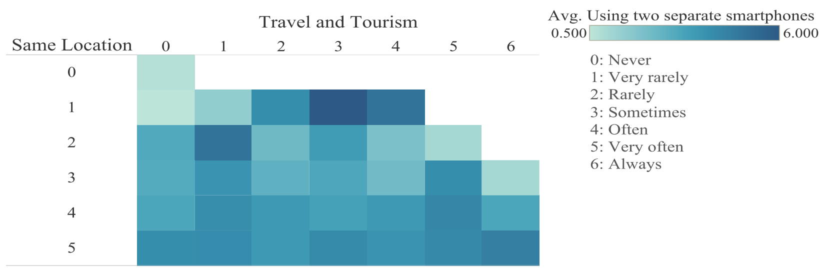
The following graphs, Figure 2.18 to Figure 2.22, depict the extent to which couples were reported to jointly shop online using either two smartphones or the same computer, i.e. the two device setups that were reported to be the most used. Results are shown against the “Travel and Tourism” product category, which was reported to be the most frequently jointly shopped for online.



Vertical axis: Extent to which couples jointly shop online using each device setup.

Horizontal axis: Product categories.

Figure 2.17. Extent of joint shopping per product category and by location.

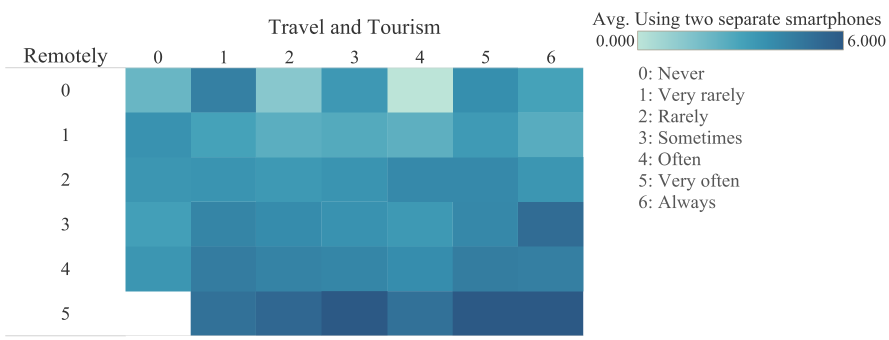


Vertical axis: Extent to which couples jointly shop online at the same location from each other.

Horizontal axis: Extent to which couples jointly shop online for travel and tourism.

Figure 2.18. Extent of co-located joint shopping, using two separate smartphones, and by location, for Travel and Tourism.

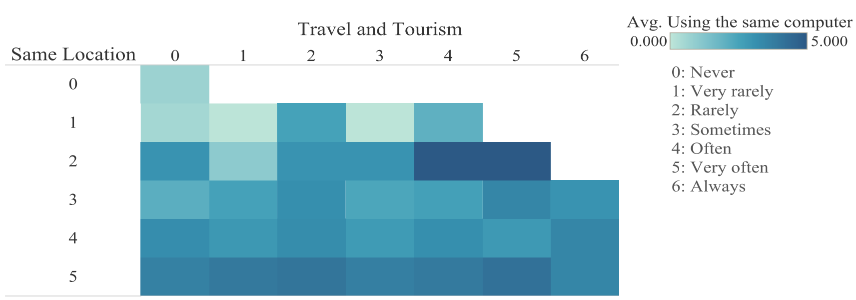
As Figure 2.18 shows, couples which use separate smartphones for joint online shopping within the Travel and Tourism product category the most are those reported to very rarely do so being physically. As Figure 2.19 shows, couples also use two smartphones the most for either co-located or physically separated joint online shopping of the same product category.



Vertical axis: Extent to which couples jointly shop online at the same location from each other.

Horizontal axis: Extent to which couples jointly shop online for travel and tourism.

Figure 2.19. Extent of physically remote joint shopping, using two separate smartphones, and by location, for Travel and Tourism.

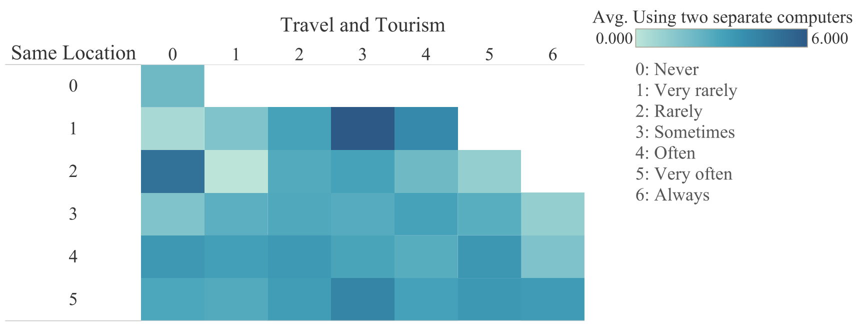


Vertical axis: Extent to which couples jointly shop online at the same location from each other.

Horizontal axis: Extent to which couples jointly shop online for travel and tourism.

Figure 2.20. Extent of co-located joint shopping by couples, using the same computer, and by location for Travel and Tourism.

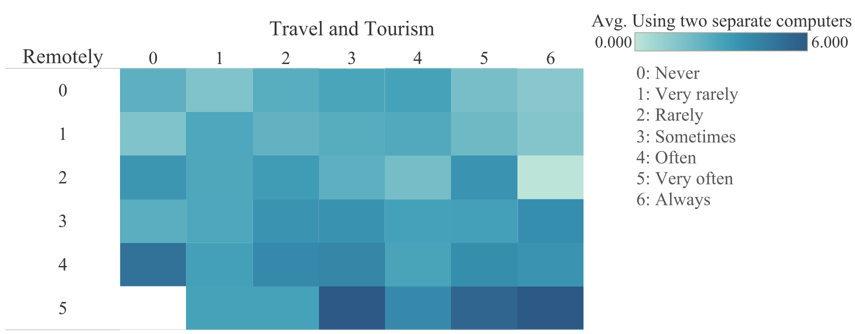
As depicted in Figure 2.20, couples jointly shopping using the same computer to the greatest extent to shop for Travel and Tourism are those which shop for that product category very often but rarely do so being co-located. Moreover, Figure 2.21 shows that couples jointly shopping using the same computer to the greatest extent to shop for Travel and Tourism are those which sometimes shop for that product category but very rarely jointly shop online at the same location from each other.



Vertical axis: Extent to which couples jointly shop online at the same location from each other.

Horizontal axis: Extent to which couples jointly shop online for travel and tourism.

Figure 2.21. Extent of co-located joint shopping, using two separate computers, and by location, for Travel and Tourism.



Vertical axis: Extent to which couples jointly shop online remotely from each other.

Horizontal axis: Extent to which couples jointly shop online for travel and tourism.

Figure 2.22. Extent of physically remote joint shopping, using two separate computers, and by location, for Travel and Tourism.

Regarding the use of two separate computers, Figure 2.22 shows that the couples jointly shopping using separate computers to the greatest extent to shop for Travel and Tourism are those which sometimes shop for that product category and very often jointly shop at remote locations from each other.

2.4 Discussions and conclusion

2.4.1 Findings

The present paper presented detailed results on several perspectives showing the extent to which as well as settings in which couples jointly use online shopping platforms. It was observed that couples spend a significant amount of time jointly navigating on the internet, with 44.62% of couples spending 3 hours/week, 28.21% spending more than 6 hours/week, and 11.79% spending more than 10 hours/week in this activity. These observations suggest that an important proportion of couples consistently jointly use web applications, websites, or other web-based software, including online shopping platforms.

Results also suggest that couples shop together in different ways, using a variety of device setups. More couples were reported to jointly shop online using two smartphones separately (93.59%), using the same computer (92.05%) or using two separate computers (86.67%). However, aggregated data revealed that couples shop together online to the greatest extent using two separate smartphones, the same computer, or two separate computers, respectively.

Just as with device setup, couples use different ergonomic layouts to shop together online. The highest proportion of couples were reported to use same website window when using the same screen (93.33%), multiple website windows when using separate screens (87.69%), and same shared window within separate screens (78.72%), respectively. Besides, this same trend was observed with regard to the extent to which couples use each device layout. Hence, it was observed that couples jointly shop online more usually using the same shared window within the same screen.

Regarding the location relative to each other when shopping together online, results suggest that couples engage in the activity in a variety of location settings. They do so mostly at the same location from each other, and they mostly do so at home in the living room and in the bedroom. However, couples were generally reported to shop online together occasionally remotely from each other.

Regarding the types of online platforms (i.e., product categories) jointly used by couples, results revealed that they shop online in a greater proportion for Travel and Tourism, Furniture and Appliances, and Cars.

Finally, results reveal a statistically significant difference in behavior between men and women during couples' joint online shopping: men tend to keep control of the mouse and keyboard more than women.

2.4.2 Implications and conclusion

This paper aimed at contributing to contemporary research in the area of multiple users interacting together with a single shared system interface to perform a task. Based on a survey of 390 participants, preliminary results in the context of online shopping platforms offer support for this paper's premise that the phenomenon warrants deeper exploration. The study results provide straightforward answers to the research questions. Overall, it was observed that most couples jointly use online platforms to accomplish the shopping task together. Moreover, they do so in a wide variety of settings, generally to a significant (frequent) extent. These settings include variety of device setups, ergonomic layouts, physical locations relative to each other, and product categories. The main limitation of this study is that the questionnaire considers the different settings independently from one another. Future research could examine direct links, such as the extent of joint use of systems relative to specific combinations of settings.

This study's findings in the context of online shopping platforms pose a call for more research in multiuser human-computer interaction, which is currently lacking within the HCI literature. Hence, several avenues for research can be considered. First, research could propose theoretical frameworks, which may subsequently facilitate the development of research models to be tested. Such frameworks could associate relevant higher-order constructs into logical layers. Second, as with past HCI literature (e.g., De

Guinea and Webster, 2013), mechanisms of joint use of shared interfaces can be investigated in terms of emotions, cognitions, and behaviors of groups of users. For instance, Tchanou et al. (2020) propose a new index for measuring gaze convergence of a user dyad during their joint use of a system interface, and they demonstrate that gaze convergence of a user dyad jointly interacting with a system interface may be negatively associated with dyad cognitive load and positively associated with dyad performance. Third, antecedents and consequences of these mechanisms can be examined. As an illustration, this study revealed that couples using a shared system interface during joint shopping, men tend to control the mouse to a significantly greater extent. Research could examine how the structure of a group of users jointly interacting with an interface shapes the emotional, cognitive, and behavioral dynamics during the task. Figuring out configurations through which groups of users perform optimally during the joint use of system interface may contribute to better system design, ultimately enabling collaborative innovation in organizations. Finally, research could investigate cross-level influences between individual and collective levels during multiuser system use, as per past recommendations about multilevel theorizing (e.g., Burton-Jones & Gallivan, 2007; Burton-Jones & Straub, 2006; Markus & Rowe, 2018; Zhang & Gable, 2017).

Finally, this study also puts forth a call for practitioners to take into account whenever possible relevant multiuser interactions in various contexts. To illustrate, system designers should develop user scenarios involving multiple users for systems that are often jointly used by multiple users. An example emerging from this study is the design of online shopping platforms for travel and tourism that considers features promoting couple collaboration during online shopping. Likewise, marketers should consider possible influences from other users jointly using such online shopping platforms.

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Chapter 3 - Essay 3

Joint Use of Information Systems: Empirical Investigation of Dyadic Use Mechanisms in Online Shopping Context[8]

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Abstract

Although information technology (IT) use is a major topic in the information systems (IS) field, research investigating IT use operated by two users together and simultaneously, a phenomenon we refer to as *joint IT use*, is lacking in the IS field. We address this gap by developing a model of dyadic joint IT use showcasing antecedents of user intention to continue joint IT use. We hypothesize direct and indirect effects of dyadic conflict and its cognitive, affective, and behavioral subdimensions on user intention to continue; we hypothesize that these indirect effects are mediated by effort and time required for users to reach consensus on dyadic decisions. Moreover, our model suggests that dyadic conflict fully mediates the influence of exogeneous constructs including dyad agreement state prior to the joint IT use, user's input device control, and system display sharing (i.e., shared vs separate system interface displays). We conducted an online role-based experiment in an online shopping context, in which participants reported joint IT use mechanisms and outcomes. Our results support our model, suggesting key direct, indirect, and mediating influences of dyadic conflict on user intention to continue joint IT use. Our study contributes by bringing new insights to understanding sources and mechanisms of user behavioral intention in a joint IT use context. This study is an encouraging departure point for future research on joint IT use. We make several recommendations stemming from our findings to IS practitioners, including permitting parallel task performance when display sharing is not compulsory, foreseeing simultaneous or sequential dyad members' input device control when display sharing is compulsory, and designing a joint use mode facilitating pre-task agreement.

Keywords: online experiment, joint IT use, dyadic processes, dyad, display sharing, shared interface, input device control, multiuser human-computer interaction, conflict, online shopping in couple.

3.1 Introduction

This paper examines the phenomenon of user dyads interacting together and simultaneously with the same information technology (IT) interface, which we refer to as *joint IT use*. Recent research suggests that this phenomenon is seldom investigated although it is common not only in organizational settings but also in hedonic settings (Tchanou et al., 2020a). IT use is a central concept in the information systems (IS) field and an important determinant of IS success (DeLone and McLean, 2003; Burton-Jones and Straub, 2006). Research suggests that infusion of an IT (i.e., the extent to which an IT is used deeply or at its fullest extent for individual and organizational performance (Fadel, 2012)) depends on how users engage in IS-related adaptation behaviors (Fadel, 2012). A common way individuals use ITs is by interacting with a single system interface collaboratively with another user (Burton-Jones and Gallivan, 2007). Hence, in this context of system use, user adaptation can be influenced by how two users cope as a dyad with IS-related events, which may originate not only directly from technology (e.g., a system failure or unexpected behavior) but also from collaboration among the users during system use (e.g., a clash over decision making). Clearly, the joint IT use perspective in IT use studies could complement understanding of IT use (e.g., a detrimental action from user's partner during dyad system use may influence direct user-system interactions). Understanding dyadic dynamics when two users interact together with a system interface may help identify conditions favoring IT use performance and, in turn, IS success. For example, recent research work shows that user dyad gaze convergence (i.e., the extent to which a user dyad looks at same locations on the screen (Tchanou et al., 2020b)) during users' simultaneous interaction with an IT interface may favor lower cognitive load and better dyadic performance – when shared mental model is important for performance. Moreover, a better understanding of the aforementioned dyadic dynamics may help improve system design by promoting system features favoring dyadic IT use mechanisms associated with performance. Hence, it is important to identify such system features, at least at a general level, to provide useful practical guidance to IT system design industry.

Limitations can be raised in the literature on IT use, in connection with the present paper's topic. First, IT use research seldom addresses the phenomenon of joint use of an IT interface by multiple users, though this is a common way systems are used not only in business contexts (e.g., two workers building a slideshow document together) but also in hedonic settings (e.g., a couple shopping online together, or a dyad of friends playing a video game together) (Burton-Jones and Gallivan, 2007; Tchanou et al., 2020a). Hence, little is known about the influence of interpersonal interactions during system use, including IS events induced by collaboration during user interaction with a system. More generally, insights on factors coming into play when multiple users interact together with the same system interface are lacking in the IS literature. In other words, the extant literature under-addresses the question as to what are joint IT use mechanisms, that is, configurations of collaborative use-related factors occurring together (Meyer et al., 1993), and what are their antecedents and consequences when a collective of users use together a shared IT interface. Second, IT use research has been heavily focused on theories grounded in the planned behavior and reasoned action paradigm (De Guinea and Markus, 2009; Venkatesh et al., 2016). Although they enable significant contributions to the IT use research stream, that literature seldom captures mechanisms occurring in the course of human-computer interaction, not only in individual IT use context but also in multiuser context.

We address these shortcomings by conceptualizing joint IT use mechanism as a group-level construct encompassing configurations of emotions, cognitions, and behaviors happening during joint IT use. We focus on the case of groups of two users, that is, user dyads, interacting interdependently with a system interface to perform a task. Moreover, as literature suggests that different system settings (e.g., system setups such as using separate computers, a same computer, or a mobile phone and a tablet) are significantly employed for joint use activities (e.g., for shopping online as a couple) (Tchanou et al., 2020a), we investigate the influence of such settings on joint IT use mechanisms. Besides, drawing from literature suggesting influence of group-level characteristics on group processes (Maynard et al., 2015), we examine the influence of a dyad-level initial states such as dyad agreement prior to IT task, on joint IT use mechanisms appearing during the task. We investigate the following research questions (RQ).

RQ1: *What are mechanisms underlying joint IT use and their impact?*

RQ2: *What is the role of system setup in the context of joint IT use?*

RQ3: *What initial dyad states influence joint IT use mechanisms?*

The present essay addresses these questions using Activity theory, literature on IS continuance, and literature on dyadic processes. This theoretical background helps explain how and why different IT use mechanisms form at individual and team level. Based on the research framework of our study, we develop a model of joint IT use in the context of joint online shopping by couples. In order to test our hypotheses, we conducted an online experiment through which we captured joint IT use mechanisms. Our results suggest the influence of system setting and dyad pre-agreement state on joint IT use mechanisms, which fully mediate influence of the former on individual behavioral intention to continue joint IT use.

This paper contributes in different ways to the literature. Our conceptualization of joint IT use mechanisms reflects how IT systems are commonly used in hedonic and utilitarian contexts. Through this perspective, we help explain how collaboration dynamics emerging from joint interactions by a user dyad with system interface may influence individual behavioral outcome. In doing so, our research also provides practical suggestions for system designers to consider the implementation of system features that promote better behavioral outcomes in joint system use context.

The remainder of this essay is as follows. First, we present theoretical perspectives that may help explain the phenomenon of study. Second, we present our resulting research framework. Third, we develop a set of hypotheses explaining how system settings and dyad initial state influence individual behavioral outcome. Fourth, we present our study, followed by a concluding discussion.

3.2 Theoretical background

3.2.1 Activity theory

Activity theory's mediation principle proposes that human experiences are shaped (or mediated) by the tools and sign systems we use (Nardi, 1996). Hence, the theory suggests that people's experience (including their emotional and cognitive experiences) can be only analyzed in association with their activities, that is, while they perform actions (Kaptelinin, 1996). Additionally, the theory suggests that analysis at the very individual unit of analysis is insufficient. Instead, the theory proposes activity system, which includes collective human activity, as unit of analysis (Engeström et al., 1999). Regarding the application of Activity theory to the IS field, in order to better understand IT use phenomenon, we need to consider not only individuals' physical interactions with an IT, but also their behaviors related to system use (Barki et al., 2007), which include collaboration with other users in the process of system use. Furthermore, Activity theory suggests that activities experience continual variation, influenced by changes in the environment (Nardi, 1996). Hence, as dyads use a system interface together, their collaborative use mechanisms evolve as changes in their environment happen, such as occurrence of IS-related events including changes in the power structure (e.g., switching input device control role) or in conflict states. Activity theory has been used in the IS literature to explain IS use at individual level. For instance, De Guinea and Webster (2013) used Activity theory as a rationale to suggest that constituents of IS use should be looked at as they occur naturally. De Guinea and Webster (2013) also used Activity theory as a ground for suggesting that IS use patterns vary overtime, depending on the type of system events, expected or unexpected.

This essay is in line with Activity theory’s recommendations: we examine joint IT use in terms of mechanisms taking place while a dyad of users jointly use a system interface. Moreover, as recommended by the theory, joint IT use is investigated not simply at the individual level, but at dyad level, in line with calls for the conceptualization of IT use as a multilevel construct (e.g., Burton-Jones and Gallivan, 2007).

3.2.2 Post-acceptance model of IS continuance (MISC)

The post-acceptance MISC, an adaptation of the Expectation-Confirmation Theory in the IS field, was proposed by Bhattacherjee (2001) to address cognitive beliefs and affect that are antecedent to people's intention to continue using an IS, a construct referred to as IS continuance intention (herein called IT continuance intention). The model, which was empirically supported, addresses three factors of IT continuance intention: confirmation of user's expectations towards IT use, perceived usefulness following user experience with IT, and satisfaction with IT use. Perceived usefulness, a central cognitive belief in the IT acceptance literature (Bhattacherjee, 2001) refers to the extent to which a user believes that his or her task performance would be enhanced through the use of a system (Davis,1989). Moreover, the post-acceptance MISC considers satisfaction an ex post feeling resulting from users' ex ante expectations or cognitive beliefs, that is, those before the IT use experience. The model stipulates that confirmation increases perceived usefulness, each of these two constructs being positively associated with satisfaction with the IT use. It also suggests that satisfaction and perceived usefulness positively influence IT continuance intention. Perceived usefulness is addressed as a cognition, while satisfaction is addressed as an emotion. Consistent with the nature of antecedents of IT continuance intention proposed by the post-acceptance MISC, the present study proposes cognitive and emotional constructs as antecedents of IT continuance intention resulting from joint IT use. In addition, we propose behavioral constructs as antecedent to IT continuance intention resulting from joint IT use (see sections 3.2.3 and 3.3.2 for related developments).

3.2.3 Dyadic dynamics and research framework

3.2.3.1 Dyadic processes and emerging states

The literature on group dynamics has considered a group a set of individuals with same or different goals and with or without interdependence (Uitdewilligen, 2011; Whitley, 2018). More specifically, research addresses the concept of dyad as a particular case of group on its own right and the most elementary form of group (Miller, 2007). In this essay, we define a user dyad as a group of two users jointly interacting with a system interface interdependently and sharing ideas, information and resources in order to add together their efforts to achieve common goals. This definition is very much similar to that of an elementary instance of team as defined in the group dynamics literature (Whitley, 2018; Uitdewilligen, 2011; Rousseau et al., 2006). The goal is common as it is directly associated with the joint task (e.g., getting a user issue resolved; buying a furniture in couple; or writing a shared online office document).

Research suggests that dyadic processes are similar to group processes (e.g., Korsgaard et al., 2008) and that most structural conditions and social processes at group level exist in dyadic interactions (Miller, 2007). Hence, it is reasonable to expect that dyads working together experience the different types of group processes. We use the taxonomy of team processes proposed by Marks et al. (2001) to categorize dyadic processes into three types. The first type is *transition dyadic processes* during which dyads engage in such task-related activities as formulating strategies, specifying goals to achieve, and planning task accomplishment (Marks et al., 2001; Maynard et al., 2015). The second type is *action dyadic processes* consisting of such activities as addressing task accomplishment, coordinating dyad interdependent actions, and monitoring progress toward goals. The third type is *interpersonal dyadic processes* composed of such activities as managing conflicts, managing dyad members' affect, and building collective motivation and confidence. These dyadic processes are dynamic interactions between dyad members happening when they perform a task together (Maynard et al., 2015). These processes generate emerging states, that is, affective, motivational, and cognitive states of dyads (Marks et al., 2001; Maynard et al., 2015). Emerging states include constructs such as dyadic conflict, dyad agreement, dyad effectiveness, dyad members' intention to continue to collaborate together, and dyad performance. In this essay, we adopt a variance approach and focus on dyad emerging states rather than on the dynamic dyad process leading to them.

3.2.3.2 Research framework

In this essay, we investigate how initial conditions (i.e., conditions in which a user dyad engages in joint IT use) are related to outcomes through mediating mechanisms including dyad emotions, cognitions, and behaviors. Hence, our research framework includes three layers as depicted in Figure 3.23. The input layer is made of initial conditions at system, individual, and dyad levels. Initial conditions at system level refer to system configurations or states through which dyadic IT use takes place. At the individual level reside factors such as personality traits, gender, mental model, or initial satisfaction with the role to play within the dyad. Dyad-level factors include constructs such as initial agreement state, shared mental model (Andres, 2011; Mathieu et al., 2000), dyad training, or dyad structure (i.e., relationship that determines responsibilities and authority between dyad members (Stewart and Barrick, 2000)).

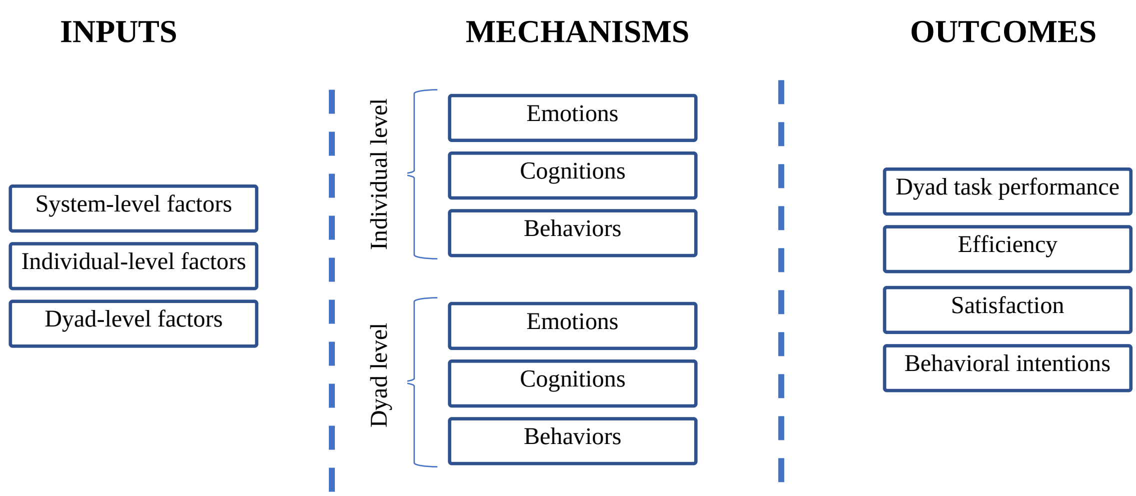


Figure 3.23. The essay’s research framework.

The mediation layer represents mechanisms that manifest during joint IT use at individual or dyad level and that influence use outcomes. We address these mechanisms as emergent states at dyad level. IT use mechanisms have been investigated in three dimensions in the literature: as cognitions, that is, user thinking and memory load; as affect, that is, user emotions related to system use (Burton-Jones and Gallivan 2007; De Guinea and Webster, 2013); and as behaviors, that is, actions a user takes. Moreover, collaborative IT use has been conceptualized as an aggregation of individual use constructs (e.g., Easley et al., 2003) or as configurations of cognitions, emotions, and behaviors emerging in a collective of users (Burton-Jones and Gallivan 2007).

Cognitions have been defined as a set of neural states related to user thinking while using a system (Burton-Jones and Gallivan, 2007). They are represented through such factors as mental model, cognitive load and cognitive conflict, that is, the cognitive dimension of conflict (Ma et al., 2017). Mental models represent elaboration of user's understanding of knowledge and relationships among a system's concepts or components (Uitdewilligen et al., 2013). Cognitive load has been referred to as the amount of resources in working memory that are allocated to achieve an activity (DeStefano & LeFevre, 2007). Cognitive conflict is related to the extent to which two parties express diverging opinions or thoughts (Ma et al., 2017).

Emotions have been defined as user's feelings during joint use of a system (Burton-Jones and Gallivan, 2007). They have been addressed in the literature through two views. The categorial view of emotions considers discrete categories that are as specific as possible, including such emotions as fear, surprise, sadness, anger, joy, or enjoyment (Grimm and Kroschel, 2005; Ekman and Friesen, 1978; Kim et al., 2013). These categories also feed other constructs such as affective conflict, that is, the emotional dimension of conflict (Ma et al., 2017). The dimensional view of emotions suggests that emotions are made of components including valence (i.e., positive affect), physiological arousal (i.e., physiological activation) and dominance (i.e., feeling of being in control) (Grimm and Kroschel, 2005; Courtemanche et al., 2018; Riedl and Léger, 2016; Grimm and Kroschel, 2005). The notion of emotions at dyad level can be conceptualized as aggregations of individual-level emotions, such as differences in dyad users' emotions resulting from differences in dyad structure (e.g., which user controls input devices) or in individual characteristics.

Behaviors are actions users take. During joint IT use, these behaviors can be of three categories. *System-oriented behaviors* are direct IT use targeted at interacting with a system or modifying aspects it. Examples include the following: dyad's users looking at same locations on the screen while jointly using an IT, the extent of which has been referred to as dyad gaze convergence in past research (Tchanou et al., 2020b). Another example of system-oriented behavior is user's inputting of data in system interface. *Task-oriented behaviors* are targeted at following, defining, or changing how the task will be performed (e.g., modifying the commonly agreed strategy to perform a task, or defining one). Finally, *collaboration-oriented behaviors* are targeted at managing interpersonal processes. They include such factors as coordination and conflict management (Zhu et al., 2010; Marks et al., 2001). As suggested in section 3.2.3.1, user behaviors may generate dyad emergent states such as behavioral conflict, the behavioral dimension of conflict (Ma et al., 2017).

The third and final layer of this essay's framework represents outcomes associated with mediating configurations of emotions, cognitions, and behaviors happening during joint IT use. The outcomes can be captured at individual level and dyad level. At individual-level, they include constructs such as user satisfaction, user's individual performance, and user's behavioral intentions associated with joint IT use experience such as dyad task performance (e.g., time and cognitive effort spent to complete a task). Dyad-level outcomes include constructs such as dyad effectiveness and dyad performance. These constructs can be operationalized in different ways including combining or aggregating corresponding individual-level constructs, in accordance with the conceptual definition of the constructs. For example, dyad total performance can be assessed using the total of individual users' respective performances, while dyad performance disparity could be assessed as the difference in individual users' performance related to a joint IT use.

3.3 Hypothesis development

In this section, we develop hypotheses about dyadic mechanisms of joint IT use, drawing from the research framework in Figure 3.23, in the specific context of joint e-commerce system use by couples. Couples' online shopping has been acknowledged as an important phenomenon that deserves attention from researchers. For instance, a recent study suggests that 53% of online purchases performed by households in Canada involve at least two users jointly shopping (Briggs, 2018). Another recent study suggests that about 94% of couples in the U.S.A. jointly shop online using a single computer at least occasionally, among them 74% sometimes or frequently doing so (Tchanou et al., 2020a). Couples' online shopping illustrates how couples – a particular case of dyad – jointly use interfaces, involving standard dyadic processes such as goal definition, agreement, negotiation, conflict management, action coordination, dyad member's affect management, and motivation building.

3.3.1 Dyadic conflict

The central construct in this essay is *dyadic conflict*, which has been a focal construct in the group processes literature (Maynard et al., 2015; Chizhik et al., 2009; Barki and Hartwick, 2004). Conflict has been addressed as a state (Hu et al., 2017; Anicich et al., 2016) – this perspective is the focus of the present essay. Moreover, conflict has been increasingly suggested as an important perspective for studying group dynamics (e.g., Ma et al., 2017; Hu et al., 2017). In an effort to improve conceptual clarity of the conflict construct based on a literature review on the subject, Ma et al. (2017) proposed a conceptualization of conflict made of four dimensions. The first one is *cognitive conflict*, which refers to expressions of divergence in thoughts, understanding and opinions about the task. Such expressions can take place while discussing, communicating, and arguing about the task. The second dimension is *affective conflict*, which refers to emotion-related clashes, that is, expressions of negative emotions including dislike, anger, and boredom. The third dimension is *interest-based conflict*, which refers to clashes resulting from personal interest, such as claims to power, reward, resources, and status. Finally, *behavioral conflict* refers to nonconstructive or destructive interactions such as being unsupportive and interfering with each other's action. In this essay, we draw from Ma et al. (2017)'s work to define dyadic conflict as dyad state emerging from incompatible expressions between dyad members, made of four dimensions including cognitive conflict, affective conflict, interest conflict, and behavioral conflict.

3.3.2 Input layer's influences

Based on above view of conflict, it is clearly expected that dyadic joint IT use by nature is prone to the appearance of dyadic conflict, as the two users share the same system interface and the same hardware (e.g., screen, mouse, keyboard, or touchpad). Moreover, conflict may result from dyad structure, including differences in dyad members' role during the task, such as input devices control (e.g., mouse, keyboard, or touchpad), defined as assignment of input device control responsibility within the dyad during joint IT use. Research suggests that when two users share a same interface display, they tend to clash over input device control, with the user not controlling input devices – herein called the *noncontrolling user* – usually pointing at the screen, claiming control, and getting bored with his or her role, leading to a deteriorating collaboration (Mekki Berrada, 2011; Steward et al., 1999). This trend has been suggested to be more pronounced in mixed dyads than in same-sex dyads (Mekki Berrada, 2011; Underwood, 2000; Stockes et al., 2007). Actually, it is important for individuals to feel in control of their environment for their wellbeing (Bandura, 1989; Skinner, 1995) and motivation (Underwood, 2000). Hence, during joint e-commerce system use by couples, we expect higher dyadic conflict when only one partner controls the input devices in a shared system display setup, compared to when each partner controls his/her own mouse in a separate system displays setup (i.e., setup in which partners interact interdependently, each with a different system interface display), for example, each of them on his or her own separate computer. Besides, research suggests that dyadic conflict is an uncomfortable dyadic state that generates negative emotions (Guerrero and La Valley, 2006; Barki and Hartwick, 2004). It involves differences in opinions expressed through arguments and is prone to manifestation of destructive behaviors from dyad members (Ma et al., 2017). Clearly, higher dyadic conflict involves higher cognitive, affective, and behavioral conflict. We herein call *controlling user* the user with input device control. We make the following hypotheses.

H1: *Shared system display setting will generate (a) higher overall dyadic conflict, (b) higher cognitive conflict, (c) higher affective conflict, and (d) higher behavioral conflict than separate system displays setting*.

Dyadic conflict can be perceived differently by each of the two parties. Literature on intragroup conflict suggests that in a dyadic relationship, power asymmetry exacerbates conflict between dyad members, and that the dyad member with less power is more likely than the other one with more power to perceive dyadic conflict (Korsgaard et al., 2008; Rousseau & Garcia-Retamero, 2007). Hence, during joint e-commerce system use by couples in a shared display setting, the noncontrolling user is likely to perceive higher dyadic conflict than the controlling user because of the former's dependency over the latter, who, controlling input device, owns responsibility of direct interactions with system interface. Moreover, perceived dyadic conflict by the noncontrolling user is likely to be higher in this setting than in a separate system displays setup granting each user control over his or her own input devices – a setting of symmetrical device control by dyad members. On the other hand, unlike the noncontrolling user, because in either system setup (shared or separate displays) the controlling user directly interacts with system interface, his or her perception of dyadic conflict is unlikely to be significantly influenced by system setup. For this reason, we do not formulate hypotheses about the effect of system setting on dyadic conflict perceived by controlling users. Hence the following hypotheses suggesting influences of the type of input device control on user's perception of dyadic conflict.

H2: *In shared system display setting, (a) overall dyadic conflict, (b) cognitive conflict, (c) affective conflict, and (d) behavioral conflict as perceived by noncontrolling users will be higher than that perceived by controlling users*.

H3: *(a) Overall dyadic conflict, (b) cognitive conflict, (c) affective conflict, and (d) behavioral conflict as perceived by noncontrolling users will be higher in shared system display setting than in separate system displays setting*.

Other factors may generate dyadic conflict. According to Barki and Hartwick (2004), three constructs are associated with conflict, namely, disagreement, negative emotion, and interference, the latter two resulting from conflict, while disagreement is an antecedent of conflict. Generally, major works in the topic suggest that conflict reflects or results from perceived disagreement about (or difference in) opinions, viewpoints, perspectives, and decision making (e.g., Hu et al., 2017; Anicich et al., 2016; De Jong et al., 2013; Barki and Hartwick, 2004; Pondy, 1967). Clearly, during joint e-commerce system use by couples, settling disagreements and aligning viewpoints or perspectives during decision-making process couples go through make it less likely for the two partners to experience conflict during the activity. Since important objectives of e-commerce system use are to search for and/or purchase a product or service online, the product or service and/or its characteristics are likely to represent a major object of disagreement between the two partners. Disagreement settlement may happen before performing the joint task – during transition processes aiming at goal definition – or during the activity. In the former situation, the two partners may engage in discussions and negotiations and find common grounds before starting the core activity, to make it smoother and straightforward. In the other situation, the two partners settle disagreements as they happen during the joint activity. In the present work, we focus on pre-task agreement, defined as the extent of settlement happening prior to the joint activity by couples. In other words, pre-task agreement refers to a form of consensus between dyad members on joint objectives and decisions to take together, prior to engaging in the joint task. Drawing from above-mentioned literature on interpersonal conflict, we make the following hypothesis.

H4: *Pre-task agreement will negatively influence (a) overall dyadic conflict, (b) cognitive conflict, (c) affective conflict, and (d) behavioral conflict, respectively*.

3.3.3 Mechanisms and consequences

As suggested in section 3.3.1, dyadic conflict may manifest in terms of task-related clashes associated with differences in opinions and understanding (i.e., cognitive conflict), negative emotions (i.e., affective conflict), nonconstructive behaviors (i.e., behavioral conflict) and personal interest-based rivalry (i.e., interest-based conflict). These manifestations are expressed through activities such as discussion, argumentation, and hostile attitudes (Ma et al., 2017; Barki and Hartwick, 2004). Consequently, when couples jointly using an e-commerce system face conflict, a discrepant happening, they are likely to be inclined to engaging into extra discussions and arguments aiming at settling the conflict and moving on with task performance – which involves spending additional time on these conflict settlement activities. Hence, such discrepant occurrence enables unexpected actions, requiring more cognitive and physiological resources than regular behaviors (De Guinea and Markus, 2009). Besides, research suggests that there is a cognitive cost in engaging into an argument, since it involves a certain degree of cognitive effort (Eemeren and Garssen, 2012). Consequently, it is expected that the more couples jointly using an e-commerce system will face conflict, the more they will be cognitively loaded, because of the higher degree of cognitive effort required for conflict settlement. Clearly, these conditions will require higher dyad effort for final consensus – defined in this essay as the extent of effort made by a couple to reach consensus over final product choice. They will also require more time frame for final consensus – defined as the extent of time needed by a couple to reach consensus over final product choice. Hence, we make the following hypotheses.

H5: *(a) Overall dyadic conflict, (b) cognitive conflict, (c) affective conflict, and (d) behavioral conflict will respectively be positively related to effort for final consensus*.

H6: *(a) Overall dyadic conflict, (b) cognitive conflict, (c) affective conflict, and (d) behavioral conflict will respectively be positively related to time frame for final consensus*.

Research suggests that dyadic conflict is undesirable and uncomfortable, including each of its subdimension we defined in section 3.3.1. (e.g., Guerrero and La Valley, 2006). Clearly, when two users jointly use an IT, they expect a positive experience. Consistent with the model of IS continuance proposed by Bhattacherjee (2001), confirmation of ex ante expectations is positively associated with intention to continue IT use. Hence, dyadic conflict is likely hinder users' intention to continue joint e-commerce system use. This development leads to the following hypotheses.

H7: *(a) Overall dyadic conflict, (b) cognitive conflict, (c) affective conflict, and (d) behavioral conflict will respectively negatively influence intention to continue joint IT use.*

Time frame for final consensus and effort for final consensus are ex post cognitive beliefs in the present context, that is, they respectively represent partners' beliefs about effort and time required for jointly using an e-commerce system, based on their perception of their experience of the joint use activity. These cognitive beliefs reflect two of the most salient technology acceptance constructs, that is, performance expectancy and effort expectancy (Venkatesh et al., 2003). Time frame for final consensus reflects ex post beliefs about joint e-commerce system use performance, that is, ex post performance expectancy, with higher values denoting lower performance. Moreover, our above definition of effort for final consensus implies that this construct reflects ex post effort expectancy. Research suggests that effort expectancy and performance expectancy are respectively negatively and positively associated with behavioral intention (Venkatesh et al., 2003). These relationships, which originate from an IT acceptance context, also apply in continuance context, as suggested by past research (Sun et al., 2016; Limayem et al., 2007; Bhattacherjee, 2001). We make the following hypotheses. The research model is presented in Figure 3.24.

H8: *Time frame for final consensus will be negatively related to intention to continue joint IT use.*

H9: *Effort for final consensus will be negatively related to intention to continue joint IT use.*

Gender has been suggested in the literature as a factor associated with emotional reactions to discrepant happenings (e.g., Riedl et al., 2013). Moreover, past research has suggested that involvement as a trait influences decision processes and information search in shopping context (e.g., Laurent and Kapferer, 1985). In addition, co-presence has been found to influence behavioral intentions through enjoyment in joint shopping context (e.g., Kim et al., 2013). Thus, we control for gender, involvement trait, and co-presence.

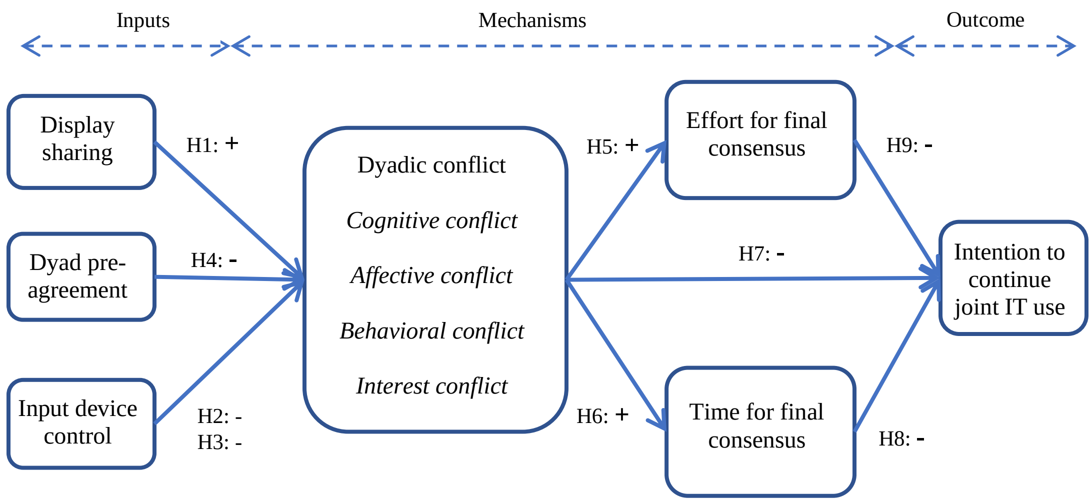


Figure 3.24. Research model.

3.4 Methodology

To test our hypotheses, we conducted a scenario-based role-playing experiment (Rungtusanatham et al., 2011). Our study was approved by the ethics committee of our institution (ethical certificate number: 2021-3978). We ran the study through Amazon Mechanical Turk (MTurk), an online crowd sourcing platform commonly used in management research and the most used online crowdsourcing platform (Aguinis et al., 2021). The experiment typically involved participants reporting about their anticipated joint e-commerce system use experience in couple in specific scenario to which they were assigned. Their reported experience was based on anticipated proceedings of couple's joint system use.

3.4.1 Study sample

Our sample frame was MTurk's U.S.A. base of about 85 000 people (Robinson et al., 2019). All participants were recruited in the U.S.A. To participate to the study, participants were required to be in couple whatever their marital status, and they had to hold an excellent record of quality participation to MTurk studies, with a 90% human intelligence task approval (i.e., previous high-quality performance) (Goodman et al., 2013). Moreover, we made sure that participants could participate only once in the study. No requirements were enforced in terms of age, gender, education, and any other individual characteristics. Participants received a compensation based on a rate of 10.80 USD per hour. We also included attention check questions among questionnaire items to control for participants' attention during the study. Doing so was in line with past studies suggesting that adding attention check question in MTurk questionnaires helps in significantly improving statistical power and reducing the probability of making Type II errors (e.g., Goodman et al., 2013).

A total of 521 persons participated in the study. However, we excluded from our sample all participants who reported not being in a relationship, failed at an attention check question, completed the study's questionnaire more than once, or partly completed the questionnaire. Based on recommendations from Aguinis et al. (2021), to further mitigate possibility of bad responses due to inattentive participants, from the resulting complete 369 responses, we excluded those of participants whom we deemed likely the most not to have read the scenario they were assigned to; we assessed the minimum acceptable reading time based on literature about human reading capabilities and excluded responses with reading speed five times higher than the expected average speed of 200 words per minute (McNair, 2009). Clearly, the loss of participants was neither related to experimental conditions nor due to response values, suggesting missing-at-random responses. Our final sample size was a total of 227 participants 59.47% of them males and 40.53% females. Table 3.5 shows demographic characteristics of our final sample. A t-test revealed non-statistically significant difference between the final sample and the excluded sample of complete responses, in terms of demographics, as showed in Table 3.6.

3.4.2 Experimental design

Participants were each randomly assigned to one experimental condition in which they were asked to imagine their experience with their partner and picture themselves in a scenario describing their couple's joint online shopping. There were six scenarios in total, presented[11] in Table 3.8, Table 3.9, Table 3.10, Table 3.11, Table 3.12, Table 3.13, and Table 3.14, showcasing all scenarios. Each scenario highlighted settings in which the couple shop together, including initial agreement condition between the two partners, system setup, and role played by the participant. Hence, each scenario depicted the couple shopping together as follows. First, either the couple makes a preliminary agreement about what product features to look for, or no preliminary agreement is made (i.e., pre-agreement vs no pre-agreement). Second, the couple shops together using either the same laptop or separate laptops (i.e., shared display vs separate displays). Finally, during the shopping activity, either the participant alone controls, or his or her partner alone controls, or both partners control input devices (i.e., mouse, keyboard, and touchpad). However, the scenarios did not consider following three unusual conditions: couple using same laptop with both partners controlling input devices, or couple using separate laptops with one of the two partners alone controlling input devices on both laptops.

Table 3.5. Demographics of the final sample.

		Frequency	**Percentage**
Age	< 18	0	0%
	18 - 25	24	10.6%
	26 - 35	117	51.5%
	36 - 45	47	20.7%
	46 - 55	24	10.6%
	> 55	15	6.6%
Gender	Man	135	59.5%
	Woman	92	40.5%
	Non-binary/Agender/Other	0	0%
Household income	< $30,000	27	11.9%
	$30,000 - $59,999	72	31.7%
	$60,000 - $89,000	58	25.6%
	$90,000 - $119,999	40	17.6%
	$120,000 - $149,000	17	7.5%
	>= $150,000	13	5.7%

Note. Household income figures are in USD.

[11]The pictures used in each scenario were adapted to match participant's gender. However, we present only one case per scenario. In addition, we present the interface for personal computers, except for scenario for which we also present an interface look for mobile phones.

Table 3.6. Demographics comparison between excluded and final sample.

Final sample vs Excluded sample	t-value	Degrees of freedom (df)	p-value
Gender [(1)]	1.589	310	0.113
Age [(2)]	-0.090	367	0.928
Household income [(2)]	-0.433	330	0.665

[(1)]: Man = 1; Woman = 2; No non-binary, agender, or other gender appeared in the final sample.
[(2)]: We used values 1, 2, 3, 4, 5, and 6 for his categorial variable, representing each category listed in

Based on the foregoing considerations, the shared display condition was equivalent to the combination of the two conditions in which one of the two partners alone controls input devices. Hence, as depicted in Table 3.7, our study followed a 2x(2x2-1) between-subject design. The sample size in all experimental groups was approximatively the same (likewise, regarding excluded data, sample size in experimental groups appeared relatively balanced – see in Table 3.B46 in Appendix B).

Table 3.7. Experimental design.

	Factors: Display sharing / Input device control		
Dyad pre-agreement	**Shared display & Participant controls**	**Shared display & Partner controls**	**Separate displays & Both partners control**
Pre-agreement	Scenario 1: 18.94% (n = 43)	Scenario 2: 17.62% (n = 40)	Scenario 3: 16.30% (n = 37)
No pre-agreement	Scenario 4: 14.10% (n =32)	Scenario 5: 17.18% (n = 39)	Scenario 6: 15.86% (n = 36)

Note. Total sample size was 227.

3.4.3 Experimental procedure

The study was administered through the Qualtrics survey administration online platform (Qualtrics, Seattle, Washington, U.S.A.). The study administration platform auto adapted its interface to match participants' type of device, including personal computers, tablets, and mobile phones. The activity flow was as follows. The introductory page included directives to participants, consent, and ethics information. Participants then had to provide their unique MTurk identification number, gender, and they reported on whether they are in couple or not. Next, they were presented the scenario they had to picture themselves in. The scenario page related a story describing all settings in which participants would jointly shop with their partner, in addition to a related summary picture. In the following page, they had to answer questions assessing their understanding of the scenario they had been assigned to. Then followed a questionnaire they took, reporting about their joint shopping experience in the pictured scenario settings. They ended the activity by reporting about personal traits, their anticipated attitude towards fictive system functionalities about shopping online in couple, and demographics.

Table 3.8. Scenario 1 – interface for personal computers.

Factor	Dyad pre-agreement	Display sharing	Input device control
Factor level value	Yes	Yes	Partner

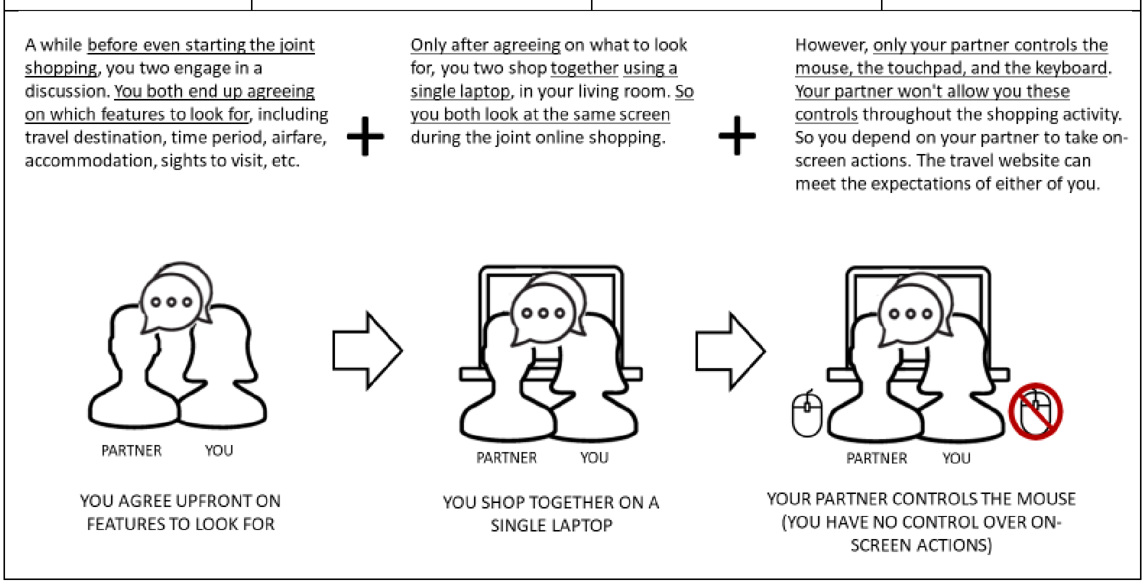
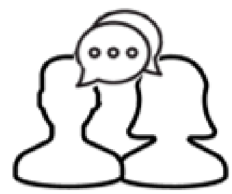


Table 3.9. Scenario 1 – interface for mobile phones.

Factor	Dyad pre-agreement	Display sharing	Input device control
Factor Level value	Yes	Yes	Partner

A while before even starting the joint shopping, you two engage in a discussion. You both end up agreeing on which features to look for, including travel destination, time period, airfare, accommodation, sights to visit, etc.



Only after agreeing on what to look for, you two shop together using a single laptop, in your living room. So you both look at the same screen during the joint online shopping.

However, only your partner controls the mouse, the touchpad, and the keyboard. Your partner won't allow you these controls throughout the shopping activity. So you depend on your partner to take on-screen actions. The travel website can meet the expectations of either of you.

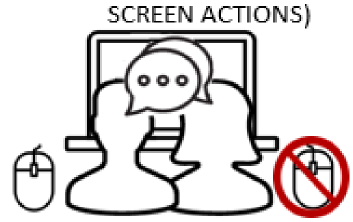


Table 3.10. Scenario 2 – interface for personal computers.

Factor	Dyad pre-agreement	Display sharing	Input device control
Factor level value	Yes	Yes	Participant

A while before even starting the joint shopping, you two engage in a discussion. You both end up agreeing on which features to look for, including travel destination, time period, airfare, accommodation, sights to visit, etc. **+**

Only after agreeing on what to look for, you two shop together using a single laptop, in your living room. So you both look at the same screen during the joint online shopping. **+**

However, only you control the mouse, the touchpad, and the keyboard. You won't allow your partner these controls throughout the shopping activity. So your partner depends on you to take on-screen actions. The travel website can meet the expectations of either of you.

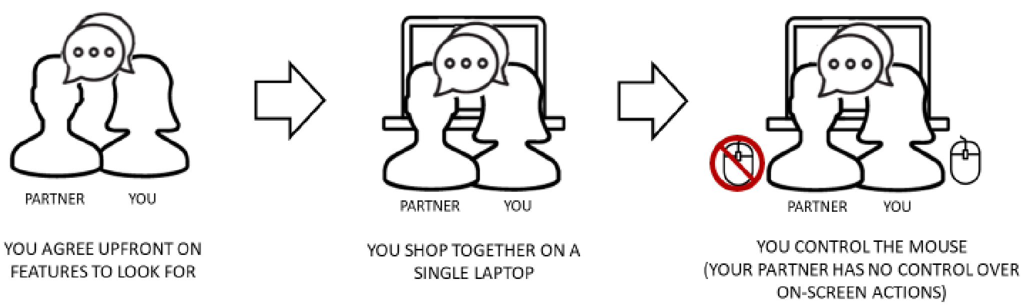


Table 3.11. Scenario 3 – interface for personal computers.

Factor	Dyad pre-agreement	Display sharing	Input device control
Factor level value	Yes	No	Both partners

A while before even starting the joint shopping, you two engage in a discussion. You both end up agreeing on which features to look for, including travel destination, time period, airfare, accommodation, sights to visit, etc. **+**

Only after agreeing on what to look for, you two shop together using separate laptops, in your living room. So each of you looks at their own screen during the joint online shopping. **+**

Moreover, each of you controls their own mouse, touchpad, and keyboard. Each of you have these controls throughout the joint shopping activity. So each of you can independently take actions on your own screen. The travel website can meet the expectations of either of you.

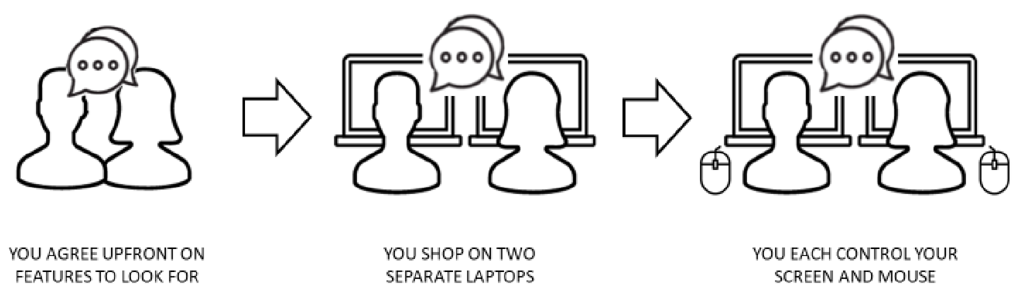


Table 3.12. Scenario 4 – interface for personal computers.

Factor	Dyad pre-agreement	Display sharing	Input device control
Factor level value	No	Yes	Partner

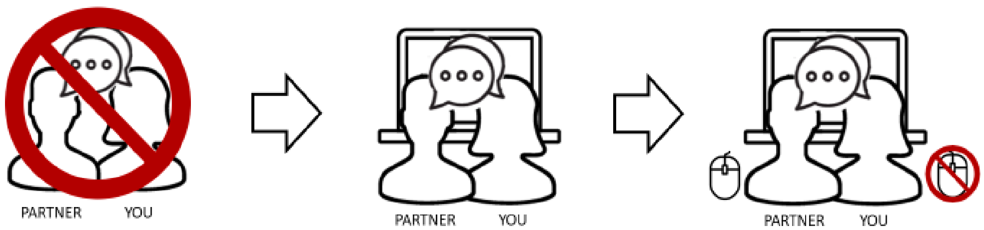
At the time you and your partner start the joint shopping, you have NOT taken any time to agree upfront together on which features to look for, including travel destination, time period, airfare, accommodation, sights to visit, etc.

+

With no upfront agreement on what to look for, you two shop together using a single laptop, in your living room. So you both look at the same screen during the joint online shopping.

+

However, only your partner controls the mouse, the touchpad, and the keyboard. Your partner won't allow you these controls throughout the shopping activity. So you depend on your partner to take on-screen actions. The travel website can meet the expectations of either of you.



YOU DO NOT DISCUSS UPFRONT ON THE FEATURES TO LOOK FOR

YOU USE A SINGLE LAPTOP TO SHOP TOGETHER, DISCUSSING THE FEATURES

YOUR PARTNER CONTROLS THE MOUSE (YOU HAVE NO CONTROL OVER ON-SCREEN ACTIONS)

Table 3.13. Scenario 5 – interface for personal computers.

Factor	Dyad pre-agreement	Display sharing	Input device control
Factor level value	No	Yes	Participant

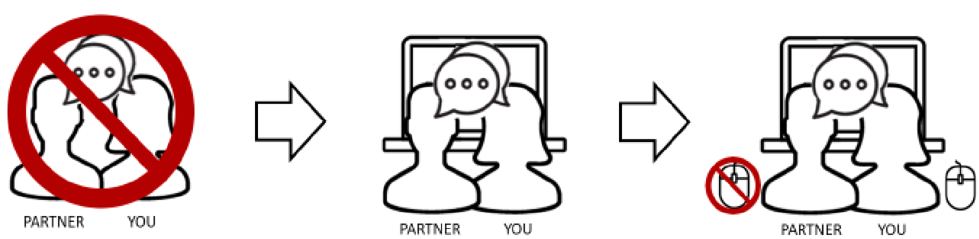
At the time you and your partner start the joint shopping, you have NOT taken any time to agree upfront together on which features to look for, including travel destination, time period, airfare, accommodation, sights to visit, etc.

+

With no upfront agreement on what to look for, you two shop together using a single laptop, in your living room. So you both look at the same screen during the joint online shopping.

+

However, only you control the mouse, the touchpad, and the keyboard. You won't allow your partner these controls throughout the shopping activity. So your partner depends on you to take on-screen actions. The travel website can meet the expectations of either of you.



YOU DO NOT DISCUSS UPFRONT ON THE FEATURES TO LOOK FOR

YOU USE A SINGLE LAPTOP TO SHOP TOGETHER, DISCUSSING THE FEATURES

YOU CONTROL THE MOUSE (YOUR PARTNER HAS NO CONTROL OVER ON-SCREEN ACTIONS)

Table 3.14. Scenario 6 – interface for personal computers.

Factor	Dyad pre-agreement	Display sharing	Input device control
Factor level value	No	No	Both partners

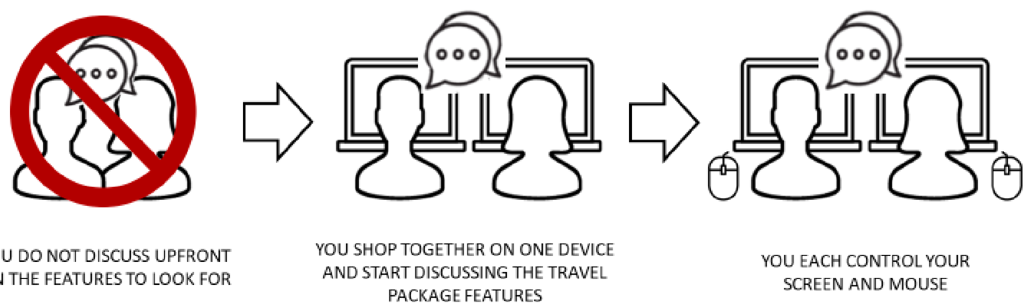
At the time you and your partner start the joint shopping, you have NOT taken any time to agree upfront together on which features to look for, including travel destination, time period, airfare, accommodation, sights to visit, etc.

+

With no upfront agreement on what to look for, you two shop together using separate laptops, in your living room. So each of you looks at their own screen during the joint online shopping.

+

Moreover, each of you control their own mouse, touchpad, and keyboard. Each of you have these controls throughout the joint shopping activity. So each of you can independently take actions on your own screen. The travel website can meet the expectations of either of you.



3.4.4 Measures

We used previously validated measures as much as possible (see Table 3.C48 and Table 3.C49 in Appendix C for all constructs' measurement items) and assessed reliability our final dataset. We measured dyadic conflict based on the measurement items proposed by Ma et al. (2017), including items measuring cognitive conflict, affective conflict, behavioral conflict, and interest conflict. We measured intention to continue joint e-commerce system use by drawing from Bhattacharjee (2001). To measure participants' involvement traits, we used the measures proposed by Laurent and Kapferer (1985), and we measured co-presence during the shopping activity based on measures from Kim et al. (2013). Besides, we measured effort for final consensus and time for final consensus using new scales, as we didn't find these construct's measures in the literature. Table 3.15 presents reliability assessment of our measurement instruments, which were generally satisfactory. Reliabilities of 0.50 to 0.60 have been deemed sufficient at early stages of research (Cronbach, 1970; Moore and Benbasat, 1991). Hence, reliability value for involvement was acceptable.

Table 3.15. Constructs' reliability assessment.[13]

Construct	Cronbach's alpha
Dyadic conflict	0.968
Cognitive conflict	0.909
Affective conflict	0.917
Behavioral conflict	0.904
Effort for final consensus	0.882
Time for final consensus	0.930
Intention to continue joint IT use	0.931
Involvement	0.638
Co-presence	0.867

3.5 Analysis and results

To perform all statistical analyzes, we used SPSS Statistics 27 software (IBM, New York, U.S.A.).

3.5.1 Manipulation check

Eight graduate students provided feedback about our scenarios, which we revised accordingly. We performed assessment of the manipulation of our three experimental factors in three phases, including in two pretest studies and in the full-scale study, using the experimental design presented in section 3.4.2. Our sample frame, participant selection criteria, and compensation were the same as those presented in section 3.4.1 for the three phases, as well as response exclusion criteria, except for reading time criteria, which we did not apply in the two pretest studies.

3.5.1.1 Pretest study 1

In a first pretest study we recorded a total of 123 responses. After exclusion of unusable responses, our sample was made of 107 participants (see Table 3.D50 in Appendix D for

[13] Because in the dyadic conflict scale only one item measures interest conflict, we could not assess reliability of the latter. For this reason, unlike the other dimensions or dyadic conflict, we did not test a specific model for interest-based conflict.

the sample's demographics). The study did not test our research model. After reading and picturing the scenario, participants answered questions testing the extent to which they understood the scenario they had been assigned to. Hence, they reported about four scenario settings and proceedings, including what product type they shop for in couple (referred to as ProductType), whether their couple agrees on product features prior to the activity (referred to as PreAgreement), whether they share the same laptop with their partner (referred to as DeviceSharing), and who controls the mouse during the activity (referred to as InputDeviceControl). The manipulation check questions were identical for all participants, whatever the experimental condition they had been assigned to (see Appendix C, Table 3.C47 for manipulation check items). For the manipulation check to be successful, we expected[14] [1] no difference in ProductType among all conditions, since all scenarios referred to the same product type; [2] significantly higher PreAgreement in the "Pre-agreement" condition than in the "No pre-agreement" condition; [3] no difference in DeviceSharing between the "Pre-agreement" and the "No pre-agreement" conditions; [4] no difference in InputDeviceControl between the "Pre-agreement" and the "No pre-agreement" conditions; [5] no difference in DeviceSharing between the "Participant controls" and the "Partner controls" conditions; [6] significantly higher DeviceSharing in the "Participant controls" condition than in the "Both partners control" conditions; [7] significantly higher DeviceSharing in the "Partner controls" condition than in the "Both partners control"; [8] no difference in PreAgreement among the "Participant controls", the "Partner controls", and the "Both partners control" conditions; [9] significantly higher InputDeviceControl in the "Participant controls" condition than in the "Partner controls" condition; and [10] no difference in PreAgreement among the three levels of the input device control factor.

We did different two-way analyses of variance (ANOVA) with contrast analysis using dyad pre-agreement and input device control as factors, respective dependent variables being PreAgreement, DeviceSharing, InputDeviceControl, and ProductType. All tests were satisfactory, except for above tests [2] ($p = 0.356$) and [3] ($p = 0.047$) suggesting an unsuccessful manipulation of the dyad pre-agreement factor and thus requiring additional

[14] The manipulation check success criteria were the same for the two pretest and the full-scale studies.

adjustments and another pretest. Descriptive statistics are shown in Table 3.16 and Table 3.17. Manipulation check results are shown in Table 3.18.

3.5.1.2 Pretest study 2

Based on pretest 1 results, we adjusted all six scenarios' wording to correct any possible clarity or accuracy issues related to the dyad pre-agreement condition. We then ran a second pretest study in which we recorded a total of 124 responses. After exclusion of irrelevant responses, our final pretest study 2' sample was made of 111 participants (see Table 3.D51 in Appendix D for the sample's demographics). This pretest study followed the same design as pretest study 1, the only difference being the adjustments we did on the scenarios' wording.

Table 3.16. Pretest study 1's descriptive statistics.

Manip. check dependent variables (1)	**Independent variables**	**Factor level**	**Min**	**Mean**	**Max**	**Std dev**
PreAgreement	Dyad pre-agreement	Dyad pre-agreement	1.000	5.537	7.000	1.463
		No dyad pre-agreement	1.000	5.245	7.000	1.839
	Display sharing	Shared display	1.000	5.352	7.000	1.837
		Separate display	1.000	5.472	7.000	1.253
	Input device control	Partner controls	1.000	5.361	7.000	2.016
		Participant controls	1.000	5.343	7.000	1.662
		Both partners control	1.000	5.472	7.000	1.253
DeviceSharing	Dyad pre-agreement	Dyad pre-agreement	1.000	4,778	7.000	2.016
		No dyad pre-agreement	1.000	4.057	7.000	2.240
	Display sharing	Shared display	1.000	3.761	7.000	2.252
		Separate display	1.000	5.722	7.000	1.111
	Input device control	Partner controls	1.000	3.667	7.000	2.255
		Participant controls	1.000	3.857	7.000	2.277
		Both partners control	3.000	5.722	7.000	1.111

(1): Dependent variable names are those defined in section 3.5.1.1.

Table 3.17. Pretest study 1's descriptive statistics (continued).

Manip. check dependent variables [1]	Independent variables	Factor level	Min	Mean	Max	Std Dev
InputDeviceControl	Dyad pre-agreement	Dyad pre-agreement	1.000	4.833	7.000	2.263
		No dyad pre-agreement	1.000	4.811	7.000	2.176
	Display sharing	Shared display	1.000	5.014	7.000	2.174
		Separate display [2]				
	Input device control	Partner controls	1.000	3.944	7.000	2.245
		Participant controls	3.000	6.114	7.000	1.105
		Both partners control [2]				
ProductType	Dyad pre-agreement	Dyad pre-agreement	3.000	5.889	7.000	1.160
		No dyad pre-agreement	2.000	6.057	7.000	1.045
	Display sharing	Shared display	2.000	6.042	7.000	1.164
		Separate display	3.000	5.833	7.000	0.971
	Input device control	Partner controls	3.000	6.194	7.000	1.064
		Participant controls	2.000	5.886	7.000	1.255
		Both partners control	3.000	5.833	7.000	0.971

(1): Dependent variable names are those defined in section 3.5.1.1.

(2): The comparison did not make sense, since it is obvious that participants assigned to scenarios picturing joint shopping using separate laptops would likely be confused by a question referring to whether one person alone controls input devices.

Table 3.18. Manipulation check results – pretest study 1

Factors	Comparison	Manipulation check dependent variables [1]	Contrast estimate	Std error	p-value	95% Confidence interval
Dyad pre-agreement	PreA – No preA	PreAgreement	0.299	0.322	0.356	[-0.340; 0.937]
		DeviceSharing	0.744	0.370	0.047	[0.009; 1.478]
		InputDeviceControl	0.082	0.387	0.833	[-0.686; 0.849]
		ProductType	-0.176	0.212	0.409	[-0.596; 0.244]
Display sharing	ShdDis - SepDis	PreAgreement	-0.125	0.338	0.712	[-0.794; 0.544]
		DeviceSharing	-1.970	0.389	<0.0001	[-2.741; -1.200]
		InputDeviceControl[2]				
		ProductType	0.211	0.226	0.353	[-0.238; 0.660]
Input device control	PN - PP	PreAgreement	-0.008	-0.395	0.984	[-0.792; 0.776]
		DeviceSharing	-0.244	0.455	0.593	[-1.146; 0.658]
		InputDeviceControl	-2.204	0.475	<0.0001	[-3.146; -1.262]
		ProductType	0.328	0.260	0.210	[-0.188; 0.844]
	PN - B	PreAgreement	-0.124	0.392	0.753	[-0.902; 0.654]
		DeviceSharing	-2.094	0.451	<0.0001	[-2.989; -1.198]
		InputDeviceControl[2]				
		ProductType	0.382	0.254	0.142	[-0.130; 0.894]
	PP - B	PreAgreement	-0.116	0.395	0.770	[-0.899; 0.667]
		DeviceSharing	-1.850	0.454	<0.0001	[-2.751; -0.948]
		InputDeviceControl[2]				
		ProductType	0.054	0.260	0.836	[-0.462; 0.569]

(1): Dependent variable names are those defined in section 3.5.1.1.

(2): The comparison did not make sense, since it is obvious that participants assigned to scenarios picturing joint shopping using separate laptops would likely be confused by a question referring to whether one person alone controls input devices.

Note: PreA = Pre-agreement; PN = partner controls; PP = Participant controls; B = Both partners control; ShdDis = Shared display; SepDis = Separate display.

Just as in pretest study 1, we ran a two-way ANOVA with contrast analysis using dyad pre-agreement and input device control as fixed factors, with PreAgreement, DeviceSharing, InputDeviceControl, and ProductType as dependent variable, respectively. Results showed that all the twelve manipulation check success criteria (listed in section 3.5.1.1) were successful. Descriptive statistics and manipulation check results are shown in Table 3.19 and Table 3.20, respectively.

3.5.1.3 Full-scale study

We double-checked the success of our factor manipulations using the full-scale study. With our final sample of 227 participants, we ran the same statistical tests as in section 3.5.1.2. Results were satisfactory for each of the assessments described in section 3.5.1.1 (i.e., criteria [1] to [10]). Descriptive statistics with manipulation check variables as well as manipulation check results are presented in Table 3.21 and Table 3.22, respectively.

We also further confirmed invalidity of the excluded sample by doing the manipulation check based on that sample of 142 responses. Using the same procedure as with the final sample, results confirmed that the excluded participants generally did not understand and were most likely not to have seriously looked at the scenario they had been assigned to. This result was suggested by the failed manipulation check for all factors, based on the excluded sample. Table 3.D52 along with Table 3.D53 and Table 3.D54 in Appendix D present related descriptive statistics and results, respectively. Moreover, to compare the final sample against the excluded sample in terms of scenario understanding, we ran contrast analyses, comparing the two samples at each level of each of the manipulated factors (IV), for each of the manipulation check variables, that is, PreAgreement, DeviceSharing, and InputDeviceControl (defined in section 3.5.1.1). Table 3.23 presents the comparison results, suggesting statistically significant differences between the final sample and the excluded sample in all relevant comparisons.

Table 3.19. Pretest study 2's descriptive statistics.

Manip. Check DV [1]	**IVs**	**Factor level**	**Min**	**Mean**	**Max**	**Std Dev**
PreAgreement	Dyad pre-agreement	Dyad pre-agreement	1.000	5.964	7.000	1.095
		No dyad pre-agreement	1.000	5.127	7.000	1.796
	Display sharing	Shared display	1.000	5.622	7.000	1.523
		Separate display	1.000	5.405	7.000	1.572
	Input device control	Partner controls	1.000	5.316	7.000	1.726
		Participant controls	1.000	5.944	7.000	1.218
		Both partners control	1.000	5.405	7.000	1.572
DeviceSharing	Dyad pre-agreement	Dyad pre-agreement	1.000	4.679	7.000	2.208
		No dyad pre-agreement	1.000	4.618	7.000	1.939
	Display sharing	Shared display	1.000	4.081	7.000	2.194
		Separate display	1.000	5.784	7.000	1.158
	Input device control	Partner controls	1.000	3.921	7.000	2.306
		Participant controls	1.000	4.250	7.000	2.089
		Both partners control	3.000	5.784	7.000	1.158
InputDeviceControl	Dyad pre-agreement	Dyad pre-agreement	1.000	5.232	7.000	1.916
		No dyad pre-agreement	1.000	5.036	7.000	1.835
	Display sharing	Shared display	1.000	5.149	7.000	1.928
		Separate display [2]				
	Input device control	Partner controls	1.000	4.605	7.000	2.237
		Participant controls	3.000	5.722	7.000	1.344
		Both partners control [2]				
ProductType	Dyad pre-agreement	Dyad pre-agreement	2.000	5.714	7.000	1.461
		No dyad pre-agreement	1.000	5.836	7.000	1.273
	Display sharing	Shared display	2.000	5.851	7.000	1.352
		Separate display	3.000	5.622	7.000	1.401
	Input device control	Partner controls	3.000	6.026	7.000	1.219
		Participant controls	2.000	5.667	7.000	1.474
		Both partners control	3.000	5.622	7.000	1.401

(1): Dependent variable names are those defined in section 3.5.1.1.

(2): The comparison did not make sense, since it is obvious that participants assigned to scenarios picturing joint shopping using separate laptops would likely be confused by a question referring to whether one person alone controls input devices.

Table 3.20. Manipulation check results – pretest study 2

Factors	**Compa-rison**	**Manip. check dependent variables[1]**	**Contrast estimate**	**Std error**	**p-value**	**95% Confidence interval**
Dyad pre-agreement	PreA – No preA	PreAgreement	0.813	0.282	0.005	[0.255; 1.371]
		DeviceSharing	0.018	0.367	0.961	[-0.710; 0.746]
		InputDeviceControl	0.165	0.346	0.635	[-0.521; 0.850]
		ProductType	-0.109	0.262	0.678	[-0.629; 0.410]
Device Setup	ShdDis - SepDis	PreAgreement	0.225	0.301	0.455	[-0.371; 0.821]
		DeviceSharing	-1.700	0.389	<0.0001	[-2.471; -0.928]
		InputDeviceControl[2]				
		ProductType	0.233	0.277	0.402	[-0.316; 0.781]
Input device control	PN - PP	PreAgreement	-0.582	0.345	0.095	[-1.266; 0.103]
		DeviceSharing	-0.334	0.450	0.459	[-1.226; 0.557]
		InputDeviceControl	-1.129	0.424	0.009	[-1.969; -0.289]
		ProductType	0.344	0.321	0.286	[-0.292; 0.981]
	PN - B	PreAgreement	-0.049	0.342	0.887	[-0.728; 0.630]
		DeviceSharing	-1.847	0.446	<0.0001	[-2.732; -0.962]
		InputDeviceControl[2]				
		ProductType	0.404	0.319	0.208	[-0.228; 1.035]
	PP - B	PreAgreement	0.533	0.347	0.128	[-0.156; 1.221]
		DeviceSharing	-1.513	0.453	0.001	[-2.410; -0.616]
		InputDeviceControl[2]				
		ProductType	0.060	0.323	0.854	[-0.581; 0.700]

(1): Dependent variable names are those defined in section 3.5.1.1.

(2): The comparison did not make sense, since it is obvious that participants assigned to scenarios picturing joint shopping using separate laptops would likely be confused by a question referring to whether one person alone controls input devices.

Note: PreA = Pre-agreement; PN = partner controls; PP = Participant controls; B = Both partners control; ShdDis = Shared display; SepDis = Separate display.

Table 3.21. Descriptive statistics with manipulation check variables – full-scale study.

Manip. Check DVs [1]	Independent variables	Factor level	Min	Mean	Max	Standard deviation
PreAgreement	Dyad pre-agreement	Dyad pre-agreement	2.000	6.067	7.000	1.136
		No dyad pre-agreement	1.000	3.252	7.000	2.270
	Display sharing	Shared display	1.000	4.688	7.000	2.251
		Separate display	1.000	4.849	7.000	2.271
	Input device control	Partner controls	1.000	4.853	7.000	2.270
		Participant controls	1.000	4.532	7.000	2.235
		Both partners control	1.000	4.849	7.000	2.271
DeviceSharing	Dyad pre-agreement	Dyad pre-agreement	1.000	4.092	7.000	2.500
		No dyad pre-agreement	1.000	3.822	7.000	2.498
	Display sharing	Shared display	1.000	2.987	7.000	2.318
		Separate display	1.000	6.027	7.000	1.343
	Input device control	Partner controls	1.000	3.080	7.000	2.420
		Participant controls	1.000	2.899	7.000	2.228
		Both partners control	1.000	6.027	7.000	1.343
InputDeviceControl	Dyad pre-agreement	Dyad pre-agreement	1.000	3.008	7.000	3.347
		No dyad pre-agreement	1.000	2.654	7.000	3.303
	Display sharing	Shared display	1.000	4.662	7.000	2.437
		Separate display [2]				
	Input device control	Partner controls	1.000	3.133	7.000	2.401
		Participant controls	1.000	6.114	7.000	1.340
		Both partners control [2]				
ProductTye	Dyad pre-agreement	Dyad pre-agreement	1.000	6.150	7.000	1.026
		No dyad pre-agreement	1.000	5.776	7.000	1.604
	Display sharing	Shared display	1.000	6.026	7.000	1.323
		Separate display	1.000	5.863	7.000	1.378
	Input device control	Partner controls	1.000	6.120	7.000	1.065
		Participant controls	1.000	5.937	7.000	1.530
		Both partners control	1.000	5.863	7.000	1.378

(1): Dependent variable names are those defined in section 3.5.1.1.

(2): The comparison did not make sense, since it is obvious that participants assigned to scenarios picturing joint shopping using separate laptops would likely be confused by a question referring to whether one person alone controls input devices.

Table 3.22. Manipulation check results – full-scale study.

Factors	Comparison	Manip. check dependent variables[1]	Contrast estimate	Std error	p-value	95% Confidence interval
Dyad pre-agreement	PreA – No preA	PreAgreement	2.827	0.235	<0.0001	[2.363; 3.290]
		DeviceSharing	0.354	0.275	0.199	[-0.188; 0.897]
		InputDeviceControl	0.330	0.212	0.120	[-0.087; 0.747]
		ProductType	0.366	0.178	0.041	[0.015; 0.718]
Device Setup	ShdDis - SepDis	PreAgreement	-0.251	0.251	0.318	[-0.747; 0.244]
		DeviceSharing	-3.050	0.293	<0.0001	[-3.627; -2.473]
		InputDeviceControl[2]				
		ProductType	0.153	0.190	0.421	[-0.221; 0.527]
Input device control	PN - PP	PreAgreement	0.096	0.286	0.738	[-0.468; 0.659]
		DeviceSharing	0.144	0.335	0.668	[-0.516; 0.803]
		InputDeviceControl	-3.023	0.257	<0.0001	[-3.530; -2.516]
		ProductType	0.153	0,217	0.480	[-0.274; 0.581]
	PN - B	PreAgreement	-0.218	0.292	0.456	[-0.792; 0.357]
		DeviceSharing	-2.983	0.341	<0.0001	[-3.655; -2.310]
		InputDeviceControl[2]				
		ProductType	0.229	0.221	0.302	[-0.207; 0.664]
	PP - B	PreAgreement	-0.313	0.286	0.275	[-0.878; 0.251]
		DeviceSharing	-3.126	0.335	<0.0001	[-3.787; -2.466]
		InputDeviceControl[2]				
		ProductType	0.075	0.217	0.729	[-0.353; 0.503]

(1): Dependent variable names are those defined in section 3.5.1.1.

(2): The comparison did not make sense, since it is obvious that participants assigned to scenarios picturing joint shopping using separate laptops would likely be confused by a question referring to whether one person alone controls input devices.

Note: PreA = Pre-agreement; PN = partner controls; PP = Participant controls; B = Both partners control; ShdDis = Shared display; SepDis = Separate display.

Table 3.23. Comparison of final and excluded samples at each level of IVs for each manipulation check DV.

DV [1]	**IV**	**Compared factor levels: final sample – excluded sample**	**Contrast estimate**	**Std error**	**p-value**	**95% Confidence Interval**
PreAgreement	DPA	Pre-agreement	0.475	0,230	0.040	[0.022; 0.928]
		No pre-agreement	-2.367	0.235	<0.0001	[-2,830; -1.904]
	DSH	Shared display	-0.975	0.252	<0.001	[-1.471; -0.479]
		Separate display	-0.660	0.342	0.054	[-1.332; 0.012]
	IDC	Partner controls	-0.734	0.355	0.040	[-1.432; -0.035]
		Participant controls	-1.213	0.359	<0.001	[-1.919; -0.506]
		Both partners control	-0.660	0.342	0.054	[-1.333; 0.013]
DeviceSharing	DPA	Pre-agreement	-1.162	0.319	<0.001	[-1.790; -0.534]
		No pre-agreement	-1.558	0.327	<0.001	[-2.200; -0.916]
	DSH	Shared display	-2.238	0.242	<0.0001	[-2.714; -1.762]
		Separate display	0.556	0.328	0.091	[-0.090; 1.201]
	IDC	Partner controls	-2.181	0.341	<0.0001	[-2.852; -1.510]
		Participant controls	-2.287	0.345	<0.0001	[-2.966; 01.608]
		Both partners control	0.556	0.329	0.092	[-0.091; 1.202]
InputDeviceControl	DPA	Pre-agreement	-0.34	0.502	0.946	[-1.020; 0.953]
		No pre-agreement	-0.819	0.513	0.103	[-1.847; 0.170]
	DSH	Shared display	-1.147	0.219	<0.0001	[-1.577; -0.717]
		Separate display [2]				
	IDC	Partner controls	-2.606	0.249	<0.0001	[-3.096; -2.116]
		Participant controls	0.230	0.252	0.362	[-0.265; 0.726]
		Both partners control [2]				

[1]: Dependent variable names are those defined in section 3.5.1.1.

[2]: The comparison did not make sense, since it is obvious that participants assigned to scenarios picturing joint shopping using separate laptops would likely be confused by a question referring to whether one person alone controls input devices.

Note: DV = manipulation check's dependent variables; DPA = Dyad pre-agreement; DSH = Display sharing; IDC = Input device control.

3.5.2 Results

Based on an average experimental group sample size of 38, our statistical power was 97% at $\alpha = 0.10$ to detect a high effect size of Cohen's $d = 1$. We applied a hierarchical regression approach to test our research model[15]. We first ran statistical models without control variables, then we added control variables to the models. Moreover, the research model was tested separately with overall conflict and with subdimensions of conflict. We controlled for participant's involvement trait and perceived co-presence during the joint activity. To test the influences from the input layer of the research model, we ran two-way analyses of covariance (ANCOVA) and two-way analyses of variance (ANOVA), along with contrasts analyses for all statistically significant F-tests. Besides, we tested influences among mechanisms and outcomes layers' constructs using the parallel mediation analysis methodology proposed by Hayes (2013). In that regard, we used Hayes' PROCESS macro, which has been a reference tool for parallel mediation analysis (e.g., Zeng et al., 2021; Duren and Yalçın, 2021; Abid et al., 2021).

3.5.2.1 Influences from the input layer's constructs

Because our research model suggests a full mediation by dyadic conflict, although they were not hypothesized, we tested direct effects of the IVs on effort for final consensus, time for final consensus, and intention to continue joint IT use (referred to as intention to continue) – see Table 3.24 for related F-test results. Regarding intention to continue, two-way ANCOVA with dyadic conflict, effort for final consensus, and time for final consensus as covariates revealed non-statistically significant main effect of each IV on participant's intention to continue, and no interaction effects. Moreover, we tested direct influence of IVs on effort for final consensus through an ANCOVA with dyadic conflict as covariate, finding non-statistically significant main effects and no interaction effects of IVs. We also assessed direct influence of IVs on time for final consensus through an ANCOVA with dyadic conflict as covariate, finding non-statistically significant main

[15]Because the shared display and input device control factors are partially confounded (the "Separate displays" and the "Both partners control" conditions are identical), for all testing of effects of the manipulated factors, we ran a separate test with [dyad pre-agreement, shared display] and with [dyad pre-agreement, input device control] as pair of independent variables. The latter was used for the reporting of main effect of dyad pre-agreement.

effect and no interaction effects. Finally, we tested the hypothesized direct influences on dyadic conflict by running two-way ANOVA with contrast analysis between the marginal means of dyadic conflict for each IV.

Table 3.24. F-test results of analysis of mediation by conflict.

DV	IV	R^2	MSE	df	df (error)	F-value	p-value	Hypothesis
Intention to continue	Dyad pre-agreement	0.689	0.279	1	212	0.244	0.622	None
	Input device control	0.689	0.873	2	212	0.764	0.467	None
	Display sharing	0.689	1.381	1	215	1.221	0.270	None
	Dyad pre-agreement * Input device control	0.689	1.401	2	212	1.225	0.296	None
	Dyad pre-agreement * Display sharing	0.689	2.419	1	215	2.139	0.145	None
Effort for final consensus	Dyad pre-agreement	0.678	1.594	1	214	1.662	0.199	None
	Input device control	0.678	0.663	2	214	0.691	0.502	None
	Display sharing	0.678	1.369	1	217	1.442	0.231	None
	Dyad pre-agreement * Input device control	0.678	0.281	2	214	0.293	0.747	None
	Dyad pre-agreement * Display sharing	0.678	0.472	1	217	0.497	0.482	None
Time for final consensus	Dyad pre-agreement	0.528	0.602	1	214	0.406	0.525	None
	Input device control	0.528	1.579	2	214	1.066	0.346	None
	Display sharing	0.528	0.985	1	217	0.662	0.417	None
	Dyad pre-agreement * Input device control	0.528	1.673	2	214	1.129	0.325	None
	Dyad pre-agreement * Display sharing	0.528	3.105	1	217	2.087	0.150	None
Dyadic conflict	Dyad pre-agreement	0.669	4.656	1	213	4.971	0.027	H4(a)
	Input device control	0.669	4.674	2	213	4.989	0.008	H2(a), H3(a)
	Display sharing	0.669	5.659	1	218	6.053	0.015	H1(a)
	Dyad pre-agreement * Input device control	0.669	0.493	2	213	0.526	0.592	None
	Dyad pre-agreement * Display sharing	0.669	0.698	1	218	0.747	0.388	None

Note. IV = independent variables; DV = dependent variables; MSE = mean squared error; df = degrees of freedom.

Table 3.25. F-test results of analysis of mediation by subdimensions of conflict.

(a) ANCOVA results – cognitive conflict, affective conflict, and behavioral conflict as covariates.

DV	IV	R^2	MSE	df	df (error)	F-value	p-value	Hypo-thesis
Intention to continue	Dyad pre-agreement	0.716	0.539	1	210	0.517	0.473	None
	Input device control	0.716	1.102	2	210	1.057	0.349	None
	Display sharing	0.716	1.776	1	213	1.713	0.192	None
	Dyad pre-agreement * Input device control	0.716	1.542	2	210	1.478	0.230	None
	Dyad pre-agreement * Display sharing	0.716	2.157	1	213	2.080	0.151	None
Effort for final consensus	Dyad pre-agreement	0.680	1.465	1	212	1.535	0.217	None
	Input device control	0.680	0.583	2	212	0.612	0.543	None
	Display sharing	0.680	1.198	1	215	1.268	0.261	None
	Dyad pre-agreement * Input device control	0.680	0.421	2	212	0.442	0.643	None
	Dyad pre-agreement * Display sharing	0.680	0.708	1	215	0.750	0.388	None
Time for final consensus	Dyad pre-agreement	0.532	0.434	1	212	0.295	0.588	None
	Input device control	0.532	1.66	2	212	1.130	0.325	None
	Display sharing	0.532	1.130	1	215	0.764	0.383	None
	Dyad pre-agreement * Input device control	0.532	1.870	2	212	1.273	0.282	None
	Dyad pre-agreement * Display sharing	0.532	3.318	1	215	2.244	0.136	None

Note. Since cognitive conflict, affective conflict, and behavioral conflict were used as covariate to in the ANCOVA testing direct effect of the IVs on the DVs, these results are the same when examining mediation by each of these subdimensions of dyadic conflict.

(b) ANOVA results for cognitive, affective, and behavioral conflict.

DV	IV	R^2	MSE	df	df (error)	F-value	p-value	Hypothesis
Cognitive conflict	Dyad pre-agreement	0.552	4.155	1	215	3.363	0.068	H4(b)
	Input device control	0.552	4.614	2	215	3.735	0.025	H2(b), H3(b)
	Display sharing	0.552	5.579	1	218	4.507	0.035	H1(b)
	Dyad pre-agreement * Input device control	0.552	1.385	2	215	1.121	0.328	None
	Dyad pre-agreement * Display sharing	0.552	1.801	1	218	1.455	0.229	None
Affective conflict	Dyad pre-agreement	0.655	4.966	1	215	4.541	0.034	H4(c)
	Input device control	0.655	3.011	2	215	2.754	0.066	H2(c), H3(c)
	Display sharing	0.655	4.581	1	218	4.213	0.041	H1(c)
	Dyad pre-agreement * Input device control	0.655	0.854	2	215	0.781	0.459	None
	Dyad pre-agreement * Display sharing	0.655	1.312	1	218	1.207	0.273	None
Behavioral conflict	Dyad pre-agreement	0.655	5.505	1	215	4.836	0.029	H4(d)
	Input device control	0.655	6.669	2	215	5.859	0.003	H2(d), H3(d)
	Display sharing	0.655	5.017	1	218	4.308	0.039	H1(d)
	Dyad pre-agreement * Input device control	0.655	0.688	2	215	0.604	0.547	None
	Dyad pre-agreement * Display sharing	0.655	0.092	1	218	0.079	0.779	None

Note. IV = independent variables; DV = dependent variables; MSE = mean squared error; df = degrees of freedom.

Regarding display sharing, results showed significantly higher dyadic conflict in the condition with shared display than in that with separate displays (F(1, 218) = 6.053; p = 0.008; C.I. = [0.115; 0.584]) and significantly higher dyadic conflict in the condition with no dyad pre-agreement than in that with dyad pre-agreement (F(1, 213) = 4.971; p = 0.014; C.I. = [0.077; 0.517]). We also obtained the following results: higher dyadic conflict as reported in the “Partner controls” experimental condition than that in the “Participant controls” condition (F(2, 213) = 4.989; p = 0.021; C.I. = [0.066; 0.598]); higher dyadic conflict as reported in the “Partner controls” experimental condition than that in the “Both partners control” condition (F(2, 213) = 4.989; p = 0.001; C.I. = [0.241; 0.790]); and non-statistically significant difference between dyadic conflict as reported in the “Participant controls” and that in the “Both partners control” condition (F(2, 213) = 4.989; p = 0.131; C.I. = [-0.086; 0.453]). Besides, no interaction effects of IVs were found. As a result, the hypotheses H1(a), H2(a), H3(a), and H4(a) were supported. Contrast analysis results about influences of the experimental factors on dyadic conflict are shown in Table 3.26.

We also tested direct influences of the IVs by considering either of cognitive conflict, affective conflict, and behavioral conflict as dependent variable. To do so, separately for each of those subdimensions of dyadic conflict, we conducted the same statistical tests as in the previous paragraph, replacing dyadic conflict in the statistical models with its subdimensions as covariates, and testing direct effects of IVs on intention to continue, effort for final consensus, and time for final consensus (see F-test results in Table 3.25(a) and Table 3.25(b)). Results showed non-statistically significant main effect of each IV on participant’s intention to continue and no interaction effects. Likewise, results showed non-statistically significant main effect of each IV on effort for final consensus and on time for final consensus, respectively, with no IVs’ interaction effects. On the other hand, results of two-way ANOVA with contrast analysis between the marginal means of each subdimension of conflict for each IV revealed the following: significantly higher cognitive conflict (F(1, 218) = 4.507; p = 0.018; C.I. = [0.077; 0.617]), higher affective conflict (F(1, 218) = 4.213; p = 0.021; C.I. = [0.061; 0.567]), and higher behavioral conflict (F(1, 218) = 4.308; p = 0.020; C.I. = [0.067; 0.591]) in the condition with shared display, compared to the condition with separate displays; and significantly higher cognitive conflict (F(1, 215) = 3.363; p = 0.034; C.I. = [0.028; 0.532]), higher affective conflict (F(1, 215) = 4.541; p = 0.017; C.I. = [0.069; 0.543]), and higher behavioral conflict (F(1, 215) = 4.836; p = 0.015; C.I. = [0.080; 0.564]) in the condition with no dyad pre-agreement, compared to that with dyad pre-agreement. In addition, compared to the “Participant controls” experimental condition, the “Partner controls” condition recorded significantly higher cognitive conflict (F(2, 215) = 3.735; p = 0.046; C.I. = [0.007; 0.616]), non-statistically significant difference in affective conflict, and significantly higher behavioral conflict ($F(2, 215) = 5.859$; $p = 0.004$; C.I. = [0.185; 0.769]). Furthermore, compared to the "Both partners control" condition, the "Partner controls" condition recorded higher cognitive conflict ($F(2, 215) = 3.375$; $p = 0.004$; C.I. = [0.201; 0.829]), higher affective conflict ($F(2, 215) = 2.754$; $p = 0.010$; C.I. = [0.124; 0.715]), and higher behavioral conflict ($F(2, 215) = 5.859$; $p = 0.001$; C.I. = [0.281; 0.884]). Finally, comparing the "Participant controls" to the "Both partners control" conditions, we found no differences neither in cognitive conflict, nor in affective conflict, nor in behavioral conflict. Besides, results showed no interaction effect of the IVs on neither cognitive conflict, nor affective conflict, nor behavioral conflict. These results, presented in detail in Table 3.26, support the hypotheses H1(b), H1(c), H1(d), H2(b), H2(d), H3(b), H3(c), H3(d), H4(b), H4(c), and H4(d). However, the hypothesis H2(c) was not supported. Contrast analyses results are summarized in Table 3.26.

3.5.2.2 Influences among mechanisms and consequences

We tested relationships among dyadic conflict, effort for final consensus, time for final consensus, and intention to continue, using the SPSS Statistics software's version of Hayes (2013)'s PROCESS macro, based on the model 4 of parallel mediations. Our statistical model (herein named Model DC) used dyadic conflict as IV, effort for final consensus and time for final consensus as parallel mediators, and intention to continue as dependent variable (DV). To test the parallel mediation models with subdimensions of dyadic conflict, we successively ran the PROCESS macro model 4 with one of the subdimension as IV and the other subdimensions as covariates[17] (we name Model Cog the model with cognitive conflict as IV, Model Aff the one with affective conflict as IV, and Model Beh the one with behavioral conflict as IV). We calculated confidence intervals through bootstrap method with 5000 samples. See results of the parallel mediation models in Table 3.27 and Table 3.28. Results for Model DC, Model Cog, Model

[17] Because the Hayes (2013)'s PROCESS macro treats covariates as independent variables, the respective statistical models with cognitive conflict, affective conflict, or behavioral conflict as IV and the other two subdimensions as covariate were equivalent to one another.

Aff, and Model Beh are also graphically summarized in Figure 3.25, Figure 3.26, Figure 3.27 and Figure 3.28.

Table 3.26. Contrast analysis - direct effect of the experimental factors.

DV	IV	Comparison	Contrast estimate	Std Error	t-value	d	p-value	Hypo-thesis
Dyadic conflict	DPA	PreA– No preA	-0.297	0.133	-2.233	0.306	0.014	H4(a)
	DSH	ShdDis - SepDis	0.349	0.142	2.458	0.333	0.008	H1(a)
	IDC	PN - PP	0.332	0.161	2.062	0.283	0.021	H2(a)
		PN - B	0.616	0.166	3.711	0.509	0.001	H3(a)
		PP - B	0.184	0.163	1.129	0.155	0.131	None
Cognitive conflict	DPA	PreA – No preA	-0.280	0.153	-1.830	0.250	0.034	H4(b)
	DSH	ShdDis - SepDis	0.347	0.163	2.129	0.288	0.018	H1(b)
	IDC	PN - PP	0.312	0.184	1.696	0.231	0.046	H2(b)
		PN - B	0.515	0.190	2.711	0.370	0.004	H3(b)
		PP - B	0.203	0.185	1.097	0.150	0.137	None
Affective conflict	DPA	PreA – No preA	-0.306	0.144	-2.125	0.290	0.017	H4(c)
	DSH	ShdDis - SepDis	0.314	0.153	2.052	0.278	0.021	H1(c)
	IDC	PN - PP	0.205	0.173	1.185	0.162	0.120	H2(c)
		PN - B	0.420	0.179	2.346	0.320	0.010	H3(c)
		PP - B	0.215	0.177	1.215	0.166	0.151	None
Behavioral conflict	DPA	PreA – No preA	-0.322	0.146	-2.206	0.301	0.015	H4(d)
	DSH	ShdDis - SepDis	0.329	0.158	2.082	0.282	0.020	H1(d)
	IDC	PN - PP	0.477	0.177	2.6949	0.368	0.004	H2(d)
		PN - B	0.582	0.182	3.1978	0.436	0.001	H3(d)
		PP - B	0.105	0.178	0.5899	0.080	0.277	None

Note. d = Cohen's d; DPA = Dyad pre-agreement; DSH = Display sharing; IDC = Input device control; PreA = Pre-agreement; PN = partner controls; PP = Participant controls; B = Both partners control; ShdDis = Shared display; SepDis = Separate displays.

Results of model DC showed statistically significant main effects of dyadic conflict respectively on effort for final consensus (F(1,225) = 481.940; p = 0.000; C.I. = [0.783; 0.911]), time for final consensus (F(1, 225) = 258.974; p = 0.000; C.I. = [0.692; 0.850]), and intention to continue (F(3, 223) = 168.022; p = 0.000; C.I. = [-0.865; -0.607]). We also found a main effect on intention to continue respectively from effort for final consensus (F(3, 223) = 168.022; p = 0.048; C.I. = [-0.268; -0.002]) and time for final consensus (F(3, 223) = 168.022; p = 0.039; C.I. = [-0.222; -0.008]). These results support our hypotheses H5(a), H6(a), H7(a), H8, and H9.

Regarding models involving subdimensions of dyadic conflict, for Model Cog, we found respective statistically significant main effects of cognitive conflict on effort for final consensus (F(3,223) = 162.364; p = 0.000; C.I. = [0.165; 0.457]) and time for final consensus (F(3, 223) = 88.149; p = 0.069; C.I. = [-0.018; 0.343]). The main effect of cognitive conflict on intention to continue was non-statistically significant. In addition, we found respective statistically significant main effects on intention[19] to continue from effort for final consensus (F(5, 221) = 115.983; p = 0.027; C.I. = [-0.277; -0.022]) and time for final consensus (F(5, 221) = 115.983; p = 0.085; C.I. = [-0.188; 0.017]). Hence, the hypotheses H5(b), H6(b), were supported, while H7(b) was not.

Results of Model Aff indicated respective statistically significant main effects of affective conflict on effort for final consensus (F(3, 223) = 162.364; p = 0.001; C.I. = [0.148; 0.483]), time for final consensus (F(3, 223) = 88.149; p = 0.005; C.I. = [0.115; 0.531]), and intention to continue (F(5, 221) = 115.983; p = 0.000; C.I. = [-0.681; -0.322]). These results support the hypotheses H5(c), H6(c), and H7(c).

Finally, results of Model Beh revealed statistically significant main effect of behavioral conflict on effort for final consensus (F(3, 223) = 162.364; p = 0.001; C.I. = [0.085; 0.368]), time for final consensus (F(3, 223) = 88.149; p = 0.004; C.I. = [0.106; 0.456]), and intention to continue (F(5, 221) = 115.983; p = 0.000; C.I. = [-0.547; -0.245]). These results support the hypotheses H5(d), H6(d), and H7(d).

[19] The results of Models Cog, Model Aff, and Model Beh were identical with regards to respective main effects of effort for final consensus and time for final consensus on intention to continue.

Table 3.27. Hayes (2013)'s PROCESS F-test results for Model DC, Model Cog, Model Aff, and Model Beh.

DV	IV	Model	R^2	MSE	df	F-value	p-value	Hypo-thesis
Effort for final consensus	Dyadic conflict	DC	0.682	0.952	1	481.940	<.0001	H5(a)
	Cognitive conflict	Cog, Aff, Beh	0.686	0.948	3	162.364	<.0001	H5(b)
	Affective conflict							H5(c)
	Behavioral conflict							H5(d)
Time for final consensus	Dyadic conflict	DC	0.535	1.466	1	258.974	<.0001	H6(a)
	Cognitive conflict	Cog, Aff, Beh	0.543	1.456	3	88.149	<.0001	H6(b)
	Affective conflict							H6(c)
	Behavioral conflict							H6(d)
Intention to continue	Effort for final consensus	DC	0.693	1.142	3	168.022	<.0001	H9
	Time for final consensus							H8
	Dyadic conflict							H7(a)
	Effort for final consensus	Cog, Aff, Beh	0.724	1.036	5	115.983	<.0001	H9
	Time for final consensus							H8
	Cognitive conflict							H7(b)
	Affective conflict							H7(c)
	Behavioral conflict							H7(d)

Note. IV = independent variables; DV = dependent variables; MSE = mean squared error; df = degrees of freedom; DC = Model DC; Cog = Model Cog; Aff = Model Aff; Beh = Model Beh.

Table 3.28. Hayes (2013)'s PROCESS results for Model DC, Model Cog, Model Aff, and Model Beh.

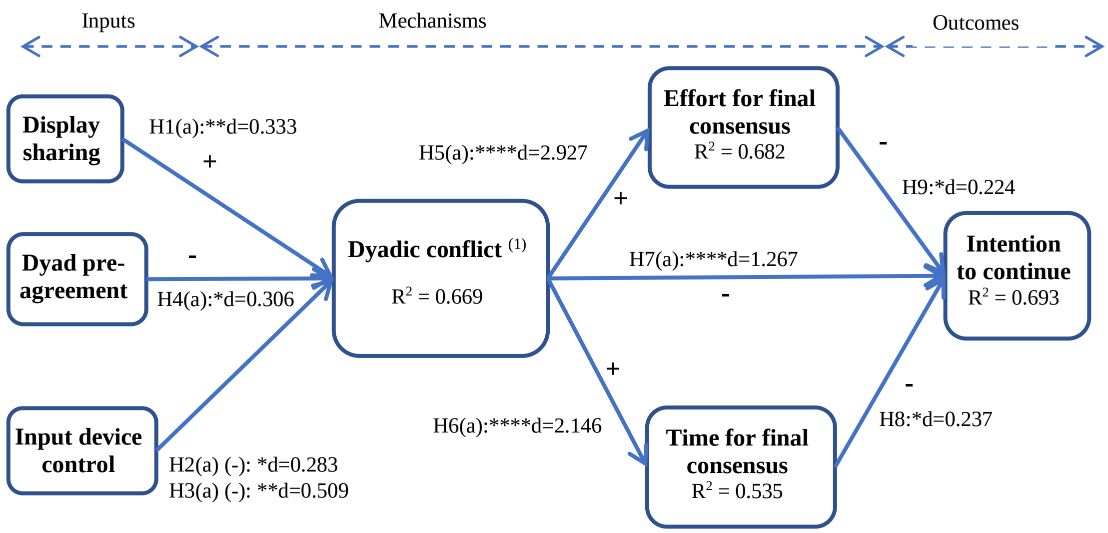
DV	Mo-del	IV	Effect	Std Error	t-value	d	p-value	Hypo-thesis
Effort for final consensus	DC	Dyadic conflict	0.847	0.039	21.953	2.927	<.0001	H5(a)
	Cog, Aff, Beh	Cognitive conflict	0.311	0.088	3.519	0.471	<.001	H5(b)
		Affective conflict	0.315	0.102	3.104	0.416	0.001	H5(c)
		Behavioral conflict	0.226	0.086	2.644	0.354	0.004	H5(d)
Time for final consensus	DC	Dyadic conflict	0.771	0.048	16.093	2.146	<.0001	H6(a)
	Cog, Aff, Beh	Cognitive conflict	0.162	0.109	1.483	0.199	0.067	H6(b)
		Affective conflict	0.323	0.126	2.568	0.344	0.005	H6(c)
		Behavioral conflict	0.281	0.106	2.647	0.354	0.004	H6(d)
Intention to continue	DC	Effort for final consensus	-0.135	0.081	-1.676	0.224	0.048	H9
		Time for final consensus	-0.115	0.065	-1.771	0.237	0.039	H8
		Dyadic conflict	-0.736	0.078	-9.457	1.267	<.0001	H7(a)
	Cog, Aff, Beh	Effort for final consensus	-0.150	0.077	-1.939	0.261	0.027	H9
		Time for final consensus	-0.086	0.062	-1.376	0.185	0.085	H8
		Cognitive conflict	0.189	0.095	1.996	0.269	0.976	H7(b)
		Affective conflict	-0.502	0.109	-4.605	0.619	<.0001	H7(c)
		Behavioral conflict	-0.396	0.091	-4.331	0.583	<.0001	H7(d)

Note. IV = independent variables; DV = dependent variables; d = Cohen's d; DC = Model DC; Cog = Model Cog; Aff = Model Aff; Beh = Model Beh.

We summarize all hypothesis testing results in Table 3.29. The results confirm twenty-eight hypotheses, with only two hypotheses not supported (i.e., H2(c) and H7(b)).

Table 3.29. Hypothesis testing results summary.

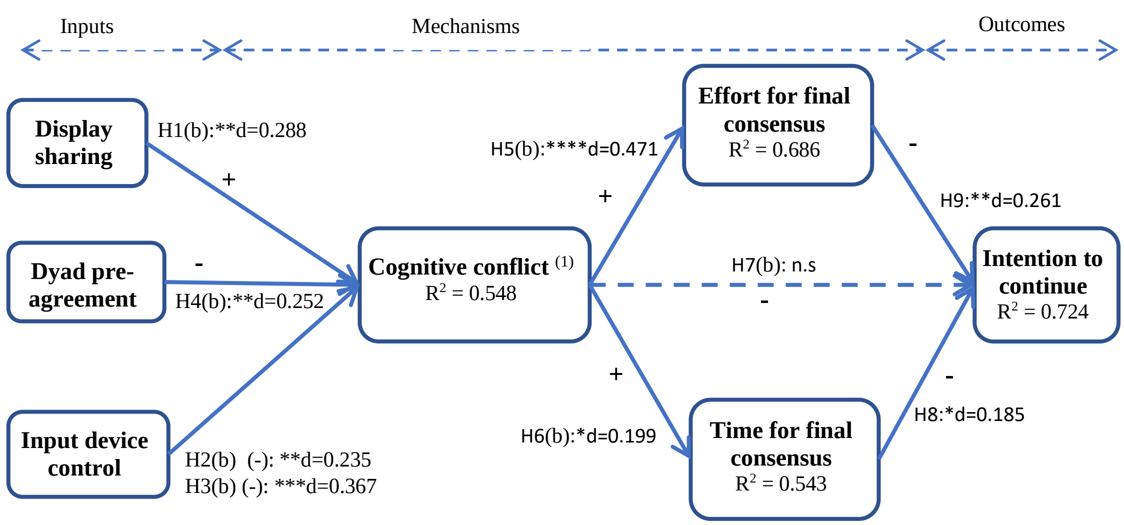
Hypothesis	**IV**	**DV**	**Support**
H1(a)	Display sharing	Dyadic conflict	Yes
H1(b)	Display sharing	Cognitive conflict	Yes
H1(c)	Display sharing	Affective conflict	Yes
H1(d)	Display sharing	Behavioral conflict	Yes
H2(a)	Input device control	Dyadic conflict	Yes
H2(b)	Input device control	Cognitive conflict	Yes
H2(c)	Input device control	Affective conflict	No
H2(d)	Input device control	Behavioral conflict	Yes
H3(a)	Input device control	Dyadic conflict	Yes
H3(b)	Input device control	Cognitive conflict	Yes
H3(c)	Input device control	Affective conflict	Yes
H3(d)	Input device control	Behavioral conflict	Yes
H4(a)	Dyad pre-agreement	Dyadic conflict	Yes
H4(b)	Dyad pre-agreement	Cognitive conflict	Yes
H4(c)	Dyad pre-agreement	Affective conflict	Yes
H4(d)	Dyad pre-agreement	Behavioral conflict	Yes
H5(a)	Dyadic conflict	Effort for final consensus	Yes
H5(b)	Cognitive conflict	Effort for final consensus	Yes
H5(c)	Affective conflict	Effort for final consensus	Yes
H5(d)	Behavioral conflict	Effort for final consensus	Yes
H6(a)	Dyadic conflict	Time for final consensus	Yes
H6(b)	Cognitive conflict	Time for final consensus	Yes
H6(c)	Affective conflict	Time for final consensus	Yes
H6(d)	Behavioral conflict	Time for final consensus	Yes
H7(a)	Dyadic conflict	Intention to continue	Yes
H7(b)	Cognitive conflict	Intention to continue	No
H7(c)	Affective conflict	Intention to continue	Yes
H7(d)	Behavioral conflict	Intention to continue	Yes
H8	Time for final consensus	Intention to continue	Yes
H9	Effort for final consensus	Intention to continue	Yes



(1): Only R^2 by Dyad pre-agreement and Input device control is represented because of confound of the latter with Display sharing.

Note. * = significant at α=0.05; ** = significant at α=0.01; *** = significant at α=0.001; **** = significant at α=0.0001.

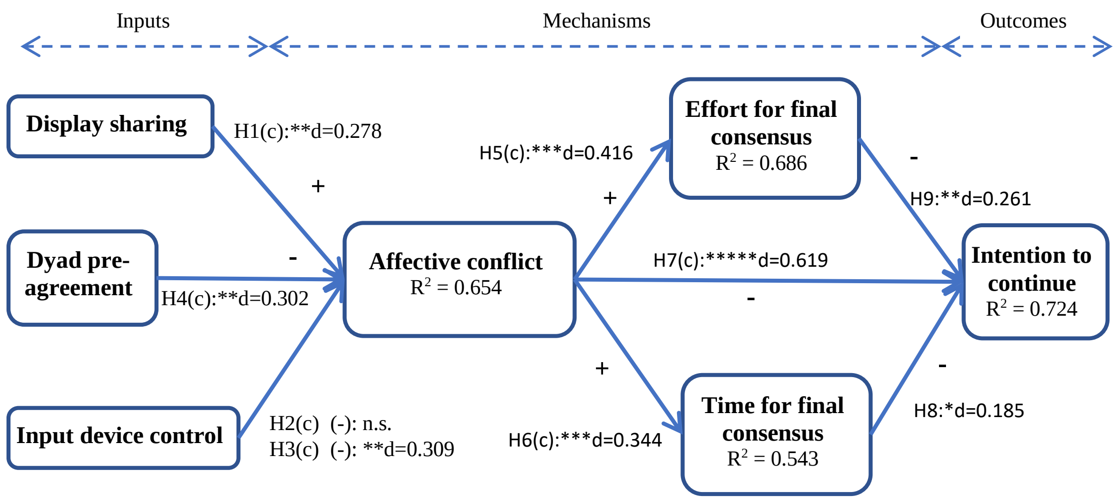
Figure 3.25. Dyadic conflict model results.



(1): Only R^2 by Dyad pre-agreement and Input device control is represented because of confound of the latter with Display sharing.

Note. * = significant at α=0.10; ** = significant at α=0.05; *** = significant at α=0.01; **** = significant at α=0.001; ***** = significant at α=0.0001.

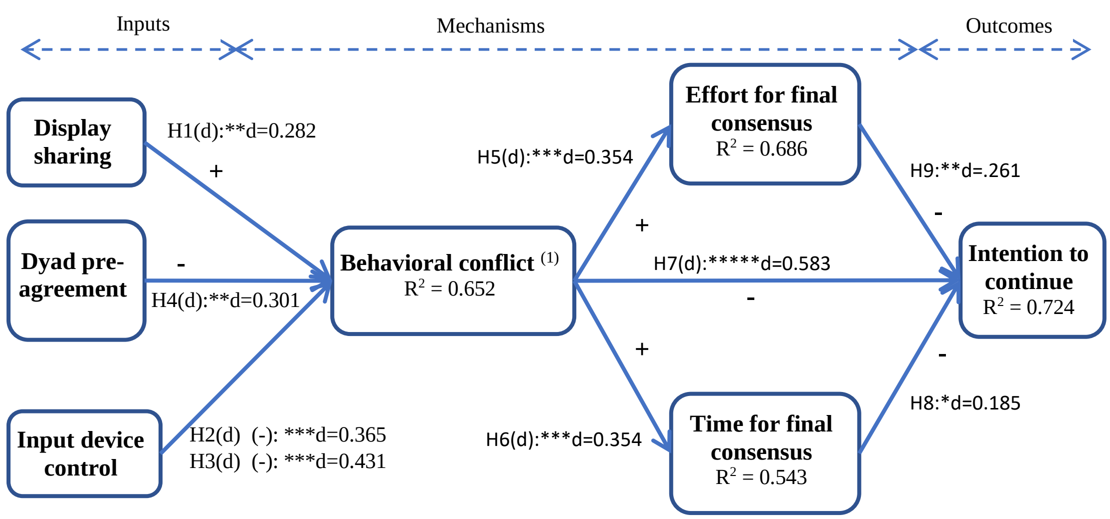
Figure 3.26. Cognitive conflict model results.



[(1)]: Only R^2 by Dyad pre-agreement and Input device control is represented because of confound of the latter with Display sharing.

Note. * = significant at α=0.10; ** = significant at α=0.05; *** = significant at α=0.01; **** = significant at α=0.001; ***** = significant at α=0.0001.

Figure 3.27. Affective conflict model results.



[(1)]: Only R^2 by Dyad pre-agreement and Input device control is represented because of confound of the latter with Display sharing.

Note. * = significant at α=0.10; ** = significant at α=0.05; *** = significant at α=0.01; **** = significant at α=0.001;

***** = significant at α=0.0001.

Figure 3.28. Behavioral conflict model results.

3.6 Discussion

3.6.1 Findings

In this essay, we put forward the role of dyadic conflict during joint IT use in the context of online shopping. Dyadic conflict can be considered a central construct in the sense that it may be very influential to behavioral intentions of users involved in a joint online shopping activity. Almost all our hypotheses were supported.

Regarding the joint IT use context, we found that computer display sharing and input device control directly influence dyadic conflict. More precisely, for joint IT task performance, sharing computer display is a factor of dyadic conflict, as it is likely to trigger competition over control of interactions with system interface (Mekki Berrada, 2011; Steward et al., 1999). As these interactions are done through input devices, our findings suggest that user's perception of dyadic conflict is influenced by the role the user plays during joint task. A dyad member is likely to perceive higher dyadic conflict when he or she does not control input devices and only indirectly interact with the system during joint tasks, but the user would perceive less dyadic conflict when he or she controls input devices alone or when each dyad member uses a separate device during the task – each of them controlling his or her own device. Perceived dyadic conflict would be equivalent to each other in these latter two configurations. We also found a direct influence of dyad pre-agreement on dyadic conflict. When user dyads engage in a joint task having made initial consensus upfront over common objectives or choices to be made together, they are likely to experience a better joint use experience than when no upfront consensus is made. This finding supports past research findings suggesting that conflict emerges from disagreement (Barki and Hartwick, 2004). All above finding also hold for specific types of conflict, including cognitive conflict, affective conflict, and behavioral conflict.

Dyadic conflict appears to be an important emerging topic in joint IT use phenomenon. Overall, we found no direct influences from display sharing, input device control, and dyad pre-agreement on intention to continue, effort for final consensus, and time for final consensus. Instead, we found that the influences of these three exogenous constructs are fully mediated by dyadic conflict overall and more specifically by cognitive, affective, and behavioral conflict, respectively. Clearly, dyadic conflict can be considered an essential construct for understanding how joint IT use system and dyad settings impact users' behavioral intentions.

Although dyadic conflict fully mediates the influence of our research model's exogenous constructs on user's intention, this full mediation is partially mediated in parallel by the required effort for final consensus and time for final consensus. As reported in Table 3.28, we found very high direct effects of dyadic conflict respectively on effort to final consensus (Cohen's d = 2.927), time for final consensus (Cohen's d = 2.146), and intention to continue (Cohen's d = 1.267), considering that high effect size corresponds to values of Cohen's d greater or equal to 0.8, while Cohen's d value between 0.5 and 0.8 reflects medium effect size (Cohen, 1988). We observed these partial mediation effects when considering cognitive, affective, and behavioral conflict, with low to medium effect sizes, with the exception that cognitive conflict doesn't influence intention to continue. Hence, that dyad have divergent opinions about the joint task is not enough to influence users' intention to continue. It takes that users often experience affective conflict (i.e., negative emotions) or behavioral conflict (i.e., undertake destructive actions from their partner), affective conflict being the most directly influential to users' intention to continue (Cohen's d = 0.619). Moreover, cognitive conflict contributed the most to the effect of dyadic conflict on required effort for final consensus (Cohen's d = 0.471), followed by affective conflict, while behavioral conflict contributed the most to the effect of dyadic conflict on required time for final consensus (Cohen's d = 0.354), an effect comparable to that of affective conflict. Hence, users' behavioral intention is likely to be very sensitive to dyadic conflict experienced during joint IT. Clearly, dyadic conflict shows promising explanatory power for future research on joint IT use.

Finally, our findings reveal that our model of joint IT use is highly explanatory for each of its endogenous constructs (see Figure 3.25, Figure 3.26, Figure 3.27, and Figure 3.28), controlling for user involvement trait and perceived co-presence during task performance. Display sharing, input device control and dyad pre-agreement explained about 66.9% of variance in dyadic conflict, a comparable observation with affective conflict and behavioral conflict (R^2 = 0.652), cognitive conflict's variance explained was also high but lower (R^2 = 0.548). Moreover, dyadic conflict explained about 68.2% of variance in effort for final consensus and 53.5% of variance in time for final consensus. Overall, we were able to explain 69.3% of variance in our model's joint IT use outcome, user's intention to continue.

3.6.2 Implications

3.6.2.1 Theoretical implications

Our essay has several implications for theory. First, an important takeaway of this essay is that user's behavioral intention vis-à-vis IT use is influenced not only by individual factors as proposed by most models of IT use but also by factors at the collective level, when IT is used jointly by users. This is even more relevant for tasks typically performed together by two users or more, such as pair programming or couple online shopping. IS researchers have called for the expansion of the conceptualization of IT use. Barki et al. (2007) propose IS use-related activity (ISURA) as a construct encompassing not only IT interaction behaviors but also activities users perform to adapt to the task, adapt to the IT, or making modifications to themselves to adapt to the IT. However, the ISURA construct is conceptualized only at the individual level. Moreover, Burton-Jones and Straub (2006) called for the conceptualization of IT use in a multilevel fashion. As they suggest, such conceptualization provides a more complete picture of IT use. The present essay is an illustration of the multilevel perspective of IT use, explaining dyad level mechanisms and individual-level impact. Particularly, our essay presents joint IT use as a phenomenon whose investigation has a high potential of significantly increasing understanding of IT use, as this phenomenon is very common in utilitarian and hedonic settings.

Our findings suggest a highly explanatory power of our model of joint IT use. Clearly dyadic conflict experienced during joint IT use and resulting effort and time required are important to understanding why individuals would continue engaging in joint IT tasks. Future studies may consider influences of these constructs when investigating multilevel mechanisms of IT use. Our findings represent a significant start for examining multilevel antecedents of IT use-related behavioral intentions.

By far the most influential construct to behavioral intention in our research model (with a very high effect - Cohen's d = 1.267), dyadic conflict appears central to the understanding of individual intention to continue joint IT use. The direct effect of dyadic conflict originates mainly from its affective and behavioral dimensions. In other words, individual intention to continue may directly originate from the extent to which partner users experience negative emotions and the extent to which they undertake destructive actions against one another during joint IT use. Conversely, cognitive conflict only indirectly influences user intention, through the mediation of resulting time and effort required for consensus during joint IT use. In other words, user intention does not directly originate from the extent to which dyad members disagree upon objectives or actions to undertake during joint IT use. These findings, although in our context of joint IT use, can be interesting to examine in research on collective IT use in general, as collective work involves two or more individuals and is prone to generating conflict through disagreements on decision making (Hu et al., 2017; Anicich et al., 2016).

Finally, our findings suggest that computer setup in which dyad users perform a joint task and the extent to which they have common goals prior to engaging in the joint task influence individual intentions, but this influence is fully mediated by dyadic conflict happening during the task. Hence, minimising dyadic conflict may represent an interesting means for mitigating user's adverse behavior against IT use. Dyad pre-agreement appears to be determinant in that purpose, as it permits anticipation and upfront settlement of disputes or clashes that would otherwise generate dyadic conflict states during joint tasks. Moreover, future research on joint IT use may focus on investigating system configurations that bring about minimal dyadic conflict, ultimately promoting positive user intentions. A better understanding of such system characteristics could be instrumental in developing practical recommendations aiming at improving joint IT use experience.

3.6.2.2 Practical implications

On a practical note, our study evidences that sharing the same computer or display can be an important source of conflict during joint IT use. Our recommendations to system designers on this point is twofold. First, when display sharing is not compulsory in joint IT tasks, it is likely that collaborating users each need to perform different subtasks from their partner's subtask at the same time, though in an interdependent way. In such context, system architectures should account for the modularity of subtasks constituting joint system use cases, permitting the task to be performed by dyad users, each of them using a separate device. Such design pattern is exemplified by online office software (e.g., Microsoft Word Online and Google Docs) allowing multiple users to build a common document, each of them simultaneously and interdependently, with real-time rendering of one another's actions in the document. Regarding online shopping by couples, e-commerce platforms may incorporate a co-navigation feature, which allows two partners to separately browse the same webpage while monitoring each other's navigation. Co-navigation designs include split screen navigation, which divides the web browser into two sub-windows, allowing partners to each control their own view of the webpage and at the same time be aware of their partner's navigation displaying in the other webpage view; location cue-based design allows users to separately navigate on a webpage while being aware, through location cue indicators, of their partner's location on the website, that is, knowing which specific webpage (or menu) their partner is navigating; lastly, shared view design allows the partner users to synchronously navigate the same webpages, with a real-time shared display on each user's computer (Yue et al., 2014). Unlike shared view design, split screen design and location cue design allow each partner to act on their own in the webpage. As a solution to this limitation, an enhanced version of shared view design can be conceived of as an asynchronous display allowing partner users not only to each scroll to the webpage locations they want but also to each take different actions on the same webpage at the same time, just like with multiuser online office software.

Furthermore, when display sharing is compulsory, that is, the joint task cannot be performed with direct interactions of both dyad users with system interface at the same time, the dyad is made of a controlling user and a non-controlling user. In that case, system designers should be mindful of the higher propensity to perceive dyadic conflict by non-controlling users, as evidenced by our study's findings. System architectures may mitigate such risk of conflict in several ways. For example, just as illustrated by some third-party software (e.g., Archwiki, 2021; Raymond, 2021), computer hardware and operating systems may incorporate dual-control modes, that is, functionalities permitting the cohabitation of two mice with independent cursors within a same system interface, each of them being controlled by a different user while the two users perform a joint task in the computer. Admittedly, in this case, dyadic conflict emergence may depend on the extent to which the dyad members are able to coordinate their respective interactions with the system; for example, that users take opposite actions would be likely to cause clashes. Another example could be that software architects consider a system functionality permitting two dyad members sharing one screen to take control of the mouse cursor in turn, either voluntarily or compulsorily (e.g., using a mouse with fingerprint reader identifying a change of user control). Such feature may be particularly useful for example when both dyad members absolutely want to control input devices (e.g., there is no trust within the dyad that leaving the mouse to the other partner is a good idea). Finally, conflict may emerge from diverging interests during dyadic use of a shared interface (Ma et al., 2017), which could translate into user gaze behavior within the screen (i.e., users would likely look at locations of interest for them in the screen). Hence, allowing controlling user to know at a glance where in the screen the noncontrolling user is looking may promote better coordination (Thepsoonthorn et al., 2016). IT practitioners may incorporate in systems the display of the gaze location of the noncontrolling user on the shared screen. Such feature may be implemented by leveraging eye-tracking technology to capture user gaze information. Gaze location may be displayed on the shared screen using location cues such as a moving light-colored disk.

Other practical implications of our study can be related to our findings suggesting higher propensity to dyadic conflict when a joint IT use is performed with no pre-agreement about the objectives of the task. For IT tasks with clearly identifiable and specific objectives (e.g., joint shopping task, dual-player games), system designers may foresee software interfaces permitting user dyad to take some time to agree on common goals or preferences related to a joint task, voluntarily or compulsorily, prior to engaging in the joint task (we exemplify such scenario at the end of this paragraph). Because in practice systems designed for single-user use are often used by user dyads, such systems could incorporate a joint-use operating mode aiming at generating better joint IT use experience in use cases involving user dyads, in addition to a default individual-use operating mode. Specifically, in online shopping context, research shows that in the U.S.A, more that 90% of couples jointly shop together (at least occasionally) on a single computer, while more than 80% do so using the same smartphone, such dyadic activities being prevalent in the travel and tourism industry (Tchanou et al., 2020a). Hence, online vendors should be mindful of the advantages a joint-use operating mode could provide. Since their e-commerce success depends on the extent to which customers use their online platform, implementing in their system a joint-use mode promoting dyad pre-agreement prior to dyad shopping would likely contribute to mitigating dyadic conflict during joint tasks, including lowering cognitive, affective, and behavioral dyadic conflict, ultimately promoting user intention to continue joint IT use. Following is an example of user scenario for a dyad illustrating the joint-use operating mode, which is depicted in Figure 3.29: the controlling user chooses the operating mode (single-user or joint-use); if the controlling user chooses the joint-use mode, then the system opens a pre-agreement interface requiring that the dyad users agree together on specific objectives or preferences (in case this interface is optional, the users can choose to cancel the pre-agreement task or to perform it together). The dyad users then agree on and choose common objectives or preferences. Once they complete the preliminary task, the core system interface displays.

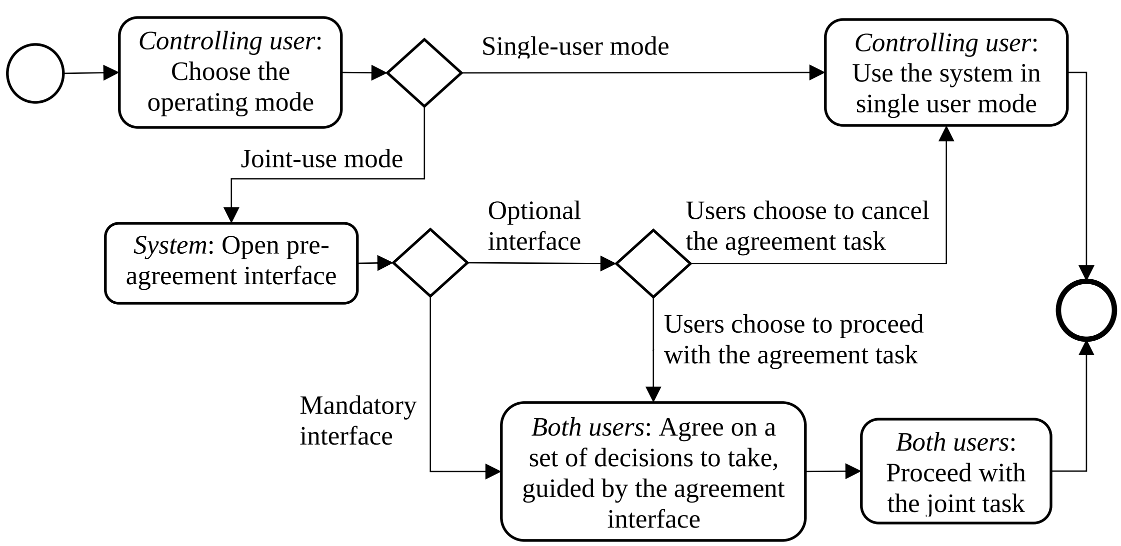


Figure 3.29. User scenario for a joint-use operating mode.

3.6.3 Contributions

This essay contributes to the literature in several ways. First, we investigate factors, mechanisms, and consequences of joint IT use, a phenomenon whose study is lacking in IS research. Our findings augment understanding of why user dyads may experience conflict (including cognitive, affective, behavioral, and interest-based conflict) during joint use of an IT, and why they may or may not intent to continue the joint activity. Second, this essay investigates IT use in a multilevel fashion, a perspective still seldom in the IS literature despite past calls to IS researchers for the consideration of multilevel conceptualizations of the construct to provide a more complete understanding of IT use (Zhang and Gable, 2017; Burton-Jones and Gallivan, 2007). Third, our results bring more insights to the IT acceptance literature. Just as literature suggests respective associations of effort expectancy and performance expectancy with behavioral intention (e.g., Venkatesh et al., 2003), the present research supports these two associations in the seldom-explored context of joint IT use, by empirically evidencing respective negative relationships between intention to continue joint IT use and effort for final consensus (representing effort expectancy) and time for final consensus (representing performance expectancy). Fourth, the essay examines the joint IT use phenomenon in line with the Activity theory, a seldom perspective in the IT use literature. As the theory proposes to study people's experience essentially in association with the related activities actions (Kaptelinin 1996), we examine factors and mechanisms of joint IT use by directly relating them to the proceedings of the activity. Moreover, as the theory promotes collective human activity as a unit of analysis for studying people's experience (Engeström et al., 1999), we investigate not only construct at individual users' level (i.e., behavioral intention) but also constructs at dyad level, including dyad pre-agreement, dyadic conflict, and time and effort for final consensus. Hence, our essay accounts not only for IT use-related construct at the user level but also for mechanisms related to collaboration surrounding direct and indirect IT use, a perspective that is complementary to the former, which is generally the focus in the IS literature. Fifth, we investigate conflict during IT use, a construct that has been seldom explored in the IT acceptance literature in spite of its apparently central role in joint IT use, though it has been examined in other IS research streams such as in IT project management literature (e.g., Boonstra et al., 2015; Bang et al., 2018). Sixth, we propose a model of joint IT use that we found to be highly explanatory of mechanisms happening when user dyads jointly use an IT and highly explanatory of user behavioral intention. Finally, our recommendations to IT practitioners may constitute an important ground for generating new insights for new types of IT systems whose design is not only centered on single-user experience but also on multiuser experience.

3.6.4 Limitations and future directions

Despite its contributions, our study has limitations. We tested our research model in the specific context of online shopping platforms. Showing that system setting, input device control and dyad pre-agreement significantly influence user's intention through the full mediation by dyadic conflict, this research is an encouraging point of departure to investigate antecedents of user's intentions in other technological contexts.

Further, we capture dyadic conflict happening during joint IT use based on one couple member's response (only one of the two partners participated to the study). Future study may consider both partner's perception of dyadic conflict, from which further insights may emerge. Moreover, an interesting research avenue could be conduct comparative analysis of the two partners' perception of dyadic conflict, based on factors creating an asymmetry in dyad structure, such as input device control when only one of the partners controls the mouse.

Unlike we investigated the specific roles of the cognitive, the affective, and the behavioral dimensions of dyadic conflict, we did not focus on the specific role of interest-based conflict because of its measurement's reliability could not be measured. Future research could examine the role of interest-based conflict comparatively to other subdimensions of dyadic conflict.

Researchers could also investigate antecedents of intention to continue joint IT use in a laboratory setting. Laboratory experiments would provide several advantages. They would allow to observe how user dyads actually collaborate. In addition, laboratory settings would permit to capture collaboration data before, during, and after joint experimental tasks. Moreover, it would be possible to capture specific collaboration events and investigate specific patterns of behaviors' impacts. Also, laboratory setting would facilitate control of several parameters, including IT stimuli used and the IT infrastructure setup, which would be common to participant dyads. All in all, laboratory settings have the potential to further increase understanding of mechanisms through which user dyads jointly use IT systems and related consequences.

Another research avenue is to empirically investigate the joint IT use phenomenon using implicit measures, that is psychophysiological measures collected while user dyads jointly perform an IT task. These measures would help add to the understanding of the phenomenon, as they help explain part of variance in related constructs that is not explained by explicit (psychometric) measures (Tams et al., 2014). In addition, because participants are unaware of implicit measures, these measures are not prone to biases such as social desirability, unlike explicit measures (Riedl and Léger, 2016).

3.7 Conclusion

This essay represents one of few research works investigating mechanisms of joint IT use by user dyads. Past IT acceptance research has mostly focused on IT use by one user in an isolated way or on collective asynchronous use of IT systems designed for group use (e.g., enterprise resource planning systems or decision support systems). Specifically, we examined the influence of the joint IT use settings (i.e., shared display vs separate display; input device control by one user, by user's partner, or by both dyad members; and dyad agreement prior to the joint task) on user intention to continue joint IT use. Through an online experiment in the context of online shopping by couples, we found strong support of our research model. Specifically, we found that dyadic conflict fully mediates the influence of joint IT use settings, and this mediation is partially mediated in parallel by required effort for final consensus and time for final consensus. These observations were generally confirmed at subdimensions of dyadic conflict, including cognitive conflict, affective conflict, and behavioral conflict. Based on our findings, we provide implications for theory and several actionable recommendations to IT practitioners. We also provide multiple research avenues. The present research represents an encouraging starting point for future empirical research on the joint IT use phenomenon.

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Chapter 4 - Essay 4

Collaborative Use of a Shared System Interface: The Role of User Gaze – Gaze Convergence Index Based on Synchronous Dual-Eye-Tracking[20]

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Featured Application: Synchronous gaze recording facilitates dual eye-tracking data processing and permits real-time assessment of dyad-level (of group-level) constructs. The proposed dyad gaze convergence index may help empirically investigate dyad convergence antecedents and consequences during collaborative use of information technologies. Synchronous real-time gaze convergence visual cues may improve collaboration and dyad performance.

Abstract

Gaze convergence of multiuser eye movements during simultaneous collaborative use of a shared system interface has been proposed as an important albeit sparsely explored construct in human-computer interaction literature. Here, we propose a novel index for measuring the gaze convergence of user dyads and address its validity through two consecutive eye-tracking studies. Eye-tracking data of user dyads were synchronously recorded while they simultaneously performed tasks on shared system interfaces. Results indicate the validity of the proposed gaze convergence index for measuring the gaze convergence of dyads. Moreover, as expected, our gaze convergence index was positively associated with dyad task performance and negatively associated with dyad cognitive load. These results suggest the utility of (theoretical or practical) applications such as synchronized gaze convergence displays in diverse settings. Further research perspectives, particularly into the construct's nomological network, are warranted.

Keywords: gaze convergence, eye-tracking, synchronous dual-gaze recording, dual eye-tracking, collaborative use, shared interface.

4.1 Introduction

User gaze during interactions with information technologies (IT) has been the object of increasing interest in management research. Multiple research works in the field of human computer interaction (HCI) have investigated user's eye movements during system use (e.g., Cyr et al., 2009; Belenky et al., 2014). In this regard, constructs related to IT user's gaze have been related with different information system (IS) -related constructs, including interest, attention, cognitive load, and confusion (Desrochers et al., 2019; Djamasbi, 2014; Etco et al., 2017; Riedl & Léger, 2016). Nevertheless, these studies have essentially focused on single-user settings. Consequently, even in the context of collaborative use, IT user's gaze indicators have been essentially recorded separately for each participant (Nyström et al., 2017; Nüssli, 2011). Indeed, studies investigating simultaneous collaborative use of a shared interface are scant in the extant literature. Thus, the true role of users' gaze in this context of IT collaborative use is not well understood.

Investigating gaze during collaborative use of shared system interfaces is important for several reasons. Firstly, gaze convergence of collectives of users, that is, the act of looking at the same location on a system interface, has been suggested to be important for group learning (e.g., Belenky et al., 2014) and group work (e.g., Kwok et al., 2012). Secondly, although most systems are designed with a single user in mind, they are frequently used in multiuser settings. Examples include individual productivity tools such as diagramming application (Sarker et al., 2005) and e-commerce platforms (Mekki Berrada, 2011). To illustrate further, a recent study revealed that 53% of online household purchases are operated by multiple users shopping online together (Briggs, 2018). These multiuser settings involve users gazing at each other or at visual objects of interest in the system interface. Finally, during collaborative interactions, users may relate to IT artefacts visualized in the system interface. Indeed, users will navigate a given interface according to their own mental models, which can also be modified during navigation. Mental models are mental elaborations of user's understanding of knowledge and relationships between concepts or systems (Uitdewilligen et al., 2013). It is thus desirable that collaborating users have similar mental models regarding the system to facilitate collaboration. It has been suggested that mental model construction may be induced by eye movements, through which individuals learn spatial structure of visual elements (e.g., Eitel et al., 2013; Schnotz & Wagner, 2018). Hence, collaboration during joint interactions with system interface may be facilitated when user gazes are convergent.

We investigated the eye movements of dyads of users during their collaborative use of a shared system interface. More precisely, we measured the extent to which the user dyads exhibited gaze convergence by looking at the same locations on the screen during system use. Moreover, we investigated the influence of gaze convergence on information system (IS) use-related constructs including cognitive states and task performance, raising the following research questions (RQ).

RQ1: *How can the degree of gaze convergence of a dyad collaborating simultaneously on a shared system interface be measured?*

RQ2: *To what extent does gaze convergence relate to dyad cognitive states and dyad performance?*

The present study sought to answer these questions methodologically and theoretically. Firstly, we empirically illustrate feasibility of simultaneously and synchronously recording eye-tracking data of user dyads, a technique still embryonic in the HCI literature. Secondly, we propose a novel index for measuring gaze convergence (GC) of user dyads, a construct still scant in the literature. Finally, we examine the role of gaze convergence in relationship with system use-related constructs, one of the very few such initiatives in the literature.

In the remainder of this paper, we test the dyad GC index and examine its validity through two consecutive studies. In the first study, we examine GC construct validity. In the second study, we develop and examine a model of GC to assess predictive validity of the proposed gaze convergence index. As expected, the dyad GC index clearly distinguished between gaze convergence and gaze divergence, and gaze convergence was found to be positively associated with dyad performance and negatively associated with dyad cognitive load. Concluding discussions follow, including research perspectives.

4.2 Theoretical Development

4.2.1 Gaze Convergence

A literature review was conducted to assess interest in the GC construct. The keywords "gaze convergence" or "shared gaze" or "scanpath comparison" were used. The search was performed mainly through some of the most prominent databases, including Web of Science, ABI/INFORM, Wiley Online Library, and ProQuest. We found no study investigating GC in the context of collaborative system use. In past research, the concept of GC has been mainly investigated in terms of mutual GC, often referring to people looking at each other (e.g., Thepsoonthorn et al., 2016). These works are mostly focused on face-to-face communication between avatars (e.g., Wang et al., 2019), between robots and humans (e.g., Thepsoonthorn et al., 2018), and between humans (e.g., Thepsoonthorn et al., 2015; Thepsoonthorn et al., 2016). Clearly, HCI research on GC during collaborative system use is still embryonic, and the question as to how to measure it remains unexplored.

In the present research, we examine two types of GC: system-oriented GC (SOGC) and mutual GC (MGC). In this study, we define SOGC as the extent to which a dyad of users look around the same locations on a shared system interface during collaborative system use. This definition considers that the two users are exposed to the same system interface layout, through the same monitor or through separate display devices with or without same dimensions. This kind of setting can be achieved via single display groupware systems, which allow coworkers to collaborate use desktop computers and mobile devices displaying the same system interface (Stewart et al., 1999). Meanwhile, MGC is defined in this research as the extent to which a dyad of users look at each other while collaborating on a shared system interface. This construct has a distinct content domain from the SOGC construct, since it focuses on dyad gazes directed to locations completely out of the system interface and monitor.

4.2.2 Eye-Tracking Technology

The use of eye-tracking (or oculometry) is emerging and informs research in IS and HCI (Dimoka et al., 2011). This trend is illustrated by the fact that for the past decade, eye-tracking has been the most used psychophysiological tool in NeuroIS research (Riedl et al., 2017). Eye-tracking is a technique permitting measurement of eye movement and gaze location, providing a researcher, at any point of time, with information about what stimulus is being processed by a user (Riedl & Léger, 2016). To capture a user's eye movements, eye-tracker systems target physiological characteristics of the eye with infrared technology along with high-resolution cameras (Riedl & Léger, 2016). This technique uses image processing software to capture two eye features (Djamasbi, 2014): the corneal reflection appearing as small bright glint on the eye pupil, and the center of the pupil. The analysis software finds the position of the user's gaze on the screen based on the relative position of the pupil center and the glint, along with trigonometric computation (Djamasbi, 2014).

Two important eye-tracking elements are saccades and fixation. Saccades are the short duration eye movements (ranging between 30 ms and 80 ms duration) with no information processing (Riedl & Léger, 2016; Holmqvist et al., 2011). Fixations are short stops between saccades (Djamasbi, 2014) generally lasting a minimum of 50 ms (e.g., for text processing) or 150 ms (e.g., for image processing). Fixations are usually analyzed at specific area of interest (AOI) defined by the researcher (Riedl & Léger, 2016; Holmqvist et al., 2011). There are five main eye-tracking measures that are usually employed: fixation duration (amount of time a point is fixated by the user), fixation frequency (or fixation counts: number of times a point is fixated), time to first fixation (the time it has taken the user to gaze inside an AOI), visit count (number of times a viewer's gaze entered an AOI), and total visit duration (length of time a user gaze remained in an AOI).

Additionally, there are two main gaze representations used with eye-trackers: fixation patterns and gaze heatmaps. Fixation patterns are two-dimensional plots of the fixation points for a given user. Gaze heatmaps are heatmaps made of the aggregation of user fixation patterns, with fixation intensities being represented using gradients of a discrete set of colors (red for high, yellow for moderate, and green for low intensity) (Courtemanche et al., 2018).

4.2.3 Synchronous Dual Gaze Recording

As the ubiquity of eye-tracking technology has increased over the past decade, so too has its affordability (Nyström et al., 2017). Today, there is far more potential to employ eye-tracking in studies regarding collaborative IT use. Correspondingly, eye-tracking experiments with multiple participants have become more common (Nyström et al., 2017; Shvarts et al., 2018). However, a major limitation of prior multiuser eye-tracking studies is that the recordings have essentially been done separately for each participant and have commonly not been synchronized, making eye-tracking data analysis tedious and imprecise. Indeed, not synchronizing the recording computers means that their clocks may not be linked, permitting an artificial temporal mismatch between concurrent actions between the participants. Although realignment of the data can be achieved by using timestamps, the procedure is prone to inaccuracies or errors (Nyström et al., 2017), and it is time-consuming and complicated. However, synchronous recording of eye gaze of multiple participants has started gaining some attention, notwithstanding the use of low-cost, low-accuracy eye-tracking devices (Shvarts et al., 2018).

To address the above concerns, the present study implemented synchronous dual gaze recording through a high-accuracy eye-tracking setup. All data recording computers for user dyads were synchronized during simultaneous collaborative use of a shared system interface. We used a dual eye-tracking method involving participants sitting each in front of a separate display. Compared to setups in which one display is shared for all participants on the same device, our method provides a higher accuracy of the eye-tracking data, since it is as precise as the eye-tracking method with one participant (Shvarts et al., 2018). An important advantage of synchronized dual eye-tracking is that it brings order to the gaze data files and eases later data analysis, allowing to track exact time and order in which the gaze data were collected (Nyström et al., 2017). For details, please see the Methodology section.

4.3 Hypothesis Development

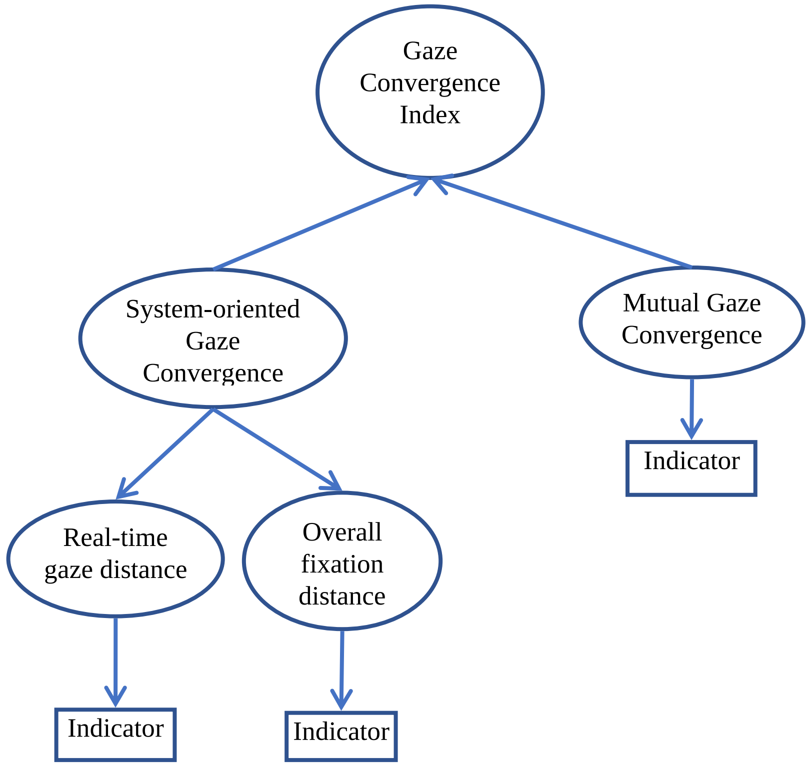
4.3.1 Gaze Convergence Index

We built a GC index based on the gaze of each dyad member (see Figure 4.30). As mentioned earlier, we conceptualize GC as comprising two formative dimensions, namely SOGC and MGC. For the sake of parsimony, and as an initial effort, the present paper examines the GC index through the SOGC dimension. Hence, in the remainder of this paper, GC is defined as the extent to which a user dyad look at the same locations in a system interface. We propose two reflective dimensions of SOGC: real-time gaze distance (RTGD) and overall fixation distance (OFD). RTGD is defined as the distance between the gaze fixation point of each dyad member at any given time. Thus, when dyad members look near the same location on the screen at any given point in time, RTGD will be small and GC will be high. Meanwhile, OFD is defined as the extent to which dyad members have overall looked at the same locations on the screen. On this basis, GC will be considered high for the duration of a task if dyad members have generally looked at the same locations with similar intensities.

These definitions hold true irrespective of the display device as long as the dyad members interact with the same interface with the same visual layout. The proposed GC index is depicted in Figure 4.30.

4.3.2 Dyad Gaze Convergence and Its Impact

In order to assess the predictive validity of the proposed GC index, we developed a model to examine salient associations with GC in the context of a user dyad collaborating simultaneously on a shared system interface. As gaze convergence is the focus of the present paper, our model is developed in the context of tasks performed jointly using a shared system interface, with the users having the same objective and focus. Figure 4.31 depicts the research model.



Note. The oval forms represent constructs and the rectangles represent direct measure of the associated subconstruct.

Figure 4.30. Gaze convergence index construct.

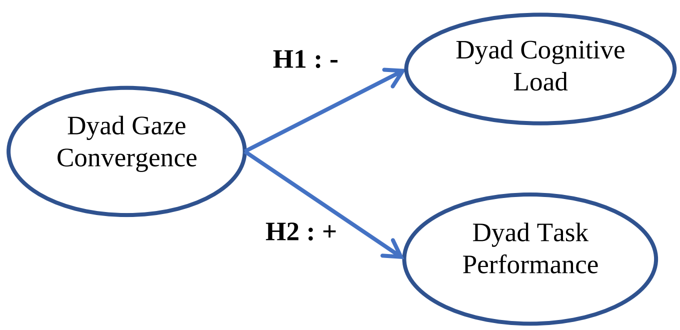


Figure 4.31. Model for predictive validity of dyad gaze convergence.

User cognition has been frequently investigated in the IS field and has been referred to as what occupies individual's mind and that s/he is aware of or not while using a system (De Guinea et al., 2013; Burton-Jones & Gallivan, 2007). Cognitive load has been a prominent construct of cognition studied in the HCI and IS disciplines, considered an indicator of efficient use of a system (Trice & Treacy, 1988; Mirhoseini, 2018). System user cognitive load has been referred to as the extent to which mental resources are employed by users to encode, activate, store, and manipulate data or information as they use a system (DeStefano & LeFevre, 2007; Mirhoseini, 2018). The present study adopts this conceptual definition in the context of user dyads collaborating simultaneously on a shared system interface. Cognitive load at dyad level results not only from each individual mind alone but also from interactions between team members, that is, it also happens socially (Pfaff, 2012). Users process information not only from the system interface but also from the other dyad member. In the context of multiple users, some level of individual effort is needed in order to reach common objectives. Moreover, individual efforts have to be coordinated and aligned to ease collective task achievement (Rousseau et al., 2006). Yet, the effort required for coordination could conceivably be eased when the dyad members share mental models (Mathieu et al., 2000) of the system interface they use together. A user's mental model within any time range may develop from how and where he or she looks at the system interface. Thus, mental model is a mechanism through which the user generates descriptions of system purpose and visual form. This permits comprehension of system functions and observed system states, and prediction of future system states (Mathieu et al., 2000). Consequently, when dyad members working together in real-time on a shared visual interface do not look at the same regions in the shared interface, they may not share the same mental model at specific moments, consequently requiring more cognitive resources to communicate and coordinate actions. Thus, we could hypothesize that the more users look at the same regions on the visual interface the less cognitive resources they will need to collaborate. Moreover, two collaborating users looking at the same locations are likely to perform better, as they would be able to better coordinate their interaction. Past research suggests that looking at the same visual objects in a system interface reduces miscoordination incidents, hence improving dyad coordination (e.g., Thepsoonthorn et al., 2016; Zhu et al., 2010). Yet, coordinated efforts facilitate the achievement of collective task, increasing team performance (Maynard et al., 2015; Gorman, 2014; Rousseau et al., 2006). Hence, we make the following hypotheses (H).

H1: *Dyad GC will be negatively associated with dyad cognitive load.*

H2: *Dyad GC will be positively associated with dyad task performance.*

4.4 Methodology

To validate our proposed GC index and investigate its hypothesized associations, we conducted two consecutive experimental studies, which were approved by the ethical committee of our institution (ethical approval code: 2020-3645). The two studies involved synchronous dual eye-tracking recording. In other words, eye movements of user dyads were recorded with real-time synchronization of clocks on two gaze data recording computers. Informed consent was obtained from all dyad members prior to participation.

The first study assessed the content validity of the proposed GC index. Content validity refers to the degree to which a construct operationalization is representative of the content domain (i.e., the substance, the matter, or the topic) of the construct (MacKenzie et al., 2011; Moore & Benbasat, 1991; Straub et al., 2004; Trochim et al., 2016). Simply put, we ascertained to what extent our GC operationalization reflected the GC of user dyads. To that end, GC was experimentally manipulated by having user dyads perform a task in two conditions: gaze convergence (referred to as the convergence condition) and gaze divergence (referred to as the divergence condition). Hence, the purpose of this study was to assess the extent to which our dyad GC index is able to distinguish between convergent and divergent dyad gaze behaviors.

The second study explored the predictive validity of the proposed GC index, that is, the extent to which the operationalization of the construct was able to correlate with or predict endogenous constructs it is theoretically expected to correlate with or predict (Trochim et al., 2016). Specifically, this study tested whether dyad GC would predict the hypothesized dependent variables, namely, dyad cognitive load and dyad task performance. User dyads engaged in collaborative tasks using the same interface on different computer monitors, with only one of the two users controlling input devices (see Figure 4.32).

This setup reflects a specific real-world setting in which users work together on the same task, on a shared system interface, to jointly perform a task. Examples include the following: two workers sharing their screen (e.g., using a screen sharing software) to work together from same or separate offices or rooms but communicating directly of through the phone; or two IT network professionals jointly working on a shared interface with separate computer monitors in a technical equipment room, as each worker needs to stay at different locations to monitor different equipment. This setup is also common among couples who shop online together remotely, as revealed by a recent paper about the state of the art on multiuser human-computer interaction settings, providing preliminary evidence specific to settings in which couples shop online together (Tchanou et al., 2020). In that survey study, more than 70% of couples shopping online together using separate screens reported sharing the same software window during the activity.

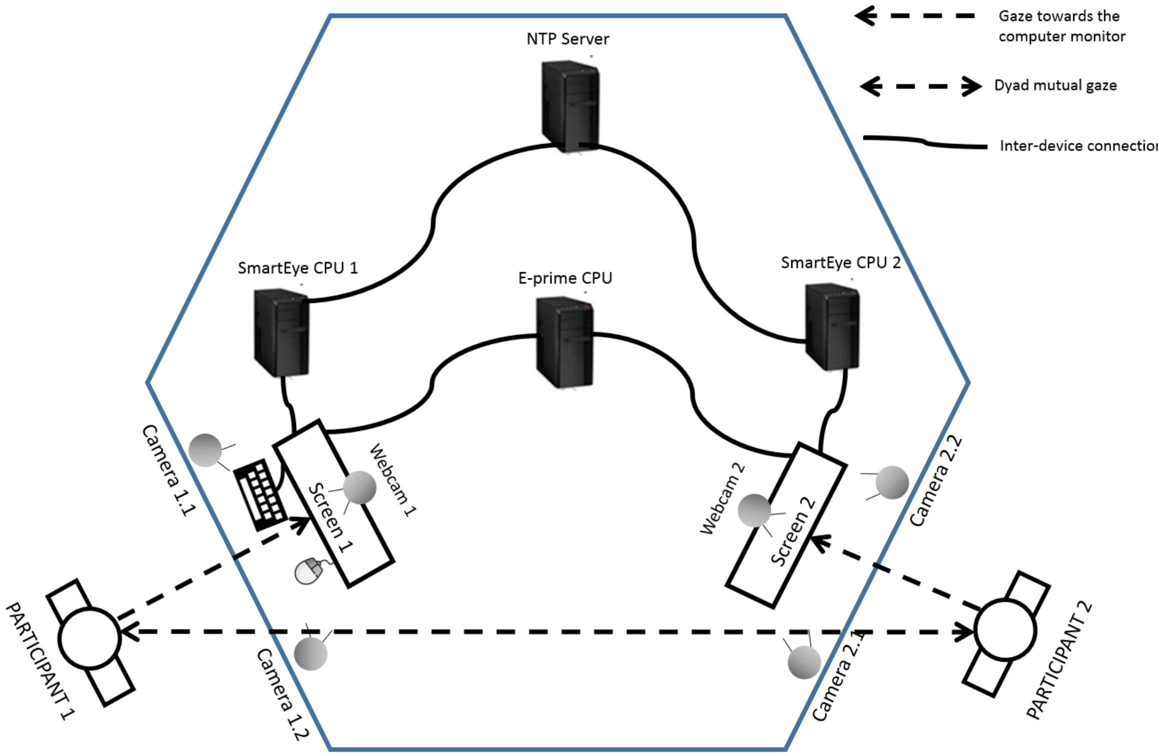


Figure 4.32. Eye-tracking experimental setup.

4.4.1 Material and Apparatus

We used SmartEye Pro (SmartEye, Gothenburg, Sweden) eye-tracking system, which enables a non-invasive temporally synchronous collection of gaze and pupil data of multiple participants. This system employs two cameras per participant for large field of view and permits measurement of a head orientation and gaze direction in 3D, including the ability to discriminate between gaze directed at the interface or at the other user in the dyad. SmartEye Pro also permits measurement of pupil diameter in real-time during the task, and it provides a great gaze accuracy (around 0.5 degrees (Smart Eye AB, 2015) for a 30 cm eye distance—a 1 degree gaze accuracy is considered high in the eye-tracking literature (Bohme et al.; Bulling & Gellersen, 2010; Liu et al., 2019; Shvarts et al., 2018)). It was configured with a sampling rate of 60 Hz. To synchronize computer clocks at all times during the studies, we configured a Network Time Protocol (NTP) Server. NTP protocol is designed to synchronize several computers' clocks across variable-delay networks, with an accuracy below one millisecond between network devices (Nyström et al., 2017).

The experimental stimuli were developed and administered using E-Prime 3.0 software (Psychology Software Tools, Sharpsburg, MD, USA). The software ran on a computer with a clock perfectly synchronized with SmartEye computers through the NTP server. A crucial benefit of E-Prime is that it is able to provide a rich set of time stamps for every event or display, allowing for direct matching with our resulting eye movement data. Moreover, E-prime permitted synchronized acquisition of questionnaire data during the experimental tasks. The stimuli were run on two identical computer monitors connected to the same computer central processing unit (CPU) to permit shared display.

In addition to the two SmartEye cameras, a video camera was fixed on the top of each user's computer monitor. The audio and video of each user's face, which were sampled by these cameras during the two experimental tasks were recorded with Media Recorder software (Noldus, Wageningen, The Netherlands), thereby permitting future assessment of behaviors such as head orientation and characteristics of auditory communication. Observer XT software (Noldus, Wageningen, The Netherlands) synchronized Media Recorder recordings to our eye-tracking recording through time stamps that were accurately linked to the absolute time of the study as provided by the NTP server.

Figure 4.32 depicts the physical setup used for both studies.

4.4.2 Users

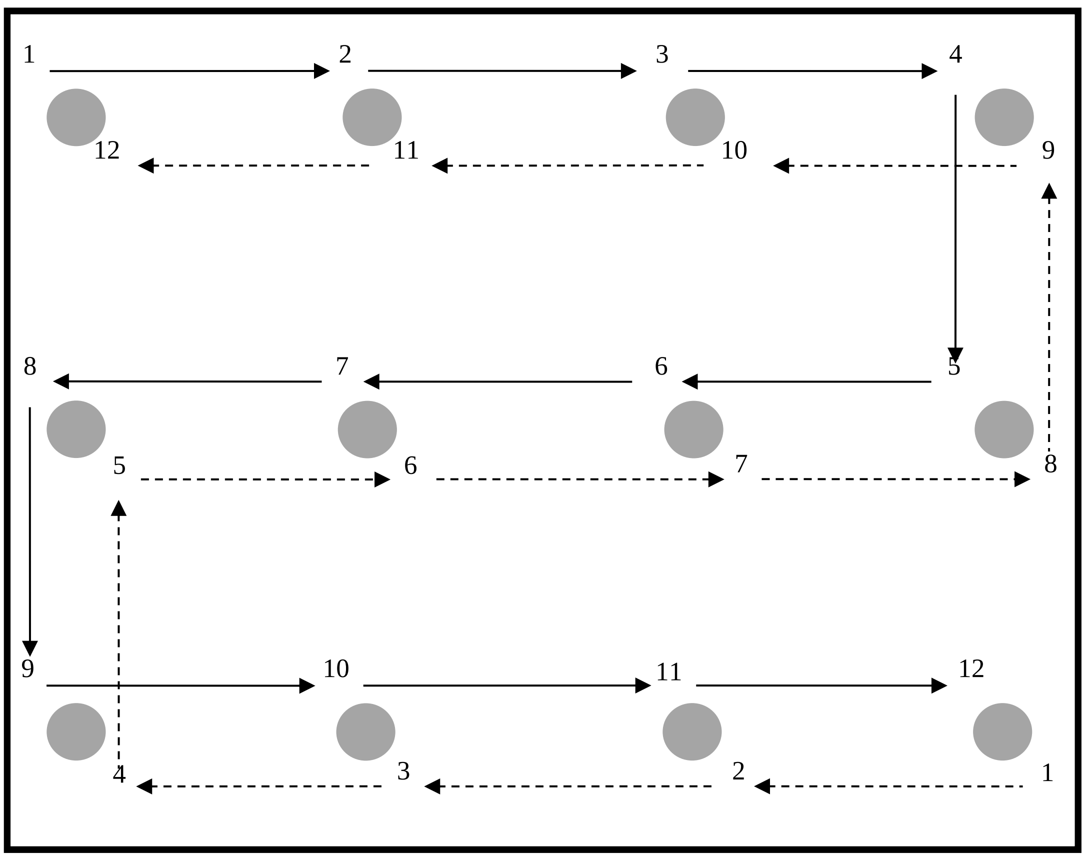
Our experimental sample comprised 8 dyads, or 16 users (5 females and 11 males), with an average age of 24.1 year-old and a standard deviation of 2.6 year-old, recruited through our institution's recruitment panel. To participate in our study, panel members had to be 18 years or older and could not have specific skin sensitivity or allergies, a history of epilepsy, neurological or any other health-related disorder, nor use a cardiac pacemaker. The recruitment was done with no requirements over whether participants knew one another, and dyads were formed randomly.

4.4.3 Experimental Procedure

One user dyad was scheduled for every experimental session (both Study 1 and Study 2). After welcoming users and ensuring no exclusion criteria were met, two research assistants asked the users to sit comfortably at their respective computer desks and briefed them about the study's purpose. User dyads sat in a configuration allowing them to gaze at each other and communicate during the tasks. Only one dyad member had access to the computer's input devices (mouse and keyboard) during every experimental task: as this study's hypotheses are not specific to any input control setting, giving that control to only one of the two dyad members allowed for more simplicity. It helped rule out possible events of no interest in the present study such as input control switching or negotiation. The research assistants proceeded to calibrate the SmartEye system for each user, based on the SmartEye system manual (Smart Eye AB, 2015). After all experimental tools were ready, the E-Prime executable file was run in full-screen mode throughout the duration of the experimental session. At the beginning of the first part of the experimental session (Study 1), participants were instructed to close their eyes and breathe for thirty seconds, then while each dyad member looked at an initial blank screen display, baseline eye parameters were recorded through SmartEye. The same process was followed at the beginning of the second part of the experimental session (Study 2), but the baseline data of the first part were used for the whole experimental session. SmartEye data were recorded throughout the entire session as well.

4.4.4 Study 1 Experimental Design

The experiment was a factorial design with repeated measures in two conditions: convergence and divergence. In both conditions, dyads were exposed to the same stimuli. The stimuli were a small blue and a small red solid colored circle moving in opposite directions along a single track of twelve fixed display positions. The two circles' displays were made to never overlap. Both circles displayed for five seconds and then immediately moved to their respective following positions. Thus, user gaze was expected to move steadily along in a stepwise fashion along each of the twelve circle positions.



Note. The bold frame represents computer screen. The gray circles represent the twelve possible positions of either blue or red circle. Solid arrows represent blue circle's movement sequence. Dotted arrows represent red circle's movement sequence. Each ordered number sequence (from 1 to 12) depicts the direction of blue circle's course and the red circle's course, respectively.

Figure 4.33. Experimental stimulus: circle movement sequences

In the convergence condition, dyads were asked to stare at the blue moving circle at all times. In the divergence condition, one dyad member was instructed to stare at the blue moving circle, while the other was instructed to stare at the red moving circle. Each user dyad was exposed to one trial of each condition, resulting in a total of sixteen trials and one hundred and ninety-two dyad eye. Figure 4.33 depicts the sequence of movements for the blue and the red circles in the experimental stimuli.

4.4.5 Study 2 Experimental Design

In the second experiment, GC was not manipulated. Dyads had to perform a psychological task collaboratively, namely, a change blindness task. Change blindness is so named due to the psychological phenomenon where a difference between two nearly identical images becomes difficult to discern when the images are viewed after a small time delay (Simons & Levin, 1997). In the present study, seven image pairs with a single subtle difference were used. The images in a given image pair were alternately displayed for one second with a one-second white blank display between them. This cycle of display was repeated for an unlimited amount of time. The cycle stopped when the dyad decided to answer the related question by pressing the “SPACE” key on the keyboard (they were instructed to do so only when the two dyad members were ready). Then a multiple-choice question displayed regarding what element of the image was changing. The question was phrased as follows: “What type of change did you notice?” There were a total of four answer options, including the option “We could not identify any change”. For each image pair trial, dyad response time and final response choice were recorded. The experiment resulted in a total of fifty-six trials across all eight dyads. The change blindness task was chosen because it is a well-known psychological task that can be readily programmed in E-Prime software for experimental purpose. Moreover, the task was driven by dyad’s common interest and objective in the visual interface. Besides, in order to further foster dyad collaboration, dyad members were told that they could collaborate during the task. The collaboration happened naturally, as participants were not limited in their movements.

4.4.6 Measures

As we are interested in where dyads look in the system interface, and since all E-Prime displays were in full-screen mode, we considered gaze location in the orthonormal plane represented by the computer screen. As suggested previously, dyad GC is high when the distance between gaze locations is low, and vice versa. We measured dyad GC in both studies as the opposite (i.e., multiplied by −1) average Euclidian distance between gaze locations of the two dyad members at all fixation points. The fixation data of both users were synchronous in time, allowing for direct comparison. Similar measures based on Euclidian distance but in context of asynchronous gaze recording have been reported to be valid measures (Anderson et al., 2015; Henderson et al., 2007; Mannan et al., 1995).

In Study 1, in order to get a more comprehensive assessment of the distribution of distance between dyad gaze locations (see time series of distances in Figure 4.34), other statistics of Euclidian distance between dyad gazes were planned for analysis, including minimum, standard deviation, 1st quartile, 2nd quartile (i.e., the median), 3rd quartile, and maximum. These analyses would reveal whether the difference between convergent and divergent gaze behavior detected by our dyad GC index is supported throughout the gaze distance data distribution, from lower (lower GC) to higher (higher GC) data points.

In Study 2, two other constructs were measured: dyad task performance, and cognitive load. We operationalized dyad task performance to be associated with higher accuracy and shorter response time. Accuracy was scored according to the following: 1 point for incorrect responses, 2 for unknown answers, and 3 for correct responses. This grading was in line with the nature of the experimental task. As every image pair had a single subtle difference and dyads had unlimited time for double-checking, it was more expected that user dyads would either find the right difference or abandon the trial without finding the image difference. Hence, incorrect response was the most penalizing answer. The sum of points for all trials in Study 2 determined a dyad's Accuracy Score. Moreover, the total time taken by a dyad to analyze the stimuli for each trial before responding was deemed as the Trial Completion Time. Dyad task performance was measured as follows:

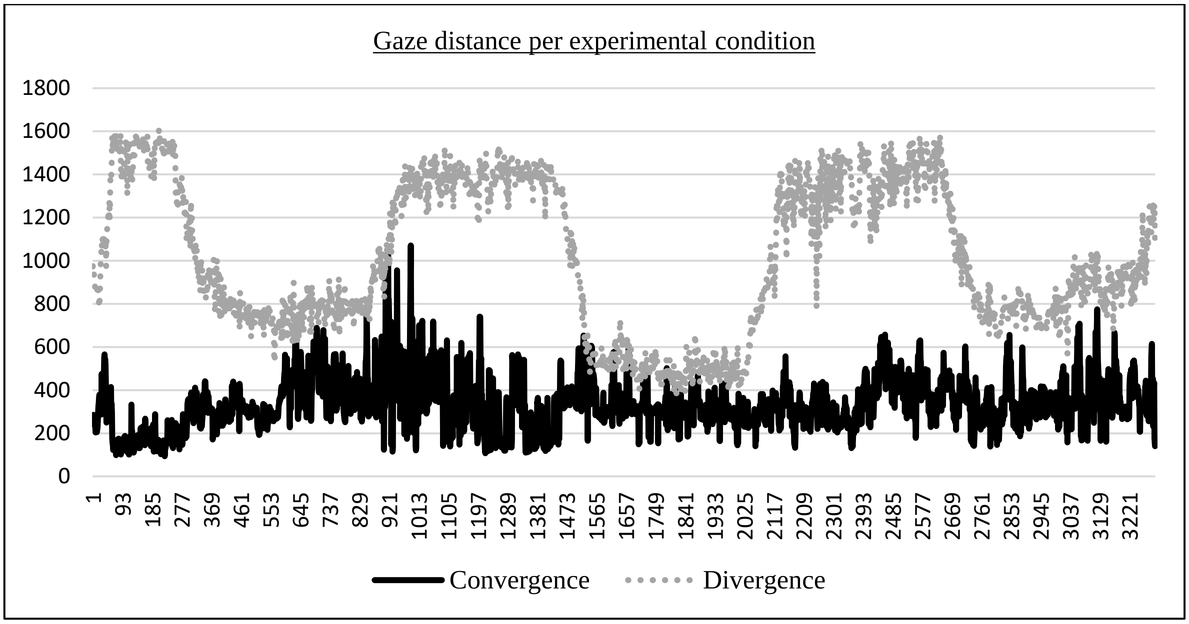
Task performance = {Accuracy Score}/{Trial Completion Time}

Meanwhile, cognitive load was indexed via pupillary dilation, a common strategy for human-computer-interface studies in the IT literature (Riedl et al., 2017; Chen & Epps, 2014; Fehrenbacher & Djamasbi, 2017). Specifically, cognitive load for an individual user was determined as the increase (or decrease) in pupil diameter during the task, that is, pupil diameter recorded during the main experimental task minus baseline recorded before the start of the experiment. Dyad cognitive load was determined as the mean cognitive load between the two users in the dyad. This operationalization of dyad cognitive load is in line with past studies of team-level cognitive load (e.g., Gopikrishna, 2017; Litchfield & Ball, 2011; Lafond et al., 2011).

4.4.7 Statistical Analyses

In study 1, manipulating gaze convergence permitted to assess content validity of dyad GC index, that is, the extent to which our measure captures gaze convergence. To do so, we used Wilcoxon signed-rank test (Wilcoxon, 1945) with Statistical Analysis Software (SAS). This statistical method is particularly useful when the population is not assumed to be normally distributed and the sample size is small. In Study 2, because our hypotheses were directional, we used one-tailed *p*-values. To get further insights related to patterns of task performance by dyads, we ran an ANOVA with a two-tailed *p*-value, as the number of trials was relatively high (fifty-six). Here we analyzed trial completion time to check for differences relative to the answer accuracy. This analysis would inform us whether dyads took different time to provide correct, wrong, or “unknown” answers. The significance level was set at $\alpha = 0.05$.

To test hypotheses H1 and H2 through the change blindness experiment (Study 2), we used a linear regression with random intercept model. Hence, we tested negative association between dyad GC and dyad cognitive load measured using pupillary dilatation as mentioned earlier. We also tested negative association between dyad GC and dyad task performance. Moreover, we used one-tailed *p*-values and significance level of $\alpha = 0.05$ for the same reasons as in the first experiment. Finally, it is important to recognize that the images used in the Change Blindness task were of lower luminosity than the blank white screen displayed immediately prior to and after each image. There is a possibility that as the time taken to complete the trial increases, the eyes become accustomed to the less luminous images, causing pupil diameter to gradually increase, and thereby causing an artificial increase in cognitive load. To control for this, we added trial completion time as a control variable in the statistical model.



Note. The sinusoidal trend in the Divergence condition is consistent with the fact that the blue and the red circles alternatively moved closer to or farther from each other overtime.

Figure 4.34. Average gaze distances within dyads in each experimental condition.

4.5 Results

4.5.1 Study 1

Results revealed that GC index values were significantly higher in the convergence condition, compared to the divergence condition (p = 0.004; r = 0.19, representing related Spearman correlation). This result is illustrated in Figure 4.34, which depicts a clear visual difference in GC between the two conditions, GC being the opposite of gaze distance as mentioned earlier. Moreover, a more detailed analysis showed significant differences in main statistics between the convergence and the divergence conditions. The convergence condition recorded the highest maximum of convergence between dyad members' gazes (p = 0.004; r = 0.31). Moreover, significantly higher GC values were recorded in the convergence condition for GC first quartile (p = 0.004; r = 0.05), second quartile (p =

0.004; r = 0.31), and third quartile (p = 0.004; r = −0.19). Besides, the convergence condition recorded significantly lower standard deviation (p = 0.02; r = 0.12). Clearly, the difference in GC between the two conditions was consistent throughout the data distribution. Thus, we are confident that the dyad GC index does measure gaze convergence (content validity is supported). Table 4.30 presents descriptive statistics for each treatment condition.

4.5.2 Study 2

Results of the linear regression with random intercept model, with trial completion time as a control variable, showed that dyads with higher GC during the task exhibited significantly less pupil dilatation ($p < 0.001$; t = −4.09), supporting hypothesis H1. Moreover, dyads with higher GC performed significantly better during the task (p = 0.003; t = 2.90), supporting hypothesis H2. Table 4.31 presents descriptive statistics, complemented with statistical results in Table 4.32 and Figure 4.35. Figure 4.36 depicts the plots for the two regression models. Finally, post-hoc regression with cognitive load as dependent variable and trial completion time as independent variable was non-statistically significant (p = 0.810; R2 = 0.001; F = 0.058).

Table 4.30. Descriptive statistics, Study 1, per experimental condition.

Variable	**Mean**		**StD**		**1st Qrtl**		**2nd Qrtl**		**3rd Qrtl**	
	C	**D**	**C**	**D**	**C**	**D**	**C**	**D**	**C**	**D**
Dyad GC	−333.51	−1013.53	−153.55	−107.67	−468.28	−1126.12	−261.59	−1007.32	−223.20	−916.55
Min GC	−1832.14	−1872.52	−167.72	−155.33	−1992.26	−2031.86	−1831.51	−1886.64	−1661.59	−1710.79
Max GC	−5.39	−36.61	−4.12	−17.86	−7.30	−46.05	−4.49	−34.88	−2.03	−25.26
StD GC	−317.81	−433.86	−126.11	−39.38	−443.02	−473.26	−280.23	−432.91	−209.35	−405.92
1st Qrtl GC	−127.96	−653.06	−39.72	−81.14	−166.37	−722.63	−135.78	−664.00	−93.14	−570.49
2nd Qrtl GC	−224.02	−931.74	−94.87	−157.93	−293.32	−1025.84	−199.64	−894.01	−157.83	−807.07
3rd Qrtl GC	−427.62	−1428.92	−277.82	−125.41	−631.48	−1556.36	−273.19	−1404.40	−247.67	−1367.46

GC = Gaze convergence; StD = Standard Deviation; Qrtl = Quartile; C = Convergence condition; D = Divergence condition. The Variable column refers to descriptive statistics examined as independent variables. With a total of sixteen participants, our sample size was eight dyads in each treatment condition.

Table 4.31. Descriptive statistics, Study 2.

Variable	Mean	StD	1st Qrtl	2nd Qrtl	3rd Qrtl
Dyad GC	−281.62	−99.64	−370.05	−301.91	−221.05
Dyad TP	2.05	0.66	1.75	1.99	2.16
Dyad PD	0.38	2.72	−0.79	0.36	2.59

GC = Gaze convergence; TP = task performance; PD = pupil diameter; StD = Standard Deviation; Qrtl = Quartile. With a total of 16 participants, i.e., 8 dyads for a total of 56 trials.

Table 4.32. Statistical results, Study 2.

DV	Effect Estimate	DF	t	*p*-Value
Dyad TP	26.19	46	2.90	0.0029
Dyad PD	−15.99	46	−4.09	0.0001

DV = Dependent variable. TP = task performance; PD = pupil dilation; DF = Degrees of freedom.

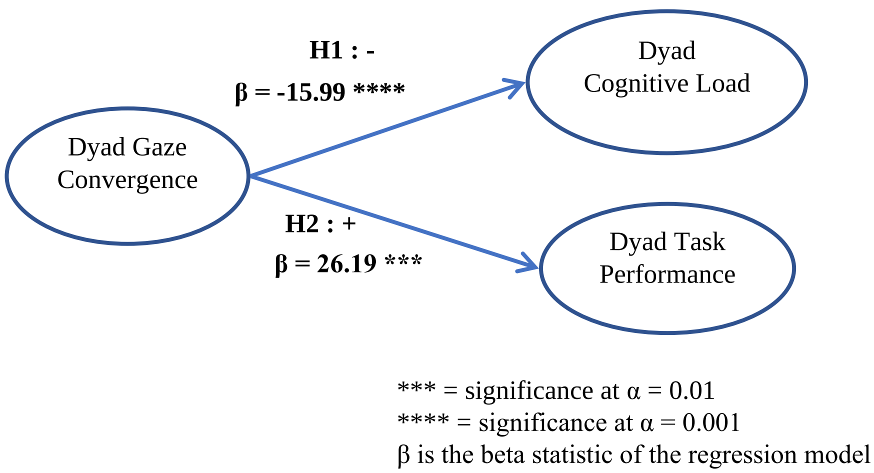
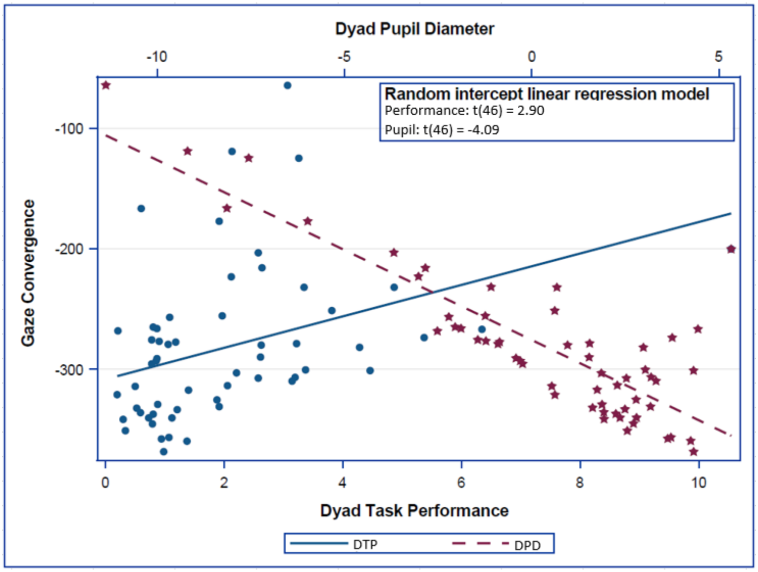


Figure 4.35. Results, Study 2.



Note. DTP = Dyad Task Performance; DPD = Dyad Pupil Diameter.

Figure 4.36. Regression plots.

To check for differences in dyad performance at trial level, we ran an analysis of variance (ANOVA). The test was significant at $\alpha = 0.05$ (F = 5.629; $p = 0.006$). Simple contrast analysis showed that dyad trial completion time was significantly lower for right answering than for “unknown” answering ($p = 0.005$; C.I. = [0.478; 2.626]) and than for wrong answering ($p = 0.043$; C.I. = [0.064; 3.628]).

4.6 Discussion

The present research conducted two studies to assess (1) the content validity of dyad GC index during collaborative use of a shared system interface, and (2) predictive validity of that dyad GC index via its relationship to dyad cognitive states and performance. By addressing these points, the present study aimed to contribute to the IS and HCI literature regarding the use of dyad GC constructs in examinations of two or more users working collaboratively on a shared system interface. As mentioned earlier, studying dyad GC is important for several reasons. First, it influences group learning (e.g., Belenky et al., 2014); second, group work is impacted by the way dyads of workers look at the screen (e.g., Kwok et al., 2012); third, dyad GC helps build similar mental models within the dyad to facilitate coordination; finally, many systems designed for single user are actually used by multiple users together, involving users gazing at visual artefacts within a system interface or at each other. Given this importance of dyad GC, our validation of the proposed dyad GC index is useful for any study relying on GC to investigate multiuser human-computer interaction. Overall, our results were very statistically significant at $\alpha = 0.001$, $\alpha = 0.01$, and $\alpha = 0.05$, giving a high degree of confidence that the investigated relationships do hold. These results are promising for future dual-eye-tracking research.

4.6.1 Content Validity

As for content validity, our proposed dyad GC index permitted clear and accurate discrimination of convergent and divergent gaze behaviors. Post-hoc analyses further confirmed this across the entire data distribution. Overall, Study 1 demonstrated that our proposed dyad GC index is in line with the conceptual definition of the dyad GC construct.

4.6.2 Predictive Validity

In line with our hypotheses, we observed that, the greater the GC of dyads, the better they performed on the Change Blindness task. As suggested in the literature, looking at the same locations reduced coordination efforts and incidents (Kwok et al., 2012; Zhu et al., 2010), facilitating better achievement of the dyad's task at hand (Maynard et al., 2015; Rousseau et al., 2006; Gorman, 2014; Sharma et al., 2020). As mentioned earlier, high performance related to answer accuracy and short trial completion time. Differences in trial completion time revealed that globally two main scenario types were observed. Dyads spending a lot of time performing the task generally ended up giving up or choosing the wrong answer. However, dyads who were fast in performing the image difference identification task generally found the right answer. In this scenario, GC was high because dyads' collaboration helped them visually converge together towards the target quickly. It may be that, for instance, as the two dyad members had to both be ready before they could move to the question, the dyad member finding the answer first and quickly was efficient in making his/her partner find it on the screen. Pehaps dyad communication influenced dyad GC, which was positively associated with higher performance. However, because our second experimental study aimed at demonstrating predictive validity of the GC index, we focus on dyad GC as an independent variable.

Also in line with our hypotheses, the greater the GC of dyads, the lesser cognitive load they exhibited. Actually, as literature suggests, during interactions between two persons, gaze direction is special in producing shift of attention on the other person (Kawai, 2011; Ristic et al., 2007). Hence in our context, at any time during interactions within a dyad, a dyad member's gazing at a location of the screen is likely to shift the other member's gaze to the same location when the former communicates to the later where he or she intends to look at. This behavior was typical and recurrent during dyad collaboration in Study 2. When dyad members interacted during the experimental task (e.g., discussing a specific visual element in the system interface), they were thus likely to look in the same regions of the screen to indicate to each other what their actions or words refer to on the interface. It may be that, knowing that the other dyad member looked at the same location during interaction reduced the cognitive load needed to make him or her shift attention to specific regions of the shared interface. A reason may be that looking at the same regions on the screen improves harmonization of dyad members' mental models of the shared system interface (Mathieu et al., 2000). Moreover, because shifting their partner's attention and gaze to screen areas required communication, faulty communication between dyad members during the task likely led to lower gaze convergence and longer times taken to look at and process the image before answering the related question. The longer they visually processed the image the more cognitive resources it took them to perform the task, that is, the higher their cognitive load. This logic applies to all trials, whether a dyad found the right answer or not, and whatever the length of time the dyad took to complete the trial. However, no association was found between the trial analysis time and cognitive load. Hence, perhaps this finding can be explained by the fact that it is more the actual visual processing of the image than the time looking at it that impacted user cognitive load. Moreover, participants were more likely to visually process the images to a greater extent when they spent more time looking at the images.

4.6.3 Advantage of Real-Time Synchronized Gaze Recording in Multiuser Human-Computer Interactions Setting

An advantage of synchronizing participants' gaze recording is that it brings order to the gaze data files and eases later data analyses, allowing the tracking of the exact time and order in which the gaze data were collected (Nyström et al., 2017). Moreover, synchronizing participants' gaze recording permitted us to develop a measure of gaze convergence using perfectly temporally aligned data, unlike existing measures that are based on Euclidian distance and use temporally asynchronous fixation data. This is a major advantage provided by our synchronized dual eye-tracking setup. Major methods for comparing two eye movement sequences based on Euclidian distance between pairs of eye fixation points (Anderson et al., 2015) were proposed by Mannan et al. (1995), Mathôt et al. (2012) and Henderson et al. (2007). Mannan et al. and Mathot et al. analyze similarity between two participants' fixation sets by computing their index of similarity based on the linear distance between each fixation point in the first fixation set and its nearest neighbor in the second fixation set, as well as the linear distance between each fixation point in the second fixation set and its nearest neighbor in the first fixation set. As the spatial distance here is always computed against the nearest neighbor in the other fixation set, a problem with this algorithm is that it does not consider the spatial variability in the distribution of the fixation sets (Henderson et al., 2007). For example, if all fixations in the first set are circumscribed within a very small area of the screen and only one fixation point in the second set is within that same area, then all fixation points in the first set will be compared to only that point from the second set. On the other hand, Henderson et al. analyze similarity between two participants' fixation sets as follows. In order to assign each fixation point in the first set to a fixation point in the second set, they analyze all possible assignments of fixation points in the first set to fixations in the second set, to find the unique assignment producing the smallest average deviation. A limitation of these algorithms is that they disregard the ordering of the fixation points of the two participants. Thus, these methods are suitable only when temporal ordering of eye fixations is not important, a condition that does not fit to the definition of the RTGD reflective measure of our SOGC construct (see Figure 4.30). The measure of RTGD in our context of joint use of shared system interface has been facilitated by the synchronized dual eye-tracking paradigm.

Moreover, in general, despite the advantages provided by existing methods for comparing two eye movement sequences, some are subject to some issues such as not considering the temporal ordering of gaze data (Linear Distance and Edit Distance methods), data loss

(MultiMatch method), high sensitivity to small temporal and spatial differences and not accounting for fixation duration (Sample-based measures) (Anderson et al., 2015). Hence, a straightforward benefit of our study is that we measure the dyad GC construct with data perfectly aligned in time and validate it in terms of content validity and predictive validity. Such measurement is appropriate to IS and HCI contexts. Since the synchronized data are not truncated nor shrunk, it accounts for the natural happening of joint use of shared system interfaces, as it is based on perfectly aligned data and acknowledges the variety of ways user dyads may look together at the screen, including all instants of diverging or converging users' gazes.

4.6.4 Contributions

The present paper theoretically contributes to the IS and HCI literature in demonstrating that GC is a valid construct with predictive validity towards performance and the cognitive states of users engaged in simultaneous collaboration on a shared user interface. Hence, this study illustrates and promotes the investigation of antecedents and consequences of GC in the IS and HCI fields. This piece or work additionally methodologically contributes to the IS and HCI literature by illustrating the feasibility of synchronous eye-tracking data recording of two or more users, a technique that improves the accuracy and simplicity of corresponding data analyses (Nyström et al., 2017). This study is one of the first ones that measure and validate gaze convergence in a synchronized multi-eye-tracker setting, involving verbal collaboration on a computerized task. Moreover, our GC index can be used in studies requiring synchronized dual eye-tracking of participants. Our experimental setup allows for real-time exploitation of GC information based on synchronized fixation data, improving accuracy of such information. For example, in addition to or in place of the display of the other participant's gaze, our experimental setup permits the real-time display of GC information of user dyads working on the same shared interface. Implementing similar experimental setups could be used in studies examining how individuals can benefit from peers and experts, projecting real-time synchronized gaze convergence cues (e.g., D'Angelo & Begel; Jarodzka et al., 2013; Król & Król, 2019; Sharma et al., 2015).

Overall, the present study marks and important first step in establishing a multiuser GC index based on synchronized fixation data of user dyads and in demonstrating its utility in predicting IS and HCI constructs.

4.6.5 Implications and Research Perspectives

Dual-eye-tracking technology has been of practical utility in research. For example, some studies in multiuser settings used eye-trackers to display and share user gaze information (e.g., Nyström et al., 2017; Zhang et al., 2017). In that context, users self-assess gaze convergence based on their coworker's gaze information. The present study can contribute to investigations of impacts of real-time gaze information display in multiuser settings. For example, research works may involve enriching above gaze information by providing users working together on an interface with real-time numerical information or visual cues (e.g., color gradients) to indicate the extent to which their gazes converge at any point of time as well as for time ranges. This information may enrich collaborative use experience, permitting the examination of gaze information impacts on collaboration. For instance, just as Kwok et al. (2012) found that partner user's gaze information display improved collaborative remote surgery, it may be examined whether synchronized real-time gaze convergence gradient display may improve collaborative remote surgery, which uses a shared software to remotely control robots operating surgery (Kwok et al., 2012). Moreover, as suggested in the literature, seeing a coworker's gaze information may promote users' attention shift triggering insight problem solving (Litchfield & Ball, 2011); in addition, learning can be improved by showing an expert's information to the learner (Nyström et al., 2017). In this regard, future research may investigate the extent to which gaze convergence information may promote shifts of attention and performance during collaborative use of a shared system interface.

The present study opens multiple avenues for further research regarding gaze convergence during collaborative use of a shared interface. For instance, research could investigate possible relationships between gaze convergence and system use-related constructs, namely, emotions, cognitions and behaviors. In this respect, system use-related constructs could be investigated as consequences as well as antecedents of gaze convergence. For example, eye-tracking-based user information may be used to examine relationships between user dyads' gaze behaviors and user emotions during collaborative use of shared system interface. Such information could be exploited to improve recommendation systems' advices (for an example of a recommendation system based on user gaze and emotions, see Jaiswal et al. (2019).

Another avenue for research could be to investigate team adaptation in the context of collaborative use of a shared system interface. Research could examine how IS triggers, namely, system-related, task-related, and collaboration-related triggers, impact the way IT users collectively look at a system interface, ultimately influencing performance. Moderating factors could be examined in terms of system, task, individual, group, and organizational characteristics. For instance, as literature suggests that system-related discrepant events are detrimental to performance (De Guinea et al., 2013), it may be investigated how such events influence gaze convergence and performance in multi-user settings.

Additionally, the success of the present study warrants further for groups of three and more users simultaneously collaborating on a shared system interface. For instance, influence of gaze convergence on learning for groups of students taking a virtual class and collaborating through the computer-supported collaborative learning system may be investigated. Likewise, it may be useful to examine how gaze convergence of groups of relatives is related to buying decisions. A tentative generalization of our operationalization of gaze convergence could involve considering the average Euclidian distance matrix of the set of users in a group, with every matrix element representing Euclidian distance between two specific users' gaze locations on the system interface overtime. Hence, such a matrix would be made of two-by-two computations using the present study's proposed dyad gaze convergence index.

Furthermore, our Study 2 was done in hedonic settings, with promising findings. As our hypotheses were not specific to hedonic settings, future real-time dual eye-tracking research could be conducted in utilitarian settings to support our GC index validity as well as the generalizability of our findings to other contexts. As the scope of our study is joint task performance using a shared system interface, it is expected that in utilitarian settings, the users' looking at the same visual artefacts in the screen will be important for the same reasons presented in the hypothesis development. Looking at the same locations on the screen is expected to help harmonize users' mental model of the system and improve collaboration during the joint task. Examples of utilitarian settings include the following. Our GC index could be examined during a learning task involving a teacher (or an expert) and a learner—or learners and their peers—interacting together with a shared system interface, to better understand how gaze convergence impacts learning performance. To illustrate, existing studies use asynchronous eye movement comparison to demonstrate that people may benefit from learning what experts have looked at (e.g., Jarodzka et al., 20137; D'Angelo & Begel) or that individuals perform better when they get real-time feedback on their gaze convergence vis-à-vis high-performing peers (e.g., Król & Król, 2019; Sharma et al., 2015). Hence, the present study's setup—more generally, synchronized multiuser-eye-tracking—could enrich these studies with the real-time gaze synchronization aspect. Moreover, during a professional task jointly performed by a dyad of workers, our GC index could be used to identify patterns of collaborative use of a shared interface that foster lower cognitive load and higher performance.

Additionally, our experimental setting—that is, joint task performance using a shared display on separate computer monitors—is only one of several common settings used for joint task performance. For example, it is common that two users sit in front of a single computer monitor to jointly perform a task. Future studies could examine gaze convergence with users sharing the same computer monitor. The model developed in this paper also applies in this context, which is very common in real business environments.

Finally, future research may focus on the measure and validation of the gyad GC construct through the OFD reflective dimension we proposed (see Figure 4.30), in the context of joint use of shared a system interface. Our experimental setup could be used in such purpose to collect perfectly synchronized dyad gaze data. However, the OFD dimension by definition does not require temporal ordering of gaze data; it looks for overall similarity in both dyad members' gaze behaviors and its focus is instead fixation positions and duration. Hence, to measure OFD in future research, existing methods of gaze similarity measures can be considered while benefiting the temporal precision and related spatial (fixation positions) accuracy provided by real-time synchronized dual eye-tracking.

4.6.6 Limitations

The first limitation of the present study resides in the fact that the measurement model was assessed through the SOGC dimension. Future research may focus on the operationalization of mutual gaze convergence and investigate its nomological network. For example, it may be examined how mutual gaze convergence is related to interpersonal processes during the collaborative use of a shared system interface. Secondly, we limited our study to dyads of users for simplicity of all aspects of the research. As mentioned earlier, the present work could be used to examine groups of three or more persons. Thirdly, this study does not investigate qualitative data related to dyad behaviors during the experimental task. Such data may provide more insights about mechanisms though which dyad members' gazes converge. For example, qualitative data may clarify how the decision processes during the dyad task (e.g., jointly deciding where to investigate on the screen) may have influenced convergence of dyad members' gazes. Fourthly, because of the exploratory nature of the present study, a small sample size was used. Nevertherless, as mentioned earlier, our very significant results are promising. Finally, this study does not control for gender and dyad familiarity, that is, whether dyad members knew each other at the time of the study. Indeed, literature suggests that group familiarity may influence group collaboration and team performance (e.g., Cattani et al., 2013; Janssen et al., 2009) and that males and females may display different gaze patterns (e.g., Abdi Sargezeh et al., 2019). Nevertheless, related risk was mitigated: participants were recruited independently from each other, and dyad were formed randomly; moreover, to analyze data related to the collaborative task, we used linear regression with random intercept model, which accounts for random effects. Notwithstanding, the role of dyad familiarity in the present context of collaborative use of a shared system interface is worth investigating in future research.

4.7 Conclusion

This paper investigates factors related to eye movements of IT user dyads during simultaneous collaboration on a shared system interface. A central concept is users' GC whose importance in the IS and HCI literature, although implied, has not been directly investigated nor measured. In the present study, we propose and test a dyad GC index. This GC index is validated in two studies. In the first study the GC index' content validity was demonstrated, as the measurement instrument was able to clearly distinguish convergence from divergence. In the second study, the GC index's predictive validity was strongly supported: as expected, we found that GC was positively associated with dyad task performance and negatively associated with dyad cognitive load. This paper has several contributions to the IS and the HCI literatures, in which research on GC's nomological network is lacking. Hence, we hope this piece of work will foster more investigations of multiuser eye-tracking in the IS and HCI fields.

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Chapter 5 - Essay 5
Joint Use of Information Systems : Explorative Laboratory Investigation of Dyadic Use Experience in E-commerce Context[22]

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Abstract

Despite extensive research on human-computer interaction and information technology (IT) use, the literature lacks insights about collaborative use of IT systems by two or more users through a shared system interface display, a phenomenon referred to as *joint IT use*. Hence, little is known about antecedents and consequences of joint IT use experience. We conducted a mixed-method exploratory laboratory study in an inductive perspective, based on a 2x2x2 within-subject design. We used self-reported, automatic facial analysis, and electrodermal activity measures, and we illustrated synchronized dual eye-tracking technique for one of the first times in IS. In a laboratory setting, thirty-five couples jointly shopped online, i) interacting with webpages with or without vertical scrolling feature, ii) agreeing or not prior to experimental tasks on product preferences, and iii) sharing system display or not, with only one partner user controlling input devices when sharing display, making input device control a between-subject factor. Results suggest that webpage vertical scrolling degrades dyadic visual coordination and emotional valence, increases required effort for joint decision-making, and deteriorates user satisfaction with joint product choices; agreeing prior to tasks promotes higher user satisfaction with product choices for users with no input device control; and users who do not control input devices experience higher emotional valence and higher serenity (i.e., lower cognitive load and lower electrodermal activation). Based on our study's emerging construct relationships, we discuss several implications and recommendations for researchers and IT system designers.

Keywords: joint system use, joint IT use, user dyad, couples, user experience, scrolling, shared display, synchronized dual eye-tracking, laboratory experiment, electrodermal activity, automatic facial analysis, psychophysiological measures.

5.1 Introduction[24]

5.1.1 Problematic and research questions

People commonly use information technology (IT) systems through individual interactions with system interfaces. This perspective is largely dominant in the human-computer interaction literature (HCI) and in the information systems (IS) field in general. Another common trend is that people jointly interact with the same shared system interfaces, a phenomenon we refer to as *joint IT use*. Examples include coworkers reviewing together dashboard together in a shared system interface, or a dyad of friends navigating together a website to buy together a product or service of common interest. However, past empirical IT use research is focused on user interaction with IT systems independently from IT-related events or activities (e.g., collaboration with other coworkers during system use), despite past calls for a more complete view of system use (Barki et al., 2007; Burton-Jones and Straub, 2006). A few exceptions can be mentioned though; Zhu et al. (2010) studied impact of collaborative online shopping communication support tools, including text chat and voice chat in shared navigation vs separate navigation settings, on coordination and perceived social presence; and Yue et al. (2014) examined co-navigation support system features, including split screen view, shared view, and location cues informing users about where partner user is browsing on a website during collaborative online shopping, and impacts on coordination and attention. These empirical research works address remote collaboration. Despite their significant contribution to the HCI literature, little is known about the nature of co-located user joint IT use experience and how IT systems should be designed to promote good joint use experience. Besides, knowledge is lacking about how user joint IT use experience (with shared system interface display) may differ from user experience generated by real-time collaboration among users, each interacting with a separate system interface display.

Examining user joint IT use experience is important for different reasons. First, user experience may significatively influence infusion of an IT, that is, the extent to which an

[24] Because of the required manuscript structure from *Cyberpsychology, Behavior, and Social Networking* journal, which we target, this essay does not have a classic format including a stand-alone literature review.

IT is employed to its fullest extent by users (Fadel, 2012). Second, unlike in a single-user HCI, in multiuser HCI, user experience may be influenced not only by direct interactions with IT system but also by factors related to collaboration and user collective's structure such as role distribution or power structure. Hence, it is necessary to identify and understand these antecedents of user experience in order to figure out how to improve it. Third, user continuance behavior may be influenced by users' confirmation of their expectations about system use (Bhattacherjee, 2001), hence in joint IT use setting, user intention to continue may be influenced by user joint use experience. Fourth, there is an economical imperative related to joint IT use; a recent survey in Canada suggests that the majority of household purchases are done jointly by two or more persons (Briggs, 2018). Moreover, recent research in the U.S.A. has shown that most couples at least occasionally jointly shop together online by sharing a single device, mostly using together the same website window during the activity (Tchanou et al., 2020a). Hence, improving joint use experience may be beneficial to business actors not only in the e-commerce industry but also in other industries providing IT-related products or services that may be jointly used by two or more persons, such as multiplayer game products. Finally, understanding antecedents of user joint use experience is essential to generate practical insights about how to design IT systems promoting quality user joint use experience.

To add to our knowledge of user joint use experience factors, our objective is, in the online shopping context, to investigate co-located dyadic system use by putting an emphasis on understanding user experience generated by dyadic dynamics and on examining system design features potentially instrumental to improving such experience. We investigate user experience as perceived by users, that is, explicit, self-reported experience, and user experience as lived by users, that is, implicit, psychophysiological experience. In that regard, we raise the following research questions (RQ):

RQ1: *What is the impact of system interface display sharing compared to asynchronous display during joint IT use?*

RQ2: *What are antecedents of joint IT use experience?*

RQ3: *Which system characteristics foster optimal joint IT use experience?*

In this essay, our approach is empirical and explorative. We aim at generating insights about the joint IT use phenomenon based on observation of actual dyadic system use. Our study is focused on the joint use of e-commerce platforms by couples. To answer our research questions, we conducted a mixed-method laboratory experiment involving couples shopping online together. In addition to traditional implicit measures, we used explicit measures as proxy to joint use experience. Specifically, we implemented synchronized dual eye-tracking, a technique recently illustrated in IS research (Tchanou et al., 2020b) and permitting to assess co-located dyad users' gaze behavior relatively to each other. Through galvanometry, we measured users' physiological activation. Besides, using video-based automatic facial analysis (AFA), we inferred emotion data (Riedl and Léger, 2016).

5.1.2 Exogenous constructs

Recent research in the U.S.A. suggests that couples shop together using different system setups to a significant extent, including using separate computers, smartphones, or tablets (hence with separate and independent displays), and using the same device (thus, jointly interacting with a single shared system interface display) (Tchanou et al., 2020a). Specifically, Tchanou et al. (2020a) found that about 87% of couples jointly shop together at least occasionally using two separate computers (with about 79% occasionally using together the same shared website window in this setup), while about 94% of couples reported using the same computer for the activity (with about 94% at least occasionally using together the same website window in this setup). Hence, we examine the influence of such device setup, which we call *display sharing*, on user experience. Because display sharing may trigger clashes and claims over mouse control (Mekki Berrada, 2011; Steward et al., 1999), we consider the role of *input device control*; in this study, input device control label will be attached to the user who controls input devices when system display is shared, even when using separate independent displays (see section 5.3.4 for more details). Besides, since dyadic interactions are prone to emergence of conflict, which may influence user emotions and behaviors (Ma et al., 2017), we examine the role of dyadic disagreement, a major antecedent of conflict (Barki and Hartwick, 2004).

Especially, we look at the impact of pre-task settlement of disagreement, a construct we name *pre-agreement*.

In addition to system display and dyadic state, we examine how system characteristics may influence user joint IT use experience. We consider system characteristics in terms of system design patterns. In doing so, we aim at generating insights about how IT systems could be built to improve joint use experience. We investigate attentional aspects of system design impacts. Past IS research suggests that dyadic gaze convergence, representing joint visual attention of user dyad during joint use of IT systems, may impact users' cognitive load and dyadic performance (Tchanou et al., 2020b). Hence, this essay focusses on system design pattern susceptible to influence the way dyads look at system interface. A feature most users are exposed to is system interface *scrolling*. Past system usability research suggests that scrolling is one of the most frequent and common human-computer interactions in interactive software systems, including Web applications, spreadsheets, and word processors (Sharma and Murano, 2020; Neervoort, 2010). With regard to scrolling feature, three main webpage design patterns are common: webpages with no scrolling, which represent interfaces displaying all of their visual content items in a single display, generally at fix locations on the screen, such that users do not need to perform any scrolling to see them (e.g., on the centris.ca real estate website, house's picture navigation webpage displaying a single picture at a time and allowing users to click on a "back" or a "next" button to display other pictures); the traditional scrolling, which involves webpages with defined amount of content (e.g., a classic university website); and infinite scrolling (Sharma and Murano, 2020), which involves webpages with content continuously loading as user reaches the webpage end, until there is no more content to be displayed (e.g., a personal journal in social media website such as Facebook.com). Because system interface scrolling implies moving webpage content and as a result may impact user gaze behavior, we look at the role of scrolling during joint IT use. As past usability research suggests, vertical scrolling, which involves moving visual content upward or downward, is most common in interface design than horizontal scrolling, which involves moving visual items leftward of rightward (Kim et al., 2016). Hence, this essay focusses on vertical scrolling.

This essay brings new theoretical and practical insights. The relationships emerging from our study raise the importance of our exogenous constructs (namely display sharing, input device control, dyadic pre-agreement, and scrolling) and the role system design can play in our phenomenon of study. Moreover, our results suggest practical insights that can be instrumental to IT professionals seeking to design IT systems that procure optimal multiuser experience. Finally, our study represents one of the very first research works in IS illustrating and leveraging the synchronized dual eye-tracking technique to measure dyad-level gaze behaviors. Generally, our results suggest an adverse effect of system interface vertical scrolling feature; higher serenity for users with no input device control than controlling users; and higher emotional valence for users with no input device control in case dyads agree before IT task performance than in the absence of pre-task agreement.

In the remainder of this essay, we first present the psychophysiological techniques we use, followed by a discussion about our experimental factors. Next, we detail our methodology and results, ending with a concluding discussion.

5.2 Methodology

We investigated our research questions through an experiment in controlled laboratory settings. The study was approved by our institution's ethical committee (ethical approval code: 2021-4041). It involved couples shopping online together. The couples had to browse together for several products and make mutually agreed product choices, considering product features. During the experiment, we collected psychometric (self-reported) and psychophysiological data that would inform about participants' joint shopping experience as they perceived it and their actual experience, respectively. We start by presenting the psychophysiological tools we use in this study. Next, we present our experimental study.

5.2.1 Eye-tracking technology

Eye-tracking is an important technology that allows to capture visual patterns or behavior of users as they are faced with a visual stimulus such as an IT. The eye-tracking technology leverages properties of the eye to capture its movements or gazes. For example, modern eye-trackers (eye-tracking devices) use corneal reflection and the identification of the center of the pupil to calculate viewer's gaze location on a stimulus, following a calibration process (Djamasbi, 2014). The two main representations that can be done using eye-trackers are *fixation patterns*, a pattern of the visualization of eye fixation points on a stimulus (fixations are short stops of user gaze between eye saccades, that is, fast eye movements with no information coding (Djamasbi, 2014)); and *gaze heatmaps*, which aggregate user fixation patterns and provide fixation intensities in terms of colors (red for high, yellow for moderate, and green for low intensity) (Courtemanche et al., 2018). Moreover, research using eye-tracking mainly uses five indicators: *pupillary dilation*, that is, change in pupillary diameter; *fixation duration* that is, amount of time a point is fixated; *fixation frequency* (or *fixation counts*), that is, number of times a user's eyes fixates a specific point; *time to first fixation* that is, time users take to look for the first time inside an area of interest (AOI) – an AOI is a specific chosen region on the screen for analysis (Holmqvist et al. 2011); *visit count*, that is, the number of times user's gaze entered an AOI; and *total visit duration*, that is, the amount of times a user's gaze stayed inside an AOI.

Recent studies have employed eye-tracking technology to capture gaze data of two or more participants during experimental tasks, a technique called *multiuser eye-tracking* (e.g., Shvarts et al., 2018). However, most of those studies involved separately recording gaze data for each participant or in an asynchronous way, requiring manual data synchronization and exposing analyzes to temporal mismatch between participants' actions (Nyström et al., 2017). Addressing this limitation, recent research by Tchanou et al. (2020a) involved real-time synchronized gaze data collection of user dyads, called *synchronized dual-eye-tracking*. Tchanou et al. illustrated feasibility of this technique through a laboratory study in which user dyads jointly performed tasks, interacting with a single shared interface. Based on the synchronized gaze data they collected, Tchanou et al. developed an index to measure gaze convergence, that is, the extent to which dyad members look at same locations in computer screen. They calculate the index as Euclidian distance between two partners' gaze location on computer screen throughout an IT task. The index may have applications such as real-time display of dyad gaze cues based on dyad gaze convergence data. Hence, collecting eye movement data of dyad members synchronously is advantageous because it allows to extract multi-user eye data that are directly temporally comparable.

5.2.2 Galvanometry

A galvanometer is a device allowing researchers to measure the conductance of the skin: using two electrodes (an anode and a cathode), a galvanometer measures electrodermal activity (EDA), defined as the extent to which the skin allows transmission of an applied electrical current (Riedl and Léger, 2016). Two main measures of skin electrical conductance are generally used: (1) *skin conductance level* (SCL), which is the overall EDA during a task and is less prone to reacting to variations in experimental conditions (Christopoulos et al., 2019); and (2) *skin conductance response* (SCR) which is a phasic (i.e., short-term) electrodermal response to a stimulus and whose signal follows a typical shape with a latency time preceding response (i.e., temporal distance between stimulus onset and the beginning of the response, typically 1 to 3 seconds) (Christopoulos et al., 2019). EDA may be employed by researchers as an indicator of emotional arousal of individuals (Riedl and Léger, 2016), as has been illustrated in past research works (e.g., Tchanou et al., 2018; Adam et al., 2013). Although EDA is usually collected and analyzed at individual level in studies involving one or a group of participants performing an experimental task, past studies have measured and synchronized EDA data from two or more participants for group-level analysis, such as inter-subject correlation analysis (e.g., Golland et al., 2015). The present study's analyses of EDA will be done at individual level.

5.2.3 Automatic facial analysis

Automatic facial analysis (AFA) is a technique based on Ekman and Friesen (1978)'s work suggesting that human emotions can be linked to particular sets of facial muscle contractions called action units, which can be produced by humans in large number (Martinez et al., 2019; Srinivasan et al., 2016). Ekman and Friesen developed a technique for quantifying and measuring most facial expressions, called the facial action coding system (FACS). AFA method uses complex algorithms including machine learning and

3D modeling. It allows to analyze huge amount of video data to infer emotions based on facial expressions (Lewinski et al., 2014). Two types of emotions can be inferred by AFA software, including emotional valence (i.e., positive affect) and emotion categories such as happiness, sadness, boredom, anger, disgust, fear and surprise. Past studies have assessed and confirmed reliability and validity of AFA measures of emotions inferred by AFA software, the most popular being FaceReader (Noldus Technology Inc, Wageningen, The Netherlands), based on Ekman and Friesen's FACS (e.g., Tanja et al., 2019; Lewinski et al., 2014). These measures of emotion have been largely used in the literature (e.g., Giroux et al., 2019; Léger et al., 2019a; Tchanou et al., 2018).

5.2.4 Participants

Participants to our study had to be 18-year-old or older, and they had to be in couple[25], whatever their marital status, and participate to the study with their partner. Because of the psychophysiological instruments we used, participants were not allowed to participate in the experiment if they had to wear glasses to work with computers and if they had health-related issues such as partial or complete facial paralysis, epilepsy, cardiac pacemaker, specific skin sensitivity, specific allergies, neurological diagnostic, or other health-related disorders. Several means were employed for sampling, including the community panel of our laboratory's institution, major digital social networks, and word-of-mouth. We also used the services of an external agency for participant recruitment. Participants' average age was 35.49, with a standard deviation of 14.21. A total of 35 couples participated to the study, that is, 70 participants, including 34 females and 36 males.

5.2.5 Material and apparatus

As we were interested in capturing gaze behavior at couple level of analysis, we implemented synchronized dual eye-tracking technique. We used two Tobii Pro Nano eye-trackers (Tobii Technology, Inc., Reston, VA, U.S.A.), one on each participant'

[25] We did not provide a specific definition of what a couple is, leaving participants assess by themselves whether they were in couple.

computer. The two computers were identical in terms of hardware characteristics and dimensions, and they ran Tobii Pro Lab 1.145 software, which managed Tobii Pro Nano hardware and stimulus administration (see Figure 5.39), and through which we defined all event markers.

We also collected physiological data including EDA using COBALT - Bluebox mobile physiological recording devices (Tech3Lab, HEC Montréal, Montreal, Québec, Canada) (Courtemanche et al., 2022), one installed on each individual participant. The device was designed to facilitate self-installation by participants. Moreover, each participant computer had a professional webcam that captured participant videos during experimental tasks. Media Recorder software (Noldus Technology Inc, Wageningen, The Netherlands) managed video recording. FaceReader software (which is provided by Noldus technology Inc.) permitted to generate emotional valence data based on the videos, through AFA technique.

Two COBALT - Bluebox synchronization devices (Tech3Lab, HEC Montréal, Montreal, Québec, Canada) served as real-time synchronization means of all psychophysiological tools. During the whole experiment, one of them simultaneously sent regular synchronization markers to all computers collecting psychophysiological data; the other Bluebox device regularly sent beacons that were captured by the two webcams to facilitate AFA. Bluebox markers permitted automatic synchronization of gaze data, physiological data, and automatic facial analysis data from two participating partners. We generated synchronized data using COBALT Photobooth software (Tech3Lab, HEC Montréal, Montreal, Québec, Canada) (Léger et al., 2019b).

5.2.6 Experimental stimulus

Participants jointly performed experimental tasks with their partner, shopping online within twelve product categories. We chose these categories based on past research suggesting they are jointly shopped for by couples to a significant extent (Tchanou et al., 2020a) and based on a limited budget of CAD $200, the amount the shopping card participants could benefit from the study (see section 5.2.8 for more details). Table 5.33 presents the product categories that were covered. The shopping tasks were performed on two types of online platforms, including a non-scrollable platform and a scrollable platform. We specifically developed the non-scrollable platform to reproduce the experience of using a shopping website with no scrolling capabilities. The platform was made of eight non-scrollable webpages, each showcasing six different products from one of the chosen product categories. In each webpage's default display were product image, name, and price. Participants had to click on a button under the price information to display product details. They could display details for only one product at a time. Every product category was used in only one webpage. We developed the platform using Axure RP9 integrated development environment (Axure Software Solutions, Inc., San Diego, California, U.S.A.). Figure 5.37 showcases examples of the non-scrollable interfaces.

Table 5.33. Product categories shopped for by couples.

<table>
<tr><th>Product category</th><th>Webpage characteristic</th></tr>
<tr><td>Cinema</td><td rowspan="8">No scrolling
(the non-scrollable platform)</td></tr>
<tr><td>Earphones</td></tr>
<tr><td>Computers</td></tr>
<tr><td>Bed and breakfast</td></tr>
<tr><td>Television set</td></tr>
<tr><td>Spa and well-being</td></tr>
<tr><td>Equipment for parks</td></tr>
<tr><td>Spectacles</td></tr>
<tr><td>Vacuum cleaners</td><td rowspan="4">Scrolling
(the scrollable platform)</td></tr>
<tr><td>Coffee machines</td></tr>
<tr><td>Patio furniture</td></tr>
<tr><td>Interior furniture</td></tr>
</table>

Participating couples also performed joint shopping tasks through a scrollable website, namely, www.bestbuy.ca, the website of a chain of stores selling a wide variety of electronic equipment (Best Buy Canada Ltd, Burnaby, British Columbia, Canada). All website interfaces were highly scrollable upward and downward, with infinite scrolling, that is, participants could click to load more content at the bottom of the same webpage whenever they scrolled to the end of product list. Their default view showcased advert banners and promoted downward scrolling for the display of product images, details, and filtering. Figure 5.38 provides an example of the scrollable website.

Figure 5.37. Example of a webpage with no scrolling.

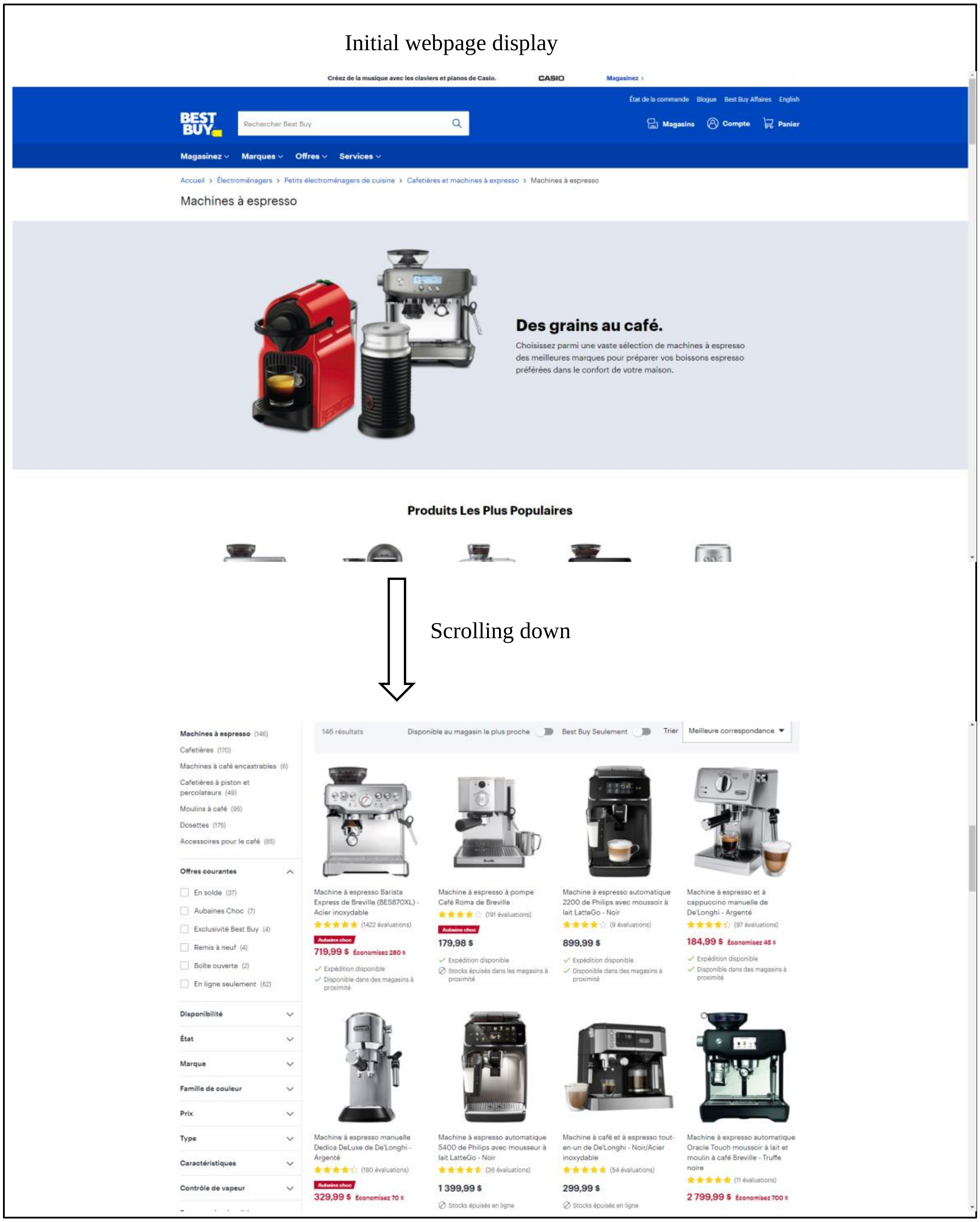


Figure 5.38. Example of a webpage with scrolling.

5.2.7 Experimental design

Our experiment followed a 2x2x2 within-subject design, summarized in Table 5.34. Participating couples shopped together in two different setups. We call the related manipulated factor *display sharing*. In the *separate displays* setup, partners each controlled their own computer, with asynchronous displays from each other. In the *shared display* setup, they used together the same computer, with only one of the two partners controlling input devices, that is, mouse and keyboard – we call that participant the *controlling user* or *controlling participant*. Conversely, we call the participant not controlling input devices *noncontrolling user* or *noncontrolling participant*. The same person acted as the controlling user throughout the shared display condition. However, partners each visualized instructions and stimuli in their own separate screen displaying the same interface. Hence, *input device control* was a manipulated factor partially confounded with display sharing, as partners were randomly assigned different roles. Although each user controls his or her own input devices in separate displays condition, input device is treated as an assigned label to one participant throughout the experiment; thus, we also examine in separate displays the differences between two partner users as per the role they play in shared display condition. This perspective allows to capture possible carry-over effect of input device control between shared and separate displays setup. For example, it is possible that a noncontrolling participant's emotional reactions when in a shared display condition impact his or her emotional reactions when in a separate display and vice-versa, because of the participant's preference in control role. In all conditions, partners took questionnaires independently from each other using a tablet PC they were provided. The ordering of the type of setup was randomized between participating couples.

We also manipulated pre-task agreement state within couples regarding product features to look for during joint online shopping. We call this factor *pre-agreement*. In the condition with pre-agreement, before they could engage in the experimental task, couples were instructed to freely discuss and agree over which product features to look for, among a predetermined list of product features associated with the product category to chop for. Partners each had to report in a questionnaire about the mutually agreed product preferences. In the conditions with no pre-agreement, partners each had to provide their own product preferences through a questionnaire, independently from each other. They were instructed not to discuss with each other before indicating those preferences. The couples were directly exposed to the joint task afterward. The time ordering of pre-agreement and no pre-agreement condition was randomized between couples. Finally, two types of shopping webpages were involved, associated with the two stimulus types we used, which materialized the manipulation if the *scrolling* construct. In the *no scrolling* conditions couples were exposed to two non-scrollable webpages per trial, each exposing a different product category – for a total of eight trials in the no-scrolling condition. In the *scrolling* condition, they jointly shopped on a scrollable website (www.bestbuy.com), for one product category per trial. Each webpage exposed only one product category, for a total of four trials in this condition (thus, twelve trials in total).

Table 5.34. Experimental design - 2x2x2 within subject.

		Pre-agreement			
		Pre-agreement		No pre-agreement	
Display sharing	Shared display (One controlling user)	No WS	WS	No WS	WS
	Separate display (Each user controlling)	No WS	WS	No WS	WS

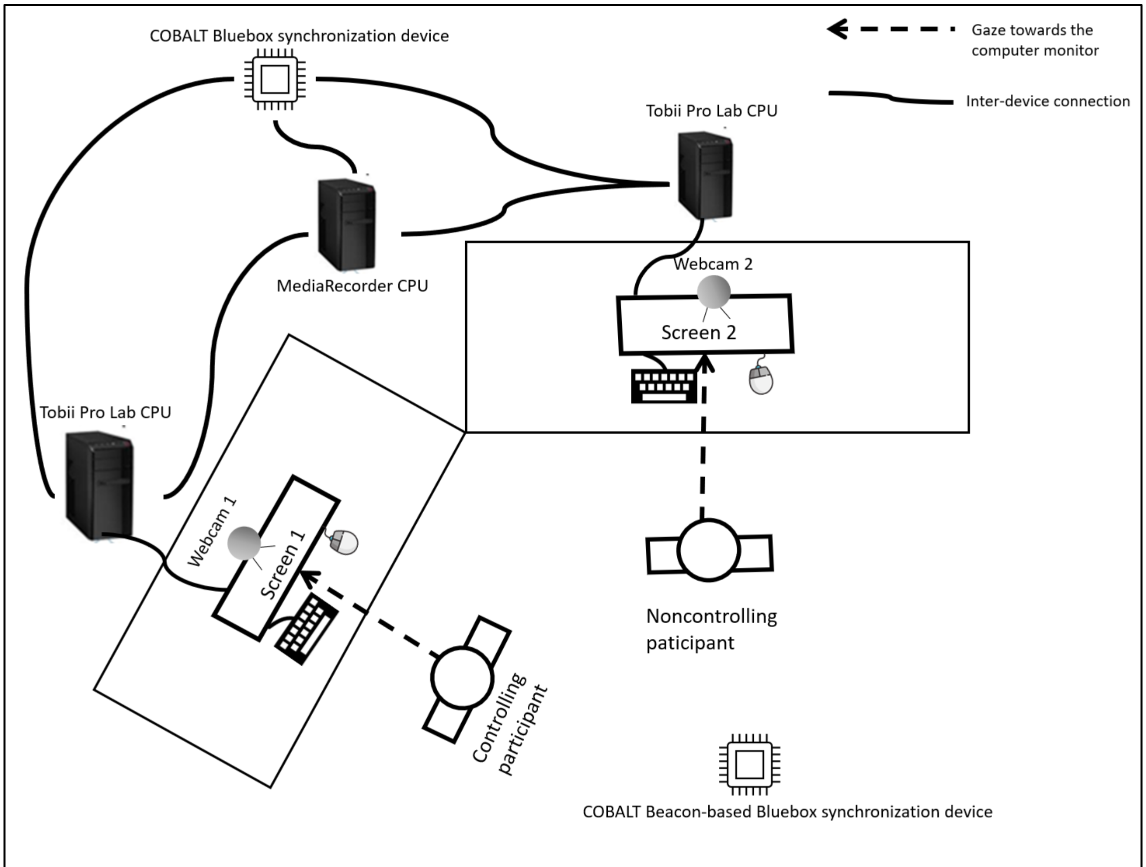
Note. WS = webpage scrolling.

5.2.8 Experimental procedure

Relating to experimental conditions with shared display, for each participating couple, we randomly assigned device control role prior to the experiment's execution. Only one of the partners acted as the controlling user throughout couple's participation in the condition with shared display. Because of the COVID-19 pandemic that was ongoing at the time of our study, the whole experimental process was conducted in accordance with special public health authorities' recommendations. Before participant arrival, we made sure all equipment were properly set up. After welcoming participating couples, a research assistant directed them to the two prepared participant seats. A same seat was assigned to the controlling user for all couples, in order to ensure all controlling users have the same environment across trials and likewise, that noncontrolling users be in the same setting across trials (see Table 5.34 for the experimental setup). The two seats, by design, had limited room for movements, in order to reduce participants' moves during experimental tasks, allowing for better capture of their facial expressions by the webcams and better tracking of their gaze behavior by the eye-trackers.

Prior to the experimental task, we explained to the participants that they would each receive a CAD $50 Best Buy gift card compensation and that by completing the whole experiment they would get a chance to win another CAD $200 gift card based on a random draw, which they could use to buy products they jointly chose on the website. This rule aimed at increasing realism of participants' task performance. We also verbally mentioned that the different psychophysiological instruments would collect a variety of data during the experiment. Then they had to read the digital consent form – which provided more detailed information – in a tablet and sign it. No personal device was allowed in the experimental room.

In order to abide by public health authorities' recommendation, participants had to install COBALT Bluebox biosensors by themselves, following an installation protocol we developed. We guided them throughout the installation, which we double-checked afterward. Afterward, participants took a pre-experiment questionnaire about their individual trait. We then calibrated the two eye-trackers after adjusting participants' seating position. After we collected baseline data, participating couples were displayed instruction flow guiding them throughout the experimental task, through Tobii Pro Lab software (see Figure 5.40 depicting task flow design). The instruction flow was mixed with stimuli display, and switches between instructions and stimuli were automatically managed by Tobii Pro Lab, limiting research assistant's physical interventions during task flow.



Note. Each partner visualized the shared display on a separate screen connected to the same computer.

Figure 5.39. Dual-eye-tracking experimental setup.

The experiment was run in two parts, each with a setup with either shared display or separate display only, depending on the time ordering of the display sharing condition couples had been randomly assigned. Participating couples had to shop for the specific product category they were instructed to shop for only. Before performing tasks in the pre-agreement condition, they each had to provide mutually agreed shopping preferences in a questionnaire. After jointly shopping for two products categories in non-scrollable interface or one product category in a scrollable interface, they had to answer questions related to the task, including perceived effort required for reaching consensus, satisfaction with their role (controlling user vs noncontrolling user), satisfaction with the product choice made by the couple, and overall satisfaction with joint shopping experience. All questionnaires were administered through Qualtrics.com online survey platform (Qualtrics, Seattle, Washington, U.S.A.), using a tablet PC.

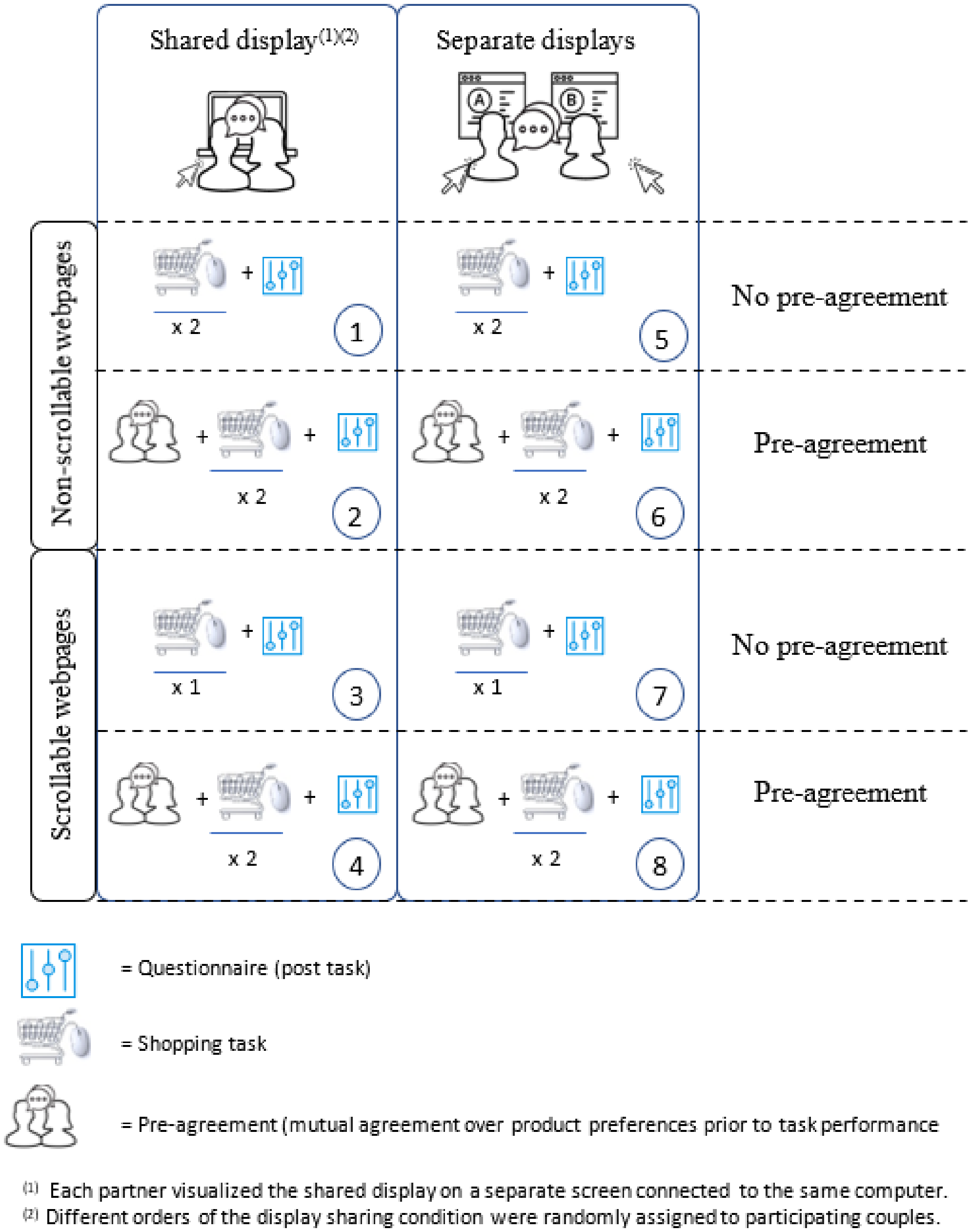


Figure 5.40. Experimental task flow.

5.2.9 Measures

We assessed participants' explicit experience using self-reported scales (see Appendix F for measurement scales). We accounted for participants' involvement attitude towards online shopping activity in couple in general, a construct we called *involvement*. We measured involvement using Laurent and Kapferer (1985)'s scale. We also captured participants' *satisfaction with joint product choice* (Cronbach's alpha = 0.970), that is, the extent to which a participant was satisfied with the final product choice jointly made with partner user. Participants reported about perceived required *effort for reaching consensus* during experimental tasks, that is, the extent to which a participant perceives it took a lot of effort to reach consensus over decisions during tasks (Cronbach's alpha = 0.924). Finally, they reported about their *satisfaction with role*, that is, the extent to which they would have preferred to have more control over input devices during joint tasks. All construct items were translated in French. Two graduate students from our institution evaluated translations, on the base of which we made adjustments to the items.

Regarding participants' implicit experience, emotional valence indicator was generated through automatic facial analysis using FaceReader software (Noldus Technology Inc, Wageningen, The Netherlands), and we used participants' EDA based on SCL average throughout experimental tasks, to measure participants' emotional arousal. With regard to cognitions, we measured cognitive load using pupillary dilation based on pupillary diameter data provided by Tobii Pro Nano eye-tracker (Riedl et al, 2017). At dyad level, we considered users' visual interest in the system interface, which has been suggested to influence collaboration during joint IT use (Tchanou et al., 2020b). We measured the extent to which participating couples looked at the same locations in system interface, a construct that has been named *gaze convergence*; we measured it based on the index proposed by Tchanou et al. (2020a), as Euclidian distance between the two users' gaze locations on the screen throughout an experimental task. However, we had to exclude psychophysiological data for part of our sample (twenty-one participants' eye-tracking and AFA data, and thirty-three participants' EDA data) because of unexpected technical issues with some individual participants' or couples' data collection (these participant data were missing at random), leading to a sample of forty-nine participants and twenty-two couples for eye-tracking and AFA, and thirty-seven participants and fourteen couples for EDA – in addition to the sample size for explicit measures, that is, seventy participants or thirty-five couples.

5.3 Analysis and results

5.3.1 Analysis

At individual-level, we performed a three-way multivariate analysis of covariance (MANCOVA) with repeated measures and contrast analyses to test the effect of display sharing, pre-agreement, and scrolling on EDA, emotional valence, cognitive load, effort for reaching consensus, and satisfaction with product choice. Input device control (IDC) factor acted as a between-subject fixed factor in the MANCOVA. For significant multivariate test, we considered the univariate tests provided by SPSS software for each dependent variable tested in this model (i.e., each three-way ANCOVA). We controlled for involvement attitude (as covariate) and gender, which has been suggested to be associated with emotional reactions (e.g., Riedl et al., 2013). Moreover, we tested direct effects from IDC on EDA, emotional valence, cognitive load, satisfaction with role (this variable was considered specifically for IDC because it refers to participant's satisfaction with IDC), and satisfaction with product choice, through a between-subject MANCOVA, and considering univariate tests provided by SPSS software for each dependent variable tested in this model, with the involvement attitude and gender as control variables. We used Sidak method to adjust for multiple comparisons.

Regarding couple-level analyses, we examined influences of display sharing, pre-agreement, and scrolling on couples' gaze convergence by running a three-way ANCOVA with repeated measures based on couple-level data. Because purposely looking at same locations clearly may require some degree of participant involvement in the dyadic collaboration, high differences in involvement in dyads can be expected to influence the extent to which participants focus their attention on the same visual locations on system interface. Hence, we controlled for partners' difference in involvement attitude towards joint online shopping.

In all three-way ANCOVAs, we tested for main effect and two-way interaction effects. All our tests were done at $\alpha = 0.05$ significance level. Figure 5.41, Figure 5.42, Figure 5.43, and Figure 5.44 present boxplot of descriptive statistics of our dependent variables. Table 5.35 and Table 5.36 present detailed descriptive statistics.

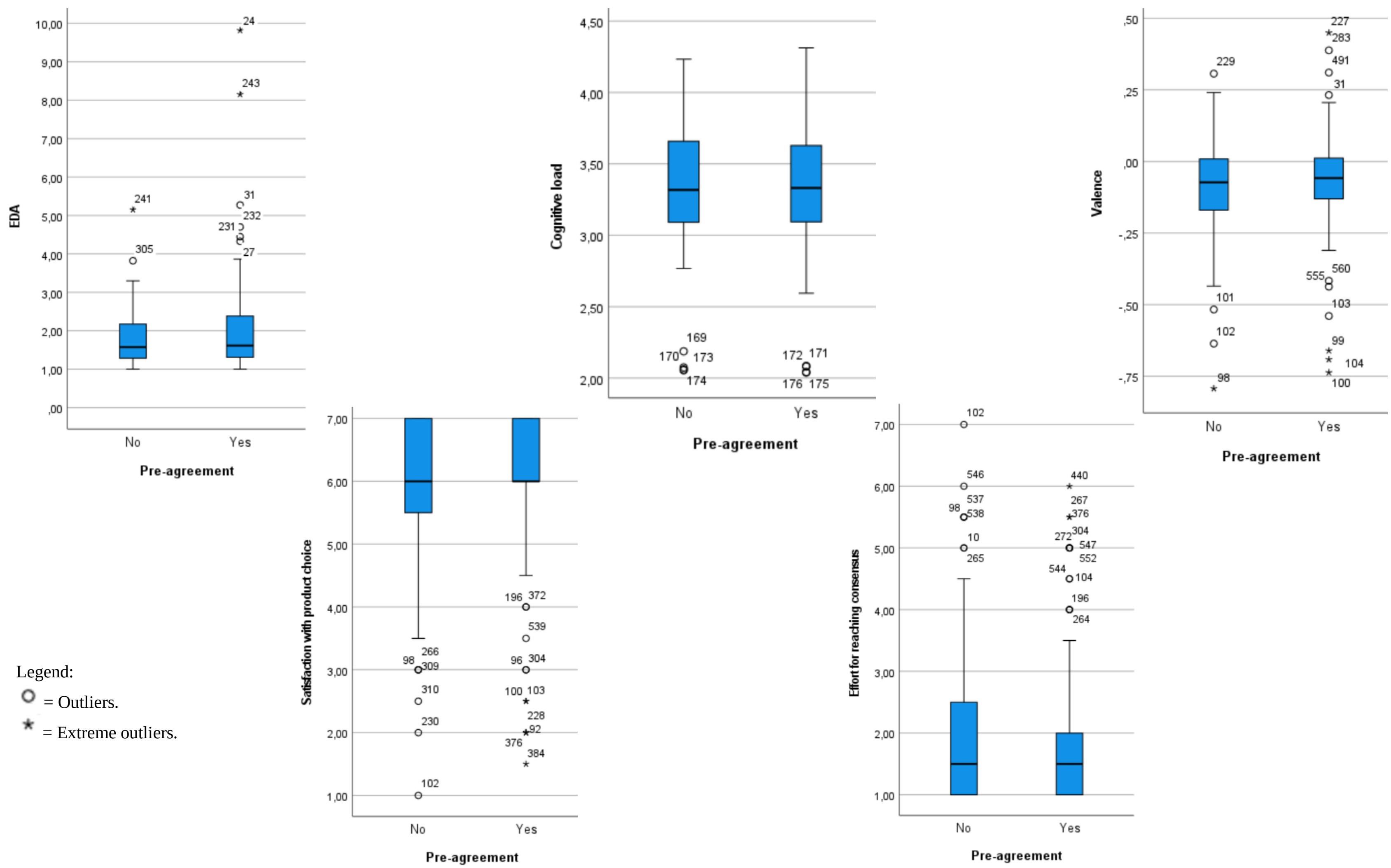


Figure 5.41. Pre-agreement factor – box plots for dependent variables.

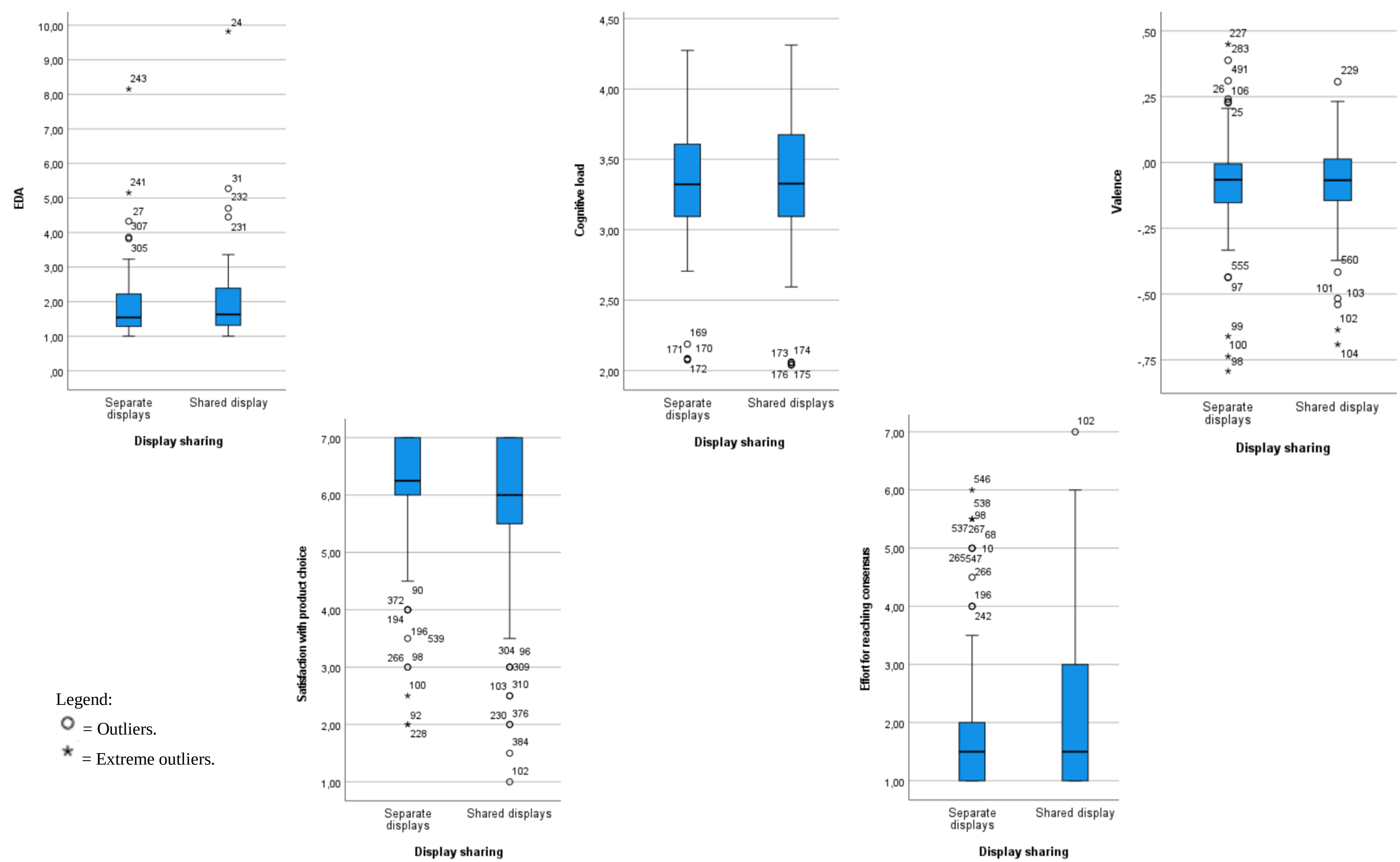


Figure 5.42. Display sharing factor – box plots for dependent variables.

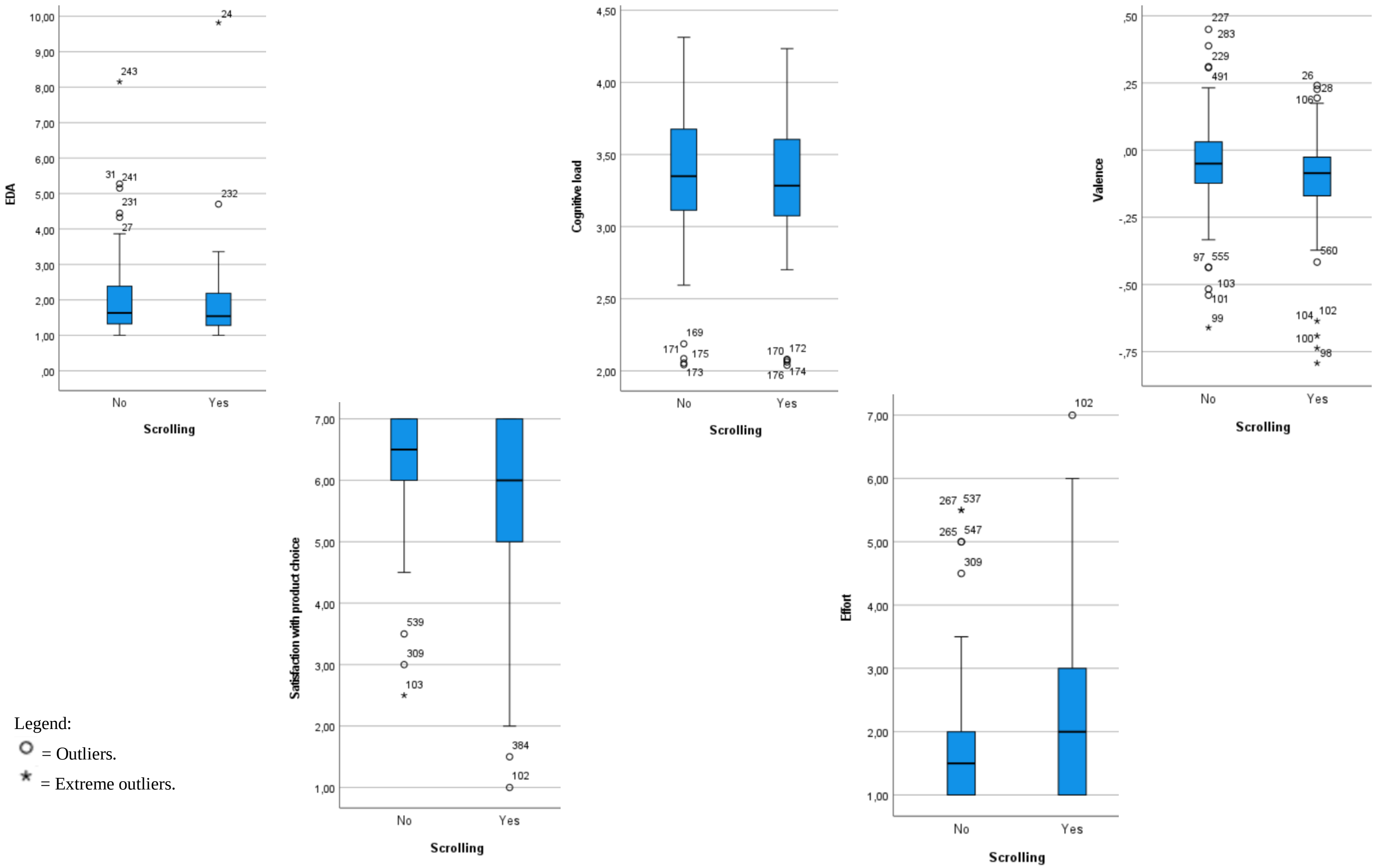


Figure 5.43. Scrolling factor – box plots for dependent variables.

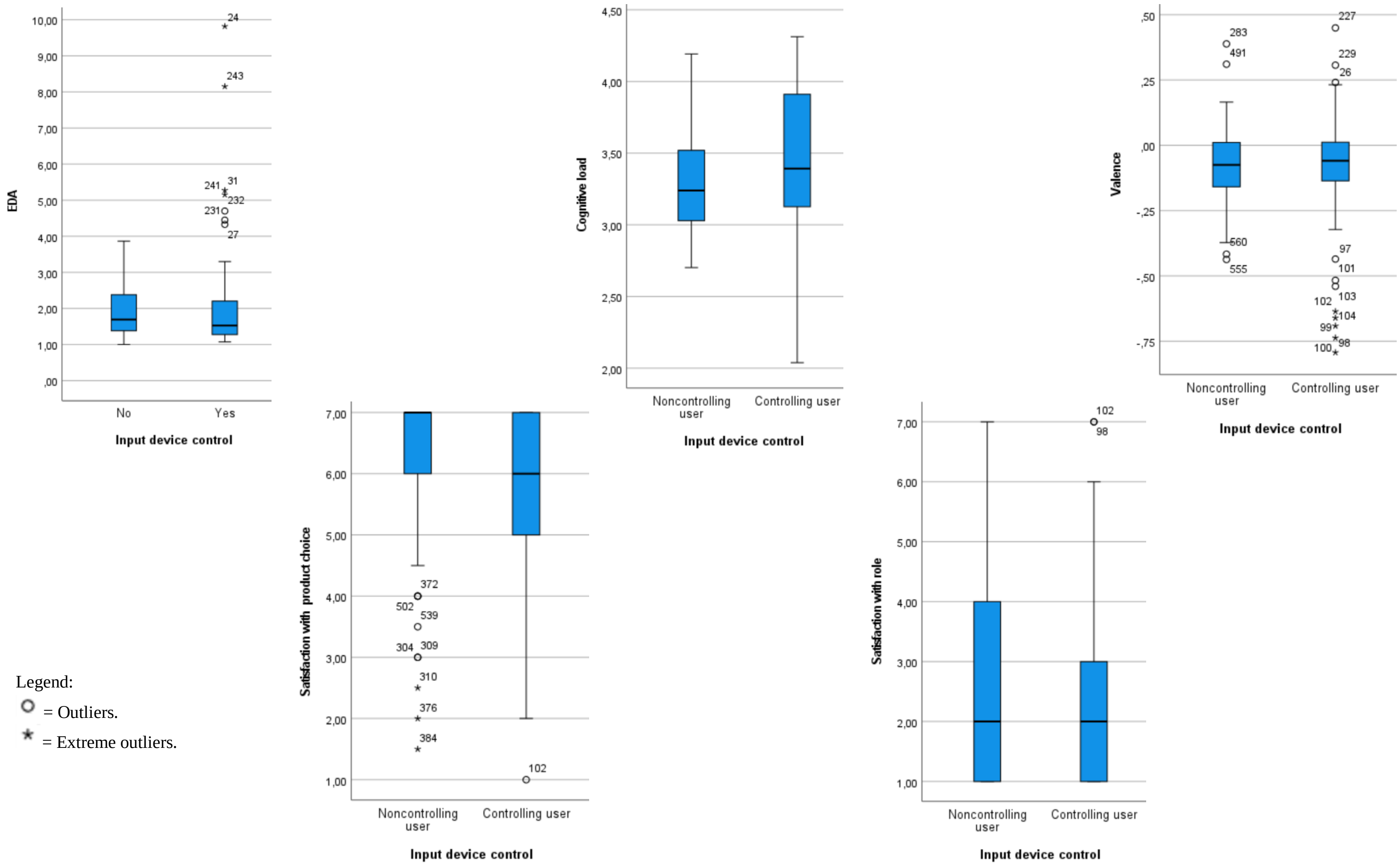
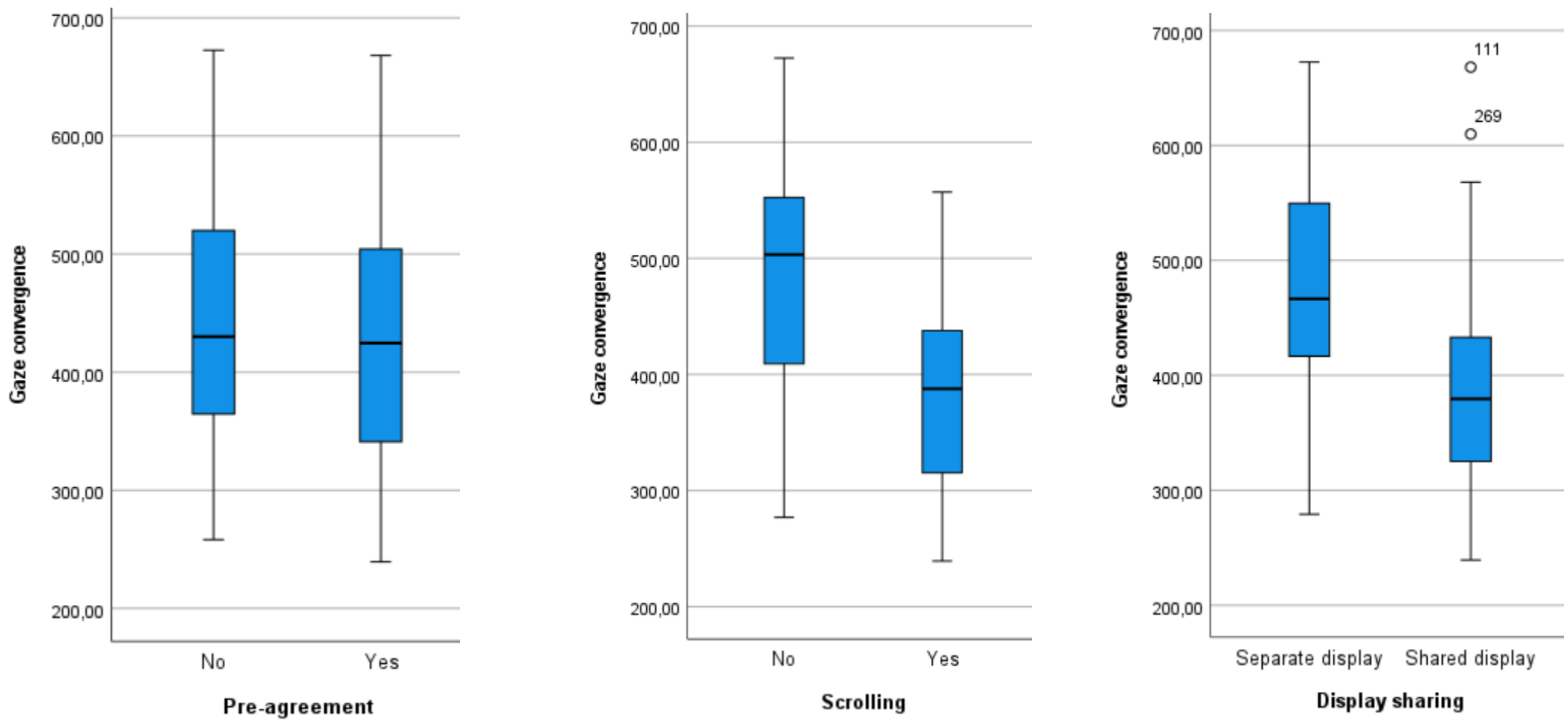


Figure 5.44. Input device control factor – box plots for dependent variables.



Legend:

○ = Outliers.

* = Extreme outliers.

Figure 5.45. Gaze convergence (couple level) - box plots.

Table 5.35. Descriptive statistics for dependent variables (1).

Level of analysis	**Dependent variables**	**Independent variables**	**Factor level**	**Mean**	**Standard deviation**
Couple level	GC	Pre-agreement	No pre-agreement	436.58	98.36
			Pre-agreement	429.95	107.03
		Display sharing	Separate display	477.98	94.65
			Shared displays	386.86	89.36
		Scrolling	No scrolling	484.79	101.16
			Scrolling	381.07	73.87
Individual level	EDA	Pre-agreement	No pre-agreement	4.98	16.67
			Pre-agreement	6.63	22.85
		Display sharing	Separate display	4.22	10.47
			Shared displays	7.32	24.95
		Scrolling	No scrolling	5.60	20.29
			Scrolling	6.03	19.82
		IDC	Noncontrolling	4.23	10.40
			Controlling	7.14	25.37
	Cognitive load	Pre-agreement	No pre-agreement	3.36	0.46
			Pre-agreement	3.36	0.46
		Display sharing	Separate display	3.36	0.44
			Shared displays	3.37	0.47
		Scrolling	No scrolling	3.40	0.46
			Scrolling	3.32	0.45
		IDC	Noncontrolling	3.27	0.32
			Controlling	3.27	0.53
	Valence	Pre-agreement	No pre-agreement	-0.09	0.16
			Pre-agreement	-0.07	0.17
		Display sharing	Separate display	-0.08	0.18
			Shared displays	-0.08	0.15
		Scrolling	No scrolling	-0.05	0.16
			Scrolling	-0.11	0.16
		IDC	Noncontrolling	-0.08	0.14
			Controlling	-0.08	0.18

Note. GC = Dyadic gaze convergence; Effort = Effort for consensus; IDC = Input device control; EDA = Electrodermal activity.

Table 5.36. Descriptive statistics for dependent variables (2).

Level of analysis	Dependent variables	Independent variables	Factor level	Mean	Standard deviation
Individual level	Effort for consensus	Pre-agreement	No pre-agreement	1.98	1.29
			Pre-agreement	1.90	1.22
		Display sharing	Separate display	1.88	1.25
			Shared displays	1.99	1.27
		Scrolling	No scrolling	1.73	1.01
			Scrolling	2.15	1.44
		IDC	Noncontrolling	1.84	1.25
			Controlling	2.02	1.26
	Satisfaction with role	Pre-agreement	No pre-agreement	2.52	1.57
			Pre-agreement	2.40	1.48
		Display sharing	Separate display	2.26	1.36
			Shared displays	2.64	1.65
		Scrolling	No scrolling	2.41	1.41
			Scrolling	2.51	1.63
		IDC	Noncontrolling	2.73	1.59
			Controlling	2.23	1.44
	Satisfaction with choices	Pre-agreement	No pre-agreement	6.02	1,18
			Pre-agreement	6.08	1.23
		Display sharing	Separate display	6.14	1.10
			Shared displays	5.96	1.30
		Scrolling	No scrolling	6.31	0.87
			Scrolling	5.78	1.43
		IDC	Noncontrolling	6.25	1.13
			Controlling	5.88	1.25

Note. GC = Dyadic gaze convergence; IDC = Input device control.

5.3.2 Results

Results are presented in Table 5.37, Table 5.38, and Table 5.39 (See Appendix G for complementary result details). Our results at couple level revealed statistically significant F-test of the effect of webpage scrolling on participating couples' gaze convergence, and simple contrast analysis showed statistically higher couples' gaze convergence in the no webpage scrolling than in the webpage scrolling condition (F(1, 18) = 8.732; p < 0.0001; C.I. = [77.400; 129.386]).

Table 5.37. MANCOVA results.

Independent variables (IVs) [1]	**df**	**df (error)**	**MSE**	**F-value**	**p-value**
DisplaySharing	4	43	0.121	1.482	0.224
Pre-agreement	4	43	0.187	2.477	0.058
Scrolling (***)	4	43	0.640	19.073	<0.001
IDC (****)	4	260	0.124	9.237	<0.0001
DisplaySharing*Pre-agreement	4	43	0.103	1.230	0.312
DisplaySharing*Scrolling	4	43	0.058	0.662	0.622
Pre-agreement*Scrolling	4	43	0.120	1.469	0.228
DisplaySharing*IDC	4	43	0.042	0.469	0.758
Pre-agreement*IDC	4	43	0.111	1.348	0.268
Scrolling*IDC	4	43	0.040	0.446	0.775

(***) = significant at $\alpha = 0.001$; (****) = significant at $\alpha = 0.0001$.

Note. IDC = Input device control;

[1]: The between-subject MANCOVA with IDC as IV was done with the following DVs: EDA, emotional valence, cognitive load, satisfaction with role, and satisfaction with product choice; and the MANCOVA with display sharing, pre-agreement, and scrolling as IVs was done with the following DVs: EDA, emotional valence, cognitive load, effort for reaching consensus, and satisfaction with product choice.

At individual level, with respect to webpage scrolling factor, the MANCOVA was statistically significant (F(4, 43) = 19.073; p < 0.0001). Therefore, we ran ANCOVA univariate test for each dependent variable, and for each significant univariate test, we ran simple contrast analysis for each main effect. For effort for reaching consensus, we found a statistically significant F-test (F(1, 46) = 8.420; p = 0.006), with simple contrast analysis showing lower required effort for reaching consensus in the condition with no webpage scrolling than in the condition with webpage scrolling (p = 0.006; t = -2.896; C.I. = [-0.519; -0.094]). In addition, the F-test was significant for satisfaction with product choices (F(1, 46) = 17.893; p < 0.001). Simple contrast analysis revealed significantly higher participant' satisfaction with joint product choices in the condition with no webpage scrolling (p < 0.001; t = 4.229; C.I. = [0.262; 0.737]). On a psychophysiological standpoint, the F-test was significant for emotional valence (F(1, 46) = 25.560; p <

0.0001). Simple contrast showed significantly higher participants' emotional valence in the condition with no webpage scrolling ($p < 0.0001$; $t = 5.083$; C.I. = [0.037; 0.085]). Finally, the F-test was statistically significant for cognitive load ($F(1, 46) = 51.331$; $p < 0.0001$). Simple contrast analysis showed significantly higher participants' cognitive load in the condition with no webpage scrolling ($p < 0.0001$; $t = 7.167$; C.I. = [0.062; 0.111]). No main effect of EDA was statistically significant in this model.

With regard to the input device control factor, the MANCOVA was statistically significant ($F(4, 260) = 9.237$; $p < 0.0001$). Thus, we ran individual ANCOVA for each dependent variable and simple contrast analysis for statistically significant univariate tests. The F-test for satisfaction with product choice was statistically significant ($F(1, 263) = 4.044$; $p = 0.045$); non-controlling participants reported significantly higher satisfaction with product choices ($p = 0.045$; $t = 2.013$; C.I. = [0.006; 0.594]). In addition, the F-test for participant satisfaction with role was significant ($F(1, 263) = 11349$; $p < 0.001$). Simple contrast showed that noncontrolling participants reported higher satisfaction with role than controlling participants ($p < 0.001$; $t = 3.376$; C.I. = [0.261; 0.995]). As per psychophysiological data, results showed a statistically significant F-test for EDA ($F(1, 263) = 4.013$; $p = 0.046$). Simple contrast revealed that non-controlling participants experienced significantly lower EDA than controlling participants ($p = 0.046$; $t = -2,003$; C.I. = [-9.719; -0.084]). Moreover, the F-test for cognitive load was statistically significant ($F(1, 263) = 9.439$; $p = 0.002$), non-controlling participants experienced significantly lower cognitive load than controlling participants ($p = 0.002$; $t = -3.074$; C.I. = [-0.272; -0.060]). However, the F-test for emotional valence was non-statistically significant.

Regarding the other factors, all MANCOVAs were non-statistically significant for display sharing, pre-agreement, and all two-way interactions except pre-agreement * input device control interaction. Despite a non-statistically significant MANCOVA, univariate test was statistically significant for pre-agreement * input device control interaction effect on valence ($F(1, 46) = 4.410$; $p = 0.041$). As depicted in Figure 5.46, this result was materialized by positive influence of pre-agreement on noncontrolling participants' valence, and no influence of pre-agreement on controlling participants' valence.

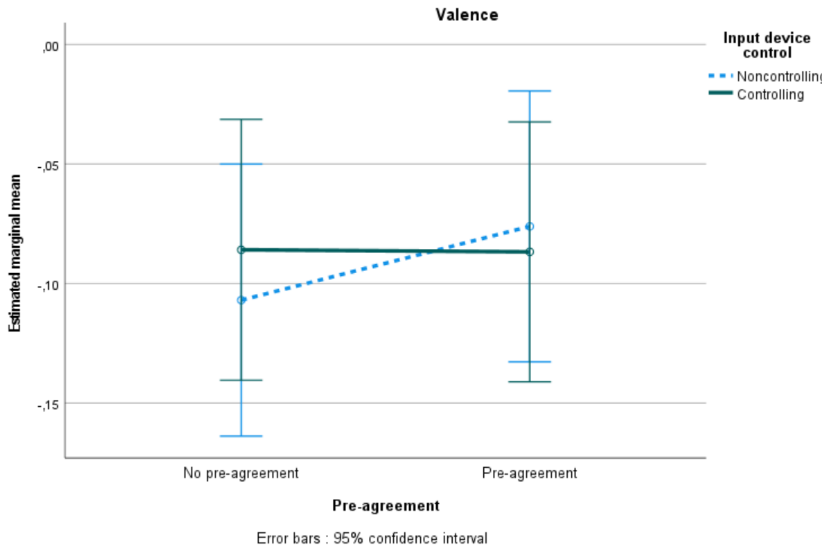


Figure 5.46. Pre-agreement * Input device control interaction.

Table 5.38. Univariate test result.

Independent variables	Dependent variables	df	df (error)	MSE	F-value	p-value
Scrolling	Gaze convergence (**)	1	18	26731.90	8.732	0.008
	EDA	1	27	10.269	2.111	0.158
	Valence (****)	1	46	0.353	25.56	<0.0001
	Cognitive load (****)	1	46	0.717	51.331	<0.0001
	Effort (**)	1	46	9.010	8.420	0.006
	SatisChoice (***)	1	46	23.885	17.893	<0.001
IDC	EDA (*)	1	263	1497.508	4.013	0.046
	Cognitive load (**)	1	263	1.712	9.439	0.002
	SatisChoice (*)	1	263	5.622	4.044	0.045
	SatisRole (***)	1	263	24.595	11.349	<0.001
	Valence	1	263	0.018	0.728	0.394
Display sharing	EDA	1	27	14.271	2.541	0.123
	Valence	1	46	000	0.013	0.908
	Cognitive load	1	46	0.042	2.996	0.090
	Effort	1	46	0.923	0.821	0.370
	SatisChoice	1	46	2.982	3.364	0.073
Pre-agreement	EDA	1	27	1.268	0.24	0.628
	Valence	1	46	0.022	3.950	0.053
	Cognitive load	1	46	0.011	2.246	0.141
	Effort	1	46	0.778	0.883	0.352
	SatisChoice	1	46	1.236	1.264	0.267

(*) = significant at α = 0.05; (**) = significant at α = 0.01; (***) = significant at α = 0.001; (****) = significant at α=0.0001.

Note. IDC = Input device control; Effort = Effort for reaching consensus; EDA = Electrodermal activity.

Table 5.39. Contrast results.

IV	DV	Esti-mate	Std Error	t-value	Cohen's d	p-value	95% Confidence interval
Scrolling (No scrolling – scroll)	Gaze convergence (****)	103.393	12.372	8.357	3.940	<0.0001	[77.400; 129.386]
	Valence (****)	0.061	0.012	5.083	1.499	<0.0001	[0.037; 0.085]
	Cognitive load (****)	0.086	0.012	7.167	2.113	<0.0001	[0.062; 0.111]
	Effort (**)	-0.307	0.106	-2.896	0.854	0.006	[-0.519; -0.094]
	SatisChoice (***)	0.499	0.118	4.229	1.247	<0.001	[0.262; 0.737]
IDC (Noncontrolling – Controlling)	EDA (*)	-4.901	2.447	-2.003	0.247	0.046	[-9.719; -0.084]
	Cognitive load (**)	-0.166	0.054	-3.074	0.379	0.002	[-0.272; -0.060]
	SatisChoice (*)	0.300	0.149	2.013	0.248	0.045	[0.006; 0.5494]
	SatisRole (***)	0.628	0.186	3.376	0.416	<0.001	[0.261; 0.995]

(*) = significant at α = 0.05; (**) = significant at α = 0.01; (***) = significant at α = 0.001; (****) = significant at α=0.0001.

Note. IDC = Input device control; Effort = Effort for reaching consensus; EDA = Electrodermal activity.

5.4 Discussion

In this essay, we examine how factors related to system, dyad, and users influence user's joint IT use experience. Adopting an inductive perspective in this research in online shopping context, we found several emerging relationships between the manipulated factors and user experience-related constructs, based on explicit and explicit measures. The two types of measures provide complementary insights, respectively reflecting users' perceived experience and their psychophysiological experience.

5.4.1 Findings

We found significant differences in couple gaze behavior between the two types of interface. Specifically, participating couples' gaze convergence was the highest when they jointly shopped using the interface with no scrolling capabilities, the effect size of webpage scrolling being very large (Cohen's d = 3.940) (high effect size refers to Cohen's d values around or greater than 0.8, while medium effect size reflects Cohen's d value between 0.2 and 0.8, and low effect size reflects Cohen's d values lower than 0.2 (Cohen, 1988)). Clearly, vertical scrolling hampered couples' ability to coordinate their visual interests on their screen, compared to non-scrollable system interfaces. A possible reason may be that because webpages with no scrolling capabilities displayed products at fixed locations on the screen, it was easier for non-controlling users to visually follow their partner during collaboration. When jointly interacting with webpages with vertical scrolling, non-controlling users perhaps had harder time visually following their partner's actions on the screen, especially when the latter scrolled to other products without notifying their non-controlling counterpart. Moreover, as suggested by our findings, in the presence of webpage scrolling, it took significantly more effort for couples to find consensus over decisions to take during shopping tasks. Specifically when in separate displays, because in condition with no scrolling participants viewed the same product display throughout an experimental task, coordination of their actions was likely not hampered by separate or any asynchronous interface scrolling by participants. Besides, our results suggest that the absence of scrolling feature in webpages was associated with higher individual satisfaction with joint product choices. Hence, the absence of scrolling favored alignment of decisions within participating couples, perhaps by promoting couples' ability to jointly keep attention on products of interest. For instance, vertical scrolling by controlling users hid displayed products by hiding other products that may have been of interest to noncontrolling users, not easing couples' discussions about hidden items. Other findings suggest that participants physiologically experienced significantly higher emotional valence when jointly shopping using the platform with no scrolling. Hence, with no scrolling, participants experienced higher positive affect and were likely happier with their joint shopping experience. These results are in line with HCI literature that suggests that infinite scrolling is not good for goal-oriented tasks in which users need to compare different options or locate specific content in lists of items (Sharma and Murano, 2020; Loranger, 2014), as is the case during joint online shopping by couples. Hence, jointly shopping online through webpages with scrolling capability presented multiple additional drawbacks related to collaboration. In addition to the aforementioned, scrolling adds a need for coordination of visual behavior of the two partner users, generates less user positive affect, increases the complexity of finding consensus, and reduces user satisfaction.

Our results on the influence of interface scrolling also suggest that participants physiologically experienced higher cognitive load when shopping using system interface with no scrolling capability. As interface scrolling hampered couples' ability to coordinate their gaze behaviors, it is likely that lower discussions over products took place, hence limiting product buying decision-related information processing. Yet, as mentioned in the previous paragraph, in the absence of interface scrolling capability, we observed higher gaze convergence, meaning that couples looked more consistently to same locations in the screen and more discussion and information processing was likely to happen, generating higher participants' cognitive load.

Other findings suggest that noncontrolling participants were more satisfied with joint product choices (Cohen's d = 0.248) than controlling participants. Moreover, as per significant interaction shown in Figure 5.46, pre-agreement moderated the influence of input device control on emotional valence such that in condition with no pre-task agreement, noncontrolling participants experienced less emotional valence than controlling users; but when couples agreed on product preferences prior to performing tasks, noncontrolling participants experienced higher emotional valence than controlling participants, while controlling users' emotional valence was the same, whether in no pre-agreement or in pre-agreement condition. Hence, agreeing prior to performing joint tasks improved noncontrolling participants' valence, which may have contributed to their satisfaction with joint product choices.

Further findings suggest that noncontrolling participants experienced lower cognitive load (Cohen's d = 0.379) and lower EDA (Cohen's d = 0.247) than controlling participants. In other words, noncontrolling participants were generally less cognitively loaded and less physiologically activated than controlling participants, but the two groups experienced similar emotional valence overall. These observations evidence that noncontrolling participants were likely more serene, as they did not bear the responsibility of performing every single on-screen action when in the shared display configuration. Because controlling users were responsible for performing on-screen action, they were more likely than noncontrolling users to cognitively process visual information on system interface. This point is aligned with the fact that noncontrolling participants reported higher satisfaction with their role during joint tasks in the shared display condition, with medium effect size (Cohen's d = 0.416). Arguably, it is likely that they to some extent didn't dislike not having to manage direct interactions with system interface and not directly coping with possible constraints or issues related to direct use

Based on our findings, our study sample did not allow to conclude on direct influence of display sharing on gaze convergence, EDA, cognitive load, effort for reaching consensus, and satisfaction with joint product choice. Likewise, we could not conclude on direct influence of pre-agreement on the same dependent variables. Moreover, we could not conclude on two-way interactions, except for significant moderation of input device control's influence on emotional valence by pre-agreement. More statistical power is needed in order to clarify these relationships.

5.4.2 Implications and future directions

As evidenced by our findings, system design may significantly influence joint IT use experience. Concerning the interface scrolling feature, researchers should consider its impact when choosing IT stimuli during empirical research, as this feature may alter dyadic dynamics during joint IT use. Arguably, this impact may hinge on the nature of products or services for joint shopping activities or on the way visual items are laid out within system interface. Our experimental study involved participants jointly shopping for products whose visual details are important, such as electronic devices or house furniture (see Table 5.33). This type of products or services may be prone to much discussion over each detail, and these discussions may be vulnerable to information scrolling by controlling user (in shared display setups) or to asynchronous scrolling by two users in separate displays setups. Conversely, for services whose visual details are likely to be considered not important, such as car insurances usually proposing long agreement contract that are difficult to read attentively, perhaps scrolling feature would not impact dyadic visual coordination. Future research may investigate the role of scrolling feature in this latter context. Furthermore, IT designers should be mindful about possible adverse effect of interface scrolling, as it may degrade users' ability to coordinate, generate negative emotions, increase difficulty in joint decision making, and decrease user satisfaction. Clearly, we recommend for goal-oriented IT-enabled tasks involving visual details likely to grab user dyad attention, that system designs with no scrolling be considered. Future research may consider the role of scrolling feature on other types of IT-enabled tasks. Since the present study focused on interface vertical scrolling another research avenue is to examine the role of horizontal scrolling system feature in a joint IT use context. Horizontal scrolling's impact may be compared to impact of vertical scrolling feature and absence of scrolling feature, to generate further insights about how optimal joint IT use may be generated. Corresponding findings may be positioned vis-à-vis past studies' suggesting mitigated impact of horizontal scrolling feature relatively to vertical scrolling (Sharma and Murano, 2020; Kim et al., 2016). Future research may also investigate other system design patterns' influence on dyadic system use.

This study's results may have several implications for theory and practice. The emerging relationships among the investigated constructs represent a ground to inform future IS research related to joint IT use. The input device control factor appears to be an important construct to explain the phenomenon of study. As evidenced by our findings, sharing system interface display may hinder the quality of joint use experience of users who directly interact with system interface, by making them less satisfied with their role in the joint task than they would if they did not control direct on-screen actions; this consideration is in line with the fact that noncontrolling users may be more serein than controlling user in that setting. Clearly, joint use experience should not be examined solely at collective level. Considering individual level emotions, cognitions, and behavior would contribute to explaining variance in endogenous constructs by considering a variety of differences in partner users. Future studies may examine the difference in attention and engagement of noncontrolling users in shared display compared to separate displays, to generate insights explaining the more serene state we observed of noncontrolling users compared to controlling users in shared system display setting. Noncontrolling user attention can be captured using eye-tracking measures such as fixation duration, fixation count, time to first fixation, and total visit duration, as mentioned in section 5.2.1 (Riedl and Léger, 2016; Djamasbi, 2014; Holmqvist et al. 2011). Besides, IS practitioners should consider the influence of one user controlling input devices alone during joint IT use. System designers may incorporate a joint use mode in system architectures. This mode could involve recommendations in system windows at different times during joint system use. Example of recommendations include system advices to users to consider switching mouse control. Joint use mode may also involve allowing users or forcing them to switch mouse control during tasks. A compulsory switch of control may be implemented using a mouse with fingerprint reader, which would identify controlling users.

The present research also highlights the importance of settling goal-oriented disagreements prior to engaging in joint system-enabled tasks. Such pre-task agreement may increase noncontrolling user satisfaction about joint decisions taken during joint tasks. Future research may investigate further dyadic states of importance to joint IT use phenomenon, including dyad-level antecedents, mechanisms, and consequences of dyadic joint IT use. Moreover, referring to aforementioned joint use mode in IT systems, system designers may incorporate pre-task agreement modules allowing user dyads to find consensus about specific identifiable goals. For example in e-commerce, systems may allow user dyads to agree on product preferences prior to engaging in joint shopping tasks.

Finally, our study was done with user dyads, specifically couples, in the e-commerce context. Future research may investigate joint IT use in laboratory in other contexts, hedonic as well as professional. As other avenues of research the joint IT use phenomenon may be further investigated with three or more users. For example it may be interesting to examine how groups of students use IT systems in order to improve group learning.

5.4.3 Contributions to IS literature

The present essay has multiple contributions. First, we add to the IS literature by investigating a seldom-studied though important phenomenon, joint IT use, filling an important gap in IS research, which has been heavily focused on individual use of IT systems in an isolated way. Second, our study contributes methodologically, as it is one of the very first empirical illustrations in the IS literature of exploitation of the synchronized dual eye-tracking technique to examine IS phenomena. Third, our findings add to knowledge about the influence of dyadic state-related, system setup-related, and system design-related constructs on user joint use experience. Fourth, we empirically examine an IT use phenomenon in laboratory setting, while users perform IT-related tasks. This approach adds to the more common perspective in IT use literature that consist in examining IT use nomological network outside of user's actual or real-time use of IT systems. Fifth, our study provides insights about differences in user experience generated by joint IT-related task performance between using a shared system display and using separate system displays. Sixth, in addition to the generally used self-reported measures, we leverage psychophysiological techniques, including eye-tracking, galvanometry, and automatic facial analysis to enrich our research, in accordance with previous calls to more research exploiting the potential of psychophysiological tools to inform IS research (e.g., Dimoka et al., 2012; Dimoka et al., 2011). Seventh, our research contributes to system usability research by evaluating a system design feature, webpage scrolling, and providing practical recommendations for system design improvement.

5.5 Conclusion

Our objective in this essay was to investigate dyadic joint IT use to generate insights about related user experience and examine how system design features can influence such experience. We did an explorative empirical study in laboratory setting. The study involved couples jointly shopping online together through shared system displays and shared system display (with only one user controlling input device when sharing system display), using system with scrolling feature and system with no scrolling capabilities, and agreeing or not over joint product preferences prior to shopping tasks. We used explicit and implicit measures at individual level and couple level. Our findings suggest that dyadic agreement prior to joint tasks is beneficial for users with no input device control, and interface vertical scrolling feature has a detrimental effect on dyadic visual coordination, individual emotional valence, required effort in joint decision-making, and satisfaction with joint decisions. Results also showed higher serenity for users not controlling input devices than for those controlling. Our study is one of the first IS research works illustrating the synchronous dual eye-tracking technique and one of a few IS studies on IT use that investigate joint IT use by user dyads. It is also one of the few IT use studies capturing use-related dynamics happening during actual system use, that is, while users perform IT-related tasks. This essay presents contributions and presents several implications for theory and practical recommendations to IS researchers and to IT designers aiming at improving joint IT use experience. We hope that our study will pave the way for future HCI and IT use research on the phenomenon of joint IT use by two or more users.

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Thesis Conclusion

Group processes and more specifically dyadic processes are more than ever driven by digital transformation happening in most areas of the modern society. A lot of activities that were performed by two or more persons are henceforth digitalized, involving multiple users jointly interacting with a system interface. Addressing the lack of insights about this phenomenon in the IS literature, the objectives of this thesis were 1) to propose insights for the conceptualization of joint IT use and a framework for examining this construct, 2) to demonstrate the importance the joint IT use phenomenon, and 3) to empirically study mechanisms through which users jointly interact with system interfaces. The thesis' essays represent complementary stories on the topic, which has been shown to be important (Tchanou et al., 2020). They capture settings at system, task, and group levels in which individuals jointly use systems, mechanisms emerging from joint use activities, and resulting impacts.

As IS research works focussing on the joint IT use perspective are seldom, in Essay 1 we proposed an analysis framework that can guide ideation in future research. The framework showcases three layers that are inter-related through an inputs-mechanisms-outcomes-inputs feedback loop pattern, drawing from reference group dynamics literature (e.g., Maynard et al., 2015; Uitdewilligen, 2011; Uitdewilligen et al., 2013; Marks, 2001). The input layer encompasses initial conditions in which joint IT use takes place, including system, task, individual, group, and organizational characteristics, as well as system-based, task-based, and collaboration-based triggers. The mechanisms layer includes emerging configurations of individual-level emotions, cognitions, and behaviors and their associated group-level constructs, along with system behaviors emerging from collaboration. This layer showcases bidirectional relationships between individual-level, group-level, and system-level constructs. The outcome layer showcases consequences of joint IT use mechanisms. This layer in turn may influence the input layer. In addition to the joint IT use analysis framework, we developed a typology made of seven types of conceptualization of joint IT use, each of them hinging on user, system, and task pillars at individual or collective level. This typology presents different perspectives for investigating joint IT use.

In Essay 2, we identified different settings and patterns of online shopping in couple. In addition, we provided key insights about the extent to which the activity is performed in the U.S.A., suggesting that most couples jointly use online shopping platforms to a significant extent, and that they do so using a variety of devices and ergonomic layouts and in a variety of physical locations relative to each other.

In Essay 3, we theoretically and empirically investigated dyadic joint IT use in the e-commerce context. We developed a model showcasing how initial conditions of joint IT use, including system setting and dyadic pre-task agreement, influence user behavioral intention, through the full mediation of dyadic conflict emerging during joint activity, which is in turn partially mediated by effort required and time required for reaching consensus.

In Essay 4, we examined the use of implicit measures, that is, measures users are unaware of during their activities (Riedl and Léger, 2016) to increase understanding of joint IT use. We addressed feasibility of simultaneous and synchronous collection of eye-tracking data from a dyad of users while they jointly interact with a system interface, a technique called *synchronous dual eye-tracking*. Moreover, we developed a model explaining how the extent to which a dyad of users look at the same location in a system display, which we call *gaze convergence* (GC), influences cognitive load and performance. Providing a conceptual definition of the GC construct, we proposed a new index for measuring the construct. We tested the GC index through two consecutive laboratory experiments involving synchronous dual eye-tracking, and we performed GC construct validation.

In Essay 5, we exploratively investigated dyadic joint IT use in the e-commerce context through a mixed-method laboratory experiment in which couples jointly shopped together in different conditions including agreement or no agreement prior to tasks, system interface with or without scrolling feature, and separate system displays or shared system display with one user controlling input devices. Leveraging psychometric (i.e., explicit) measures along with psychophysiological (thus implicit) measures, the essay unveiled new emerging relationships among constructs, suggesting factors and consequences of joint IT use experience.

Theoretical contributions

This thesis has several theoretical contributions. In Essay 2, we provided empirical justification of why IS researchers should investigate and develop understanding of the joint IT use perspective. We also gave some insights about possible orientations of such research. Essay 1 provided theoretical ground for the investigation of the phenomenon of study. The proposed perspective responds to past calls for more consideration of not only direct IT use (i.e., user's direct interactions with system interface) but also dynamics surrounding IT use, including IT use-related events and indirect IT use through collaboration, in a multilevel standpoint (Zhang and Gable, 2017; Burton-Jones and Gallivan, 2007; Barki et al., 2007). We exemplified the perspective by empirically investigating the impact of user dyad GC on cognitive load (Essay 4), antecedents and consequences of dyadic conflict, effort required, and time required for dyadic consensus during joint IT use, and the impact of system design features, pre-task dyadic agreement, system display sharing, and input device control on joint IT use experience (Essay 3 and Essay 5). I addition, the typology we proposed in Essay 1 is, to the best of our knowledge, among the very first multilevel typologies of conceptualization of joint IT use. It may contribute to clarifying specific contexts in which IT use is studied in a multilevel fashion. Besides, the joint IT use framework we proposed in Essay 1 provides a structured view for the study of mechanisms of joint IT use, their antecedents, and their outcomes. This framework is generic and can apply to a diverse set of contexts, including hedonic and utilitarian. In addition, it can be used to investigate joint use of different types of IT systems by two or more users.

Our findings contribute to the understanding of how user dyads jointly interact with IT systems and what factors may drive their resulting experience, including emotions, cognitions, and behaviors. Essay 2 revealed that couples jointly use online shopping systems to a great extent and in diverse settings, including multiple types of device setups, different ergonomic layouts, and multiple physical locations relative to each other, to shop for a diverse set of product categories (i.e., products from different industries). Moreover, Essay 3's findings position dyadic conflict as a central construct that deserves further attention in joint IT use research, as it fully mediated the influence of device setup (i.e., sharing display or not) on user behavioral intention. In couple online shopping context, we found that users perceive higher dyadic conflict when sharing the same system interface display during joint shopping. In addition, they perceive higher dyadic conflict when they do not control input devices. Besides, we found that subdimensions of dyadic conflict, including cognitive, affective, behavioral conflict, and interest conflict, taken together, significantly explain the phenomenon of study; but each of the first three subdimensions plays similar and significant but weaker roles than the higher-order construct. Essay 3 also highlights the importance of dyadic agreement prior to IT task, which we found negatively influences dyadic conflict. We also found that dyadic conflict negatively influences user intention to continue, through the partial mediation of required effort and time for dyadic consensus, respectively. These findings illustrate multilevel influences explaining joint IT use phenomenon. On another hand, we conceptualized the GC construct in Essay 4 and developed and validated an index to measure it. This construct and its proposed index can be used to empirically investigate the nomological network of joint IT use, for instance, to examine antecedents and consequences of user dyads' gaze behavior during joint IT use activities. Moreover, our findings in Essay 4 suggest that GC explains significant variance in users' cognitive load and dyadic performance during joint IT-enabled tasks. Clearly, GC plays a significant role in the mechanisms through which user dyads jointly interact with system interfaces. Furthermore, Essay 5 implemented a complementary approach to Essay 3's field experiment by capturing joint IT use-related data while user dyads jointly use a system, in laboratory setting. It also exploited psychophysiological measures users are unaware of, to explain how dyad-related, system setup-related, and system design-related factors influence joint IT use experience.

Practical contributions

On a practical point of view, this thesis can be instrumental to IS researchers and practitioners. Essay 2 shows, through a snapshot of couple online shopping in the U.S.A., that joint IT use is an important phenomenon address. Our findings pose a call to system designers and marketing practitioners to foresee e-commerce solutions that address use cases involving user dyads. Moreover, based on Essay 3's findings, we provided several recommendations to IT practitioners for system design that generates not only better single-user experience but also better joint use experience, which may promote better adoption of an IT system (Fadel, 2012), particularly e-commerce systems. As sharing system display is likely to generate dyadic conflict, when systems are prone to be jointly used by user dyads, their architecture may incorporate *co-navigation* features based on a *split-screen design*, which divides system interface so that users can each control their navigation while monitoring their partner's; a *location cue design*, which provides separate control to each user and visual cues indicating where in the website their partner is currently navigating; or a *shared view design*, which provides identical interface display to both users (Yue et al., 2014). We suggested that shared view design may be enhanced by permitting simultaneous and asynchronous actions within system interface by each dyad member. Moreover, when systems must be used with identical interface display for the two users, operating systems may implement *dual-control mode* providing asynchronous input device control to both users. Furthermore, still to mitigate impact of display sharing on dyadic conflict, system designers may leverage *eye-tracking* technology to display location cues indicating a noncontrolling user's gaze within system interface, to allow controlling user to be aware of their partner's visual interest in the system in real-time, in order to facilitate users' initiatives mitigating interest conflict. Essay 3 also suggested that dyad agreement prior to joint IT task is desirable, as it is likely to prevent or limit dyadic conflict. We recommended and described a design pattern that incorporates a joint-use mode in which dyad members may optionally or mandatorily agree on task objectives through an agreement interface before proceeding with the joint IT-enabled task. Furthermore, Essay 5 practical contribution complement Essay 3's in that it recommends joint use modes to address drawbacks of not controlling input devices, of display sharing, and of no pre-task agreement; but Essay 5 also evaluated system interface scrolling as a design feature and does not recommend it in joint use context, especially for goal-oriented tasks in which item visual details are important.

This thesis also has methodological contribution. To the best of our knowledge, Essay 4 and Essay 5 are among the first IS studies to measure and validate GC based on gaze data collection using a *synchronized multi-eye-tracking* methodology, and they are among the first studies in the IS literature to empirically investigate this technique. Our gaze convergence index can be used for practical applications. Our methodological setup permits to exploit real-time GC information generated using synchronized gaze data. Hence, the GC index we proposed can be used to display real-time gaze convergence-related visual cues to dyad members during joint IT-enabled tasks, which may improve collaboration performance (Nyström et al., 2017; Kwok et al., 2012; Litchfield and Ball, 2011).

Research avenues

All in all, this thesis puts forward the importance of the joint IT use phenomenon and poses a call for more research on the topic in IS research. As one of the first few efforts in that direction, the thesis proposes theoretical insights that may contribute to generating more understanding of antecedents, mechanisms, and consequences of joint IT use. The typology of joint IT use conceptualizations we proposed in Essay 1 may contribute to future research by guiding researchers in clarification of the single-level or multilevel conceptualization of IT use-related constructs in line with different research contexts and questions. Moreover, as our empirical studies (Essay 3 and Essay 4) are focused on a variance views of joint IT use mechanisms, future studies may examine this dynamic in a process perspective. Process approaches would bring insights about change processes based on chains of events and about time ordering of participating entities (Poole, 2000).

Taking special interest in user dyads, the thesis provides theoretical, empirical, and methodological insights about the phenomenon of study. We hope that this research work constitute a starting point for further theoretical and methodological investigation of this topic. Future research may empirically examine dyadic joint IT use in different contexts, as well as joint IT use by more than two users (e.g., studying IT-enabled teamwork or group training). Researchers may also investigate specificities of joint IT use related to different types of system setting such as those we presented in Essay 1 (section 1.2.1). For example, studying joint use of a system in a *single interface with synchronous display* setting might expose different challenges than studying the phenomenon with a system in the *single interface with asynchronous display* setting. In the former setting, only one user usually controls input devices and the other user indirectly interacts with the system, while in the latter setting, all users have more control. Furthermore, Essay 2 provides a picture of the extent of joint system use practice, and Essay 3 tests the model we propose, both in the online shopping context. Notwithstanding, we developed research framework and research models with a broad perspective that can apply to other contexts. Hence, future work on the topic may address our research questions in other contexts, including hedonic and utilitarian. For example, researchers may apply our research models to multiplayer video gaming as well as to the investigation of how coworkers jointly use enterprise systems and resulting individual and group performance.

In line with the Activity Theory, which suggests that activities can be best studied while they happen (Kaptelinin, 1996), in Essay 3 and Essay 4, we developed models depicting constructs manifesting while user dyads perform joint tasks. Other studies may take other approaches based the Theory of Reasoned Action paradigm (TRA) (Fishbein and Ajzen 1975) to examine factors driving user adoption of a technology based on user cognitive beliefs about not only technology itself but also IT-related activities including collaboration during joint system use. This perspective presents significant opportunities for either extending existing models of technology acceptance aligned with the TRA paradigm (Venkatesh et al., 2016; Venkatesh et al., 2003; Davis, 1989) or developing new multilevel or group-level models of technology acceptance (e.g., Sarker et al., 2005).

The synchronous dual-eye-tracking technique we used in Essay 4 and Essay 5 facilitates data processing, as it removes the burden of manually synchronizing gaze data after data collection. Researchers may use this methodology to empirically study joint IT use mechanisms related to dyad-level (or more generally group-level) constructs. For example, future studies may examine the influence of differences in attention within user dyads or groups on group performance, during joint IT tasks in group work or group training contexts. IS researchers may also investigate other methodological opportunities for synchronized dual recording of psychophysiological data from dyads during joint interactions with a system, including automatic facial analysis (AFA), electrodermal activity (EDA), and electroencephalography (EEG), three of the main psychophysiological tools for collecting implicit measures. For example, *hyperscanning*, a method for acquiring brain data of two or more participants simultaneously during interactive group activities and relate these data (Barraza et al., 2019; Hemakom et al., 2018), can be used based on AFA, EDA, and EEG data (e.g., Stone et al., 2019; Hu et al., 2018) synchronously collected from groups of users during joint interactions with IT system interfaces.

The present thesis' several theoretical and practical contributions, along with research perspectives it exposes, can be considered a starting point that may generate important research programs in academia as well as in the IT industry. Hence, we anticipate that the significant knowledge generation potential in the still understudied joint IT use topic will be a source of new generations of not only IT systems fostering better joint IT use experience but also users-system-processes sociotechnical dynamics promoting better individual, group, and organizational performance.

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Appendix A. Essay 2 pairwise comparisons of bar charts' levels

Table 2.A40. Pairwise comparisons of bar charts' levels (1).

Dependent Variable	Level 1	Level 2	t-value	Adjusted p-value – Holm-Bonferroni
Type of products	Clothing and Fashion	Furniture and Appliances	0.07	1
Type of products	Clothing and Fashion	Groceries	5.79	<0.0001
Type of products	Clothing and Fashion	Travel and Tourism	-6.80	<0.0001
Type of products	Clothing and Fashion	Classified Ads Websites	0.65	1
Type of products	Clothing and Fashion	Art and Shows	5.04	<0.0001
Type of products	Clothing and Fashion	Cars	3.88	<0.001
Type of products	Clothing and Fashion	Computers and Electronics	-3.15	0.03
Type of products	Clothing and Fashion	Leisure Activities	-1.43	1
Type of products	Clothing and Fashion	Paper News and Magazines	7.75	<0.0001
Type of products	Clothing and Fashion	Real Estate	4.01	<0.001
Type of products	Furniture and Appliances	Groceries	5.72	<0.0001
Type of products	Furniture and Appliances	Travel and Tourism	-6.87	<0.0001
Type of products	Furniture and Appliances	Classified Ads Websites	0.58	1
Type of products	Furniture and Appliances	Art and Shows	4.97	<0.0001
Type of products	Furniture and Appliances	Cars	3.81	<0.001
Type of products	Furniture and Appliances	Computers and Electronics	-3.23	0.02
Type of products	Furniture and Appliances	Leisure Activities	-1.50	1
Type of products	Furniture and Appliances	Paper News and Magazines	7.67	<0.0001
Type of products	Furniture and Appliances	Real Estate	3.93	<0.001

Table 2.A.41. Pairwise comparisons of bar charts' levels (2).

Dependent Variable	Level 1	Level 2	t-value	Adjusted p-value – Holm-Bonferroni
Type of products	Groceries	Travel and Tourism	-12.59	<0.0001
Type of products	Groceries	Classified Ads Websites	-5.14	<0.0001
Type of products	Groceries	Art and Shows	-0.75	1
Type of products	Groceries	Cars	-1.91	0.67
Type of products	Groceries	Computers and Electronics	-8.94	<0.0001
Type of products	Groceries	Leisure Activities	-7.22	<0.0001
Type of products	Groceries	Paper News and Magazines	1.96	0.66
Type of products	Groceries	Real Estate	-1.78	0.82
Type of products	Travel and Tourism	Classified Ads Websites	7.45	<0.0001
Type of products	Travel and Tourism	Art and Shows	11.84	<0.0001
Type of products	Travel and Tourism	Cars	10.68	<0.0001
Type of products	Travel and Tourism	Computers and Electronics	3.65	0.01
Type of products	Travel and Tourism	Leisure Activities	5.37	<0.0001
Type of products	Travel and Tourism	Paper News and Magazines	14.55	<0.0001
Type of products	Travel and Tourism	Real Estate	10.81	<0.0001
Type of products	Classified Ads Websites	Art and Shows	4.39	<0.001
Type of products	Classified Ads Websites	Cars	3.23	0.02
Type of products	Classified Ads Websites	Computers and Electronics	-3.80	<0.001
Type of products	Classified Ads Websites	Leisure Activities	-2.08	0.52
Type of products	Classified Ads Websites	Paper News and Magazines	7.09	<0.0001
Type of products	Classified Ads Websites	Real Estate	3.36	0.02

Table 2.A.42. Pairwise comparisons of bar charts' levels (3).

Dependent Variable	**Level 1**	**Level 2**	**t-value**	**Adjusted p-value – Holm-Bonferroni**
Type of products	Art and Shows	Cars	-1.16	1
Type of products	Art and Shows	Computers and Electronics	-8.19	<0.0001
Type of products	Art and Shows	Leisure Activities	-6.47	<0.0001
Type of products	Art and Shows	Paper News and Magazines	2.70	0.10
Type of products	Art and Shows	Real Estate	-1.03	1
Type of products	Cars	Computers and Electronics	-7.03	<0.0001
Type of products	Cars	Leisure Activities	-5.31	<0.0001
Type of products	Cars	Paper News and Magazines	3.87	<0.001
Type of products	Cars	Real Estate	0.13	1
Type of products	Computers and Electronics	Leisure Activities	1.72	0.85
Type of products	Computers and Electronics	Paper News and Magazines	10.90	<0.0001
Type of products	Computers and Electronics	Real Estate	7.16	<0.0001
Type of products	Leisure Activities	Paper News and Magazines	9.18	<0.0001
Type of products	Leisure Activities	Real Estate	5.44	<0.0001
Type of products	Paper News and Magazines	Real Estate	-3.74	0.00
Device	Using one computer	Using two separate computers	1.82	0.11
Device	Using one computer	Using one tablet	9.02	<0.0001
Device	Using one computer	Using two separate tablets	10.96	<0.0001
Device	Using one computer	Using one smartphone	6.59	<0.0001
Device	Using one computer	Using two separate smartphones	-3.85	<0.001

Table 2.A.43. Pairwise comparisons of bar charts' levels (4).

Dependent Variable	Level 1	Level 2	t-value	Adjusted p-value – Holm-Bonferroni
Device	Using two separate computers	Using one tablet	7.20	<0.0001
Device	Using two separate computers	Using two separate tablets	9.13	<0.0001
Device	Using two separate computers	Using one smartphone	4.77	<0.0001
Device	Using two separate computers	Using two separate smartphones	-5.68	<0.0001
Device	Using one tablet	Using two separate tablets	1.94	0.11
Device	Using one tablet	Using one smartphone	-2.43	0.05
Device	Using one tablet	Using two separate smartphones	-12.87	<0.0001
Device	Using two separate tablets	Using one smartphone	-4.37	<0.0001
Device	Using two separate tablets	Using two separate smartphones	-14.81	<0.0001
Device	Using one smartphone	Using two separate smartphones	-10.44	<0.0001
Location	Remotely from each other	Same location - Bedroom	-7.30	<0.0001
Location	Remotely from each other	Same location - Living room	-11.70	<0.0001
Location	Remotely from each other	Same location - Kitchen	1.22	0.89
Location	Remotely from each other	Same location - Yard	6.97	<0.0001
Location	Remotely from each other	Same location - Garage	9.29	<0.0001
Location	Remotely from each other	Same location - Separate rooms	0.21	1
Location	Remotely from each other	Same location - Out of home	1.83	0.40

Table 2.A.44. Pairwise comparisons of bar charts' levels (5).

Dependent Variable	Level 1	Level 2	t-value	Adjusted p-value – Holm-Bonferroni
Location	Same location - Bedroom	Same location - Living room	-4.40	<0.0001
Location	Same location - Bedroom	Same location - Kitchen	8.53	<0.0001
Location	Same location - Bedroom	Same location - Yard	14.27	<0.0001
Location	Same location - Bedroom	Same location - Garage	16.59	<0.0001
Location	Same location - Bedroom	Same location - Separate rooms	7.52	<0.0001
Location	Same location - Bedroom	Same location - Out of home	9.14	<0.0001
Location	Same location - Living room	Same location - Kitchen	12.93	<0.0001
Location	Same location - Living room	Same location - Yard	18.67	<0.0001
Location	Same location - Living room	Same location - Garage	20.99	<0.0001
Location	Same location - Living room	Same location - Separate rooms	11.92	<0.0001
Location	Same location - Living room	Same location - Out of home	13.54	<0.0001
Location	Same location - Kitchen	Same location - Yard	5.75	<0.0001
Location	Same location - Kitchen	Same location - Garage	8.07	<0.0001
Location	Same location - Kitchen	Same location - Separate rooms	-1.01	0.94
Location	Same location - Kitchen	Same location - Out of home	0.61	1
Location	Same location - Yard	Same location - Garage	2.32	0.14
Location	Same location - Yard	Same location - Separate rooms	-6.75	<0.0001
Location	Same location - Yard	Same location - Out of home	-5.13	<0.0001

Table 2.A.45. Pairwise comparisons of bar charts' levels (6).

Dependent Variable	**Level 1**	**Level 2**	**t-value**	**Adjusted p-value – Holm-Bonferroni**
Location	Same location - Garage	Same location - Separate rooms	-9.08	<0.0001
Location	Same location - Garage	Same location - Out of home	-7.46	<0.0001
Location	Same location - Separate rooms	Same location - Out of home	1.62	0.53
Screen layout	Same screen - Same website window	Same screen - Multiple website windows open	10.85	<0.0001
Screen layout	Same screen - Same website window	Separate screens - Same shared website window	7.95	<0.0001
Screen layout	Same screen - Same window	Separate screens - Multiple website window	2.37	0.02
Screen layout	Same screen - Multiple website windows open	Separate screens - Same shared website window	-2.90	0.01
Screen layout	Same screen - Multiple website windows open	Separate screens - Multiple website windows	-8.48	<0.0001
Screen layout	Separate screens - Same shared website window	Separate screens - Multiple website windows	-5.58	<0.0001
Mouse usage	Men	Women	4.86	<0.0001

Appendix B. Essay 3 experimental groups' sample size for excluded responses

Table 3.B46. Excluded responses number per experimental condition.

	Factors: Display sharing / Input device control		
Dyad pre-agreement	**Shared display & Participant controls**	**Shared display & Partner controls**	**Separate displays & Both partners control**
Pre-agreement	Scenario 1: 15.49% (n = 22)	Scenario 2: 13.38% (n = 19)	Scenario 3: 21.13% (n = 30)
No pre-agreement	Scenario 4: 14.79% (n = 21)	Scenario 5: 19.04% (n = 27)	Scenario 6: 16.20% (n = 23)

Note. Total sample size was 142.

Appendix C. Essay 3 measurement scales

Table 3.C47. Manipulation check items.

Manipulated factor	**Manipulation check item**
Display sharing	In this scenario, we shop as a couple using two separate laptops.
Dyad pre-agreement	In this scenario, before even starting the joint online shopping task, we discuss and end up agreeing on the features of the items to look for.
Input device control	In this scenario, I alone control the mouse, the touchpad, the keyboard. My partner depends on me to take on-screen actions.
	In this scenario, my partner and I shop together for a travel package. [(1)]

[(1)]: This element measured whether participants understood what type of product was involved in their experimental condition.

Table 3.C48. Construct items.

Construct	**Items**	**Source**
Cognitive conflict	We would experience conflict of ideas during the online shopping with my partner. During the online shopping, we would often have disagreements about the online shopping we do together. During the online shopping, we would often have conflicting opinions about the task we were doing.	Ma et al. (2017)
Affective conflict	My partner or I would often get angry while doing the online shopping together. My partner or I would often show annoyance during the online shopping we do together. My partner and I would be frustrated shopping online together.	Ma et al. (2017)
Behavioral conflict	During the online shopping done together, my partner and I would often obstruct or interfere with each other's actions. During the online shopping done together, my partner or I would often be uncooperative. During the online shopping done together, my partner would often be unsupportive of my actions, or I would often be unsupportive of his/hers.	Ma et al. (2017)
Interest conflict	Each of us would fight for his/her own benefit during the couple's online shopping.	Ma et al. (2017)

Table 3.C49. Construct items (continued).

Construct	Items	Source
Effort for final consensus	It would be very hard to reach a consensus together on the final buying decision. It would take a lot of effort to agree on the final buying decision.	New scale
Time for final consensus	It would take us much more time than normal to reach a consensus on the final choices. Shopping online together would take much longer under these conditions. Shopping online together under these conditions would be very inefficient in terms of time.	New scale
Intention to continue	I would not intend to continue shopping online with my partner. My intensions would be to continue shopping jointly with my partner rather than any alternative. (1) If I could, I would like to DISCONTINUE shopping online together with my partner.	Bhattacharjee (2001)
Involvement	Shopping online with my partner for vacation packages is very important to me. (1) For me, shopping online with my partner for these products or services does not matter. It is not a big deal if we make a mistake when we jointly shop online for vacation packages. It's hard to make a bad choice when you engage in such online shopping activity together. I can't say that I particularly like shopping online for these products or services with my partner. You can really tell about a person by the vacation packages he or she picks out. (1)	Laurent and Kapferer (1985)
Co-presence	I would hardly notice my partner while we shop online together. I would often be aware of my partner's presence while we shop online together. (1) During our joint online shopping with my partner, I would often feel as if I were all alone.	Kim et al. (2013)

(1): Dropped, as had no correlation with the other items, which were all highly correlated to one another.

Appendix D. Essay 3 manipulation check results

Pretest study 1

Table 3.D50. Pretest study 1 sample's demographics.

		Frequency	Percentage
Age	< 18	0	0%
	18 - 25	19	17.8%
	26 - 35	49	45.8%
	36 - 45	25	23.45
	46 - 55	7	6.5%
	> 55	7	6.5%
Gender	Man	71	66.4%
	Woman	35	32.7%
	Non-binary/Agender/Other	1	0.9%
Household income	< $30,000	15	14.0%
	$30,000 - $59,999	38	35.5%
	$60,000 - $89,000	35	32.7%
	$90,000 - $119,999	11	10.3%
	$120,000 - $149,000	8	7.5%
	>= $150,000	0	0%

Pretest study 2

Table 3.D51. Pretest study 2 sample's demographics.

		Frequency	**Percentage**
Age	< 18	0	0%
	18 - 25	22	19.8%
	26 - 35	54	48.6%
	36 - 45	20	18.0%
	46 - 55	13	11.7%
	> 55	2	1.8%
Gender	Man	67	60.4%
	Woman	44	39.6%
	Non-binary/Agender/Other	0	0%
Household income	< $30,000	9	8.1%
	$30,000 - $59,999	34	30.6%
	$60,000 - $89,000	40	36.0%
	$90,000 - $119,999	22	19.8%
	$120,000 - $149,000	3	2.7%
	>= $150,000	3	2.7%

Full-scale study

Table 3.D52. Descriptive statistics with manipulation check variables – full-scale study's excluded data.

Manip. Check DVs [1]	**IVs**	**Factor level**	**Min**	**Mean**	**Max**	**Standard deviation**
PreAgreement	Dyad pre-agreement	Dyad pre-agreement	1.000	5.592	7.000	1.154
		No dyad pre-agreement	3.000	5.620	7.000	1.005
	Display sharing	Shared display	3.000	5.663	7.000	0.891
		Separate display	1.000	5.509	7.000	1.339
	Input device control	Partner controls	3.000	5.587	7.000	0.979
		Participant controls	4.000	5.744	7.000	0.790
		Both partners control	1.000	5.509	7.000	1.339
DeviceSharing	Dyad pre-agreement	Dyad pre-agreement	1.000	5.254	7.000	1.273
		No dyad pre-agreement	1.000	5.380	7.000	1.428
	Display sharing	Shared display	1.000	5.225	7.000	1.363
		Separate display	1.000	5.472	7.000	1.324
	Input device control	Partner controls	1.000	5.261	7.000	1.290
		Participant controls	1.000	5.186	7.000	1.452
		Both partners control	1.000	5.472	7.000	1.324

[1]: Dependent variable names are those defined in section 3.5.1.1.

Table 3.D53. Descriptive statistics with manipulation check variables – full-scale study's excluded data (continued).

Manip. Check DVs [1]	**IVs**	**Factor level**	**Min**	**Mean**	**Max**	**Standard deviation**
InputDeviceControl	Dyad pre-agreement	Dyad pre-agreement	1.000	3.042	7.000	3.527
		No dyad pre-agreement	1.000	3.493	7.000	3.246
	Display sharing	Shared display	4.000	5.809	7.000	0.928
		Separate display [2]				
	Input device control	Partner controls	4.000	5.739	7.000	0.976
		Participant controls	4.000	5.884	7.000	0.879
		Both partners control [2]				
ProductType	Dyad pre-agreement	Dyad pre-agreement	3.000	5.859	7.000	0.930
		No dyad pre-agreement	3.000	5.732	7.000	1.082
	Display sharing	Shared display	3.000	5.753	7.000	1.003
		Separate display	3.000	5.868	7.000	1.020
	Input device control	Partner controls	3.000	5.87	7.000	0.956
		Participant controls	3.000	5.930	7.000	1.033
		Both partners control	3.000	5.868	7.000	1.020

[1]: Dependent variable names are those defined in section 3.5.1.1.

[2]: The comparison did not make sense, since it is obvious that participants assigned to scenarios picturing joint shopping using separate laptops would likely be confused by a question referring to whether one person alone controls input devices.

Table 3.D54. Manipulation check results – full-scale study's excluded data.

Factors	Comparison	Manip. check dependents variables[1]	Contrast estimate	Std error	p-value	95% Confidence interval
Dyad pre-agreement	PreA – No preA	PreAgreement	0.006	0.183	0.975	[-0.356; 0.358]
		DeviceSharing	-0.101	0.226	0.655	[-0.548; 0.346]
		InputDeviceControl	0.226	0.123	0.069	[-0.018; 0.471]
		ProductType	0.112	0.171	0.516	[-0.227; 0.450]
Device setup	ShdDis - SepDis	PreAgreement	0.132	0.187	0.482	[-0.238; 0.502]
		DeviceSharing	-0.297	0.231	0.201	[-0.753; 0.160]
		InputDeviceControl[2]				
		ProductType	-0.115	0.176	0.517	[-0.463; 0.234]
Input device control	PN - PP	PreAgreement	-0.132	0.231	0.567	[-0.588; 0.324]
		DeviceSharing	0.116	0.284	0.683	[-0.446; 0.678]
		InputDeviceControl	-0.096	0.155	0.536	[-0.404; 0.211]
		ProductType	-0.318	0.216	0.142	[-0.745; 0.108]
	PN - B	PreAgreement	0.068	0.220	0.758	[-0.367; 0.503]
		DeviceSharing	-0.233	0.271	0.392	[-0.770; 0.304]
		InputDeviceControl[2]				
		ProductType	-0.269	0.206	0.193	[-0.676; 0.138]
	PP - B	PreAgreement	0.200	0.222	0.370	[-0.239; 0.640]
		DeviceSharing	-0.349	0.274	0.205	[-0.891; 0.193]
		InputDeviceControl[2]				
		ProductType	0.049	0.208	0.813	[-0.362; 0.460]

(1): Dependent variable names are those defined in section 3.5.1.1.

(2): The comparison did not make sense, since it is obvious that participants assigned to scenarios picturing joint shopping using separate laptops would likely be confused by a question referring to whether one person alone controls input devices.

Note: PreA = Pre-agreement; PN = partner controls; PP = Participant controls; B = Both partners control; ShdDis = Shared display; SepDis = Separate display.

Appendix E. Essay 4 experimental protocol for dual-eye-tracking

This appendix presents the detailed experimental protocol that was followed in the present study once the physical and software infrastructure were deployed. It includes detailed technical setups we performed before, during, and after experimental tasks. These elements demonstrate the feasibility of the present thesis' studies, as well as our mastering of technicalities involved in the methodology based on dual-eye-tracking. The protocol is presented in its original language, that is, in French.

Procédure avant l'arrivée des participants[26]

---

1. Allumer l'ordinateur de la salle d'observation
   1.1. Observer + Media Recorder
2. Allumer les ordinateurs de la salle de groupe
   2.1. SmartEye (2)
   2.2. E-Prime (1)
3. **SmartEye**
   3.1. Allumer les deux ordinateurs SmartEye
   3.2. Double-cliquer sur l'icône « SmartEye Pro » dans chacun des 2 ordinateurs SmartEye pour ouvrir l'application SmartEye Pro.
4. **E-prime**
   4.1. Allumer l'ordinateur E-prime ainsi que les deux écrans de participant
5. Vérifier que TOUS les ordinateurs de collecte sont connectés au serveur NTP
   5.1. Cliquer sur l'heure en bas à gauche > « Modifier les paramètres de la date et de l'heure » > Onglet « Temps Internet » > Serveur 10.10.99.5
   5.2. Ouvrir l'application « NTP Time Server Monitor » dans les ordinateurs SmartEye
   5.3. Redémarrer le service NTP à travers l'application « NTP Time Server Monitor » de chacun des ordinateurs en question.

[26] The experiment's protocol and proceeding were done in French.

5.4. Répéter sur tous les ordinateurs

6. **Observer**

6.1. Sur le bureau, cliquer sur le raccourci Observer XT « 117_Milla ».

6.2. Créer une nouvelle observation avec la nomenclature « obs_117_pXX » (suivre le numéro de participant dans le workflow).

6.2.1. Click droit sur « Observation », puis « New »

6.3. Mettre la syncbox à <u>**120**</u> secondes.

6.3.1. « View Settings » -> Syncbox -> Enable Syncbox pulse

7. **MediaRecorder**

7.1. Sur le bureau, ouvrir le raccourci MediaRecorder « 117_Milla »

7.2. La caméra s’affiche

7.3. Vérifier que la syncbox est visible

7.3.1. Si elle est tombée, appeler Emma ou David.

8. **Camtasia** (ordinateur E-Prime) :

8.1. Ouvrir 177_Milla.tscproj

8.2. New Recording > Full Screen > Camera Off > Audio Off

9. **Questionnaires en ligne sur la tablette :**

9.1. Débrancher et allumer les deux tablettes « Milla1 » et « Milla2 » dans la salle d’observation.

9.2. Ouvrir le questionnaire « Milla_tâche_2 » dans chacune des tablettes

9.3. Entrer les numéros respectifs du participant « pXX » dans chacune des tablettes

9.3.1. Déposer la tablette en veille sur le poste de chaque participant.

10. Préparer les deux formulaires de consentement.
11. Allumer le panneau « Ne pas entrer ».
12. Préparer un chronomètre pour la baseline de 1min30.
13. Fermer la lumière de la salle d’observation.
14. Mettre l’uniforme

Procédure pour l'accueil des participants

15. Accueil des participants

    15.1. *« Bonjour,*

    Je m'appelle XXX. Merci beaucoup de t'être déplacé pour faire cette expérience. Ta participation ici va durer environ 1h30. Nous te remettrons ensuite une carte-cadeau COOP d'une valeur de 30$. L'expérimentation a pour but d'étudier l'utilisation collaborative des technologies de l'information en contexte d'interface partagée. Il te sera demandé d'effectuer des tâches simples basées sur des interfaces conjointement avec ton ou ta partenaire d'utilisation. Si à tout moment tu te sens inconfortable dans l'expérience, s'il-te-plaît préviens nous et nous arrêterons immédiatement l'expérimentation. »

16. Demander de mettre dans une case boucles d'oreille, piercing, lunettes et cellulaire éteint. Demander de jeter la gomme.

17. Amener le participant dans la salle de collecte et fermer la porte de la salle.

18. Énumérer les outils qui seront utilisés aujourd'hui sur chaque participant et lui demander s'il a des questions.

19. Signer formulaire de consentement pour chaque participant.

    19.1. *« Voici un formulaire mentionnant que tu acceptes de participer de ton plein gré à la présente étude. Lis-le attentivement et signe-en les deux copies. Si tu as des questions, tu peux les poser à tout moment; nous t'entendons de l'autre côté de la vitre miroir. »*

    19.2. Attendre que le participant ait fini de lire et signer les deux formulaires de consentement puis retourner dans la salle.

    19.3. Signer les deux formulaires de consentement.

        19.3.1. Si un changement doit être apporté aux formulaires, s'assurer que la modification soit faite sur les deux formulaires et que <u>vous et le participant avez indiqué vos initiales</u> à coté de chaque changement!

19.4. ☐ Mettre un des deux formulaires immédiatement dans le cartable, et donner au participant l'autre copie.

Verbatim : *« Aujourd'hui, tu vas participer à une expérience d'utilisation conjointe d'interfaces avec ton ou ta partenaire. Je t'expliquerai le déroulement de l'expérience plus en détail avant de commencer. »*

20. Poser les questions du session log au participant
21. Assoir le participant ayant la souris (participant A) au poste avec souris, et participant sans contrôle de la souris sur le poste sans souris.
22. Demander aux participants de faire le questionnaire de pré-expérimentation

---

Calibration SmartEyes

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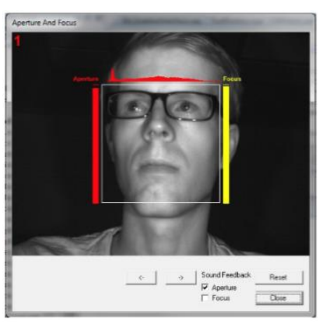
23. **Verbatim** *« Participant [nom du participant] : bien vouloir t'assoir confortablement sur ton siège. Nous allons à présent ajuster les caméras. Bien vouloir fixer regarder l'écran en face de vous »*

23.1. Cliquer sur *Focus* en haut au centre.

23.1.1. Ajuster la première caméra à droite du participant pour que la ligne rouge d'Aperture et la ligne jaune de Focus rejoignent le maximum. Pour ce faire, il faut s'assurer que le visage du participant soit dans le cadre. Ajuster les caméras de façon à ce que son visage soit dans le cadre.



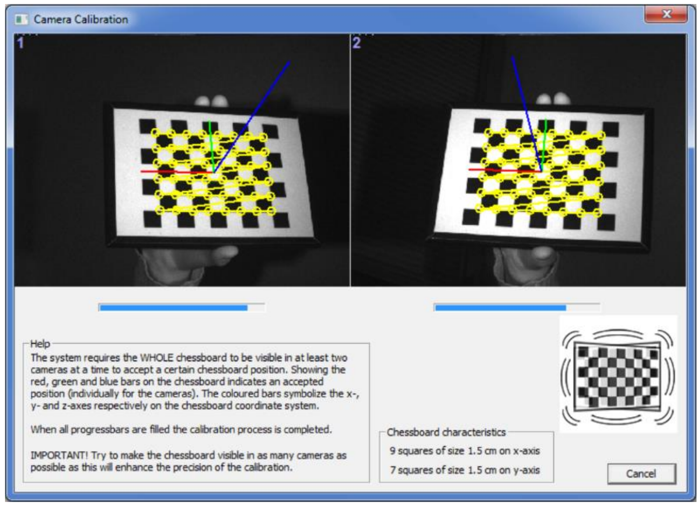
23.1.2. Répéter l'étape 23.1.1. pour la deuxième caméra.

23.1.3. Cliquer sur Close.

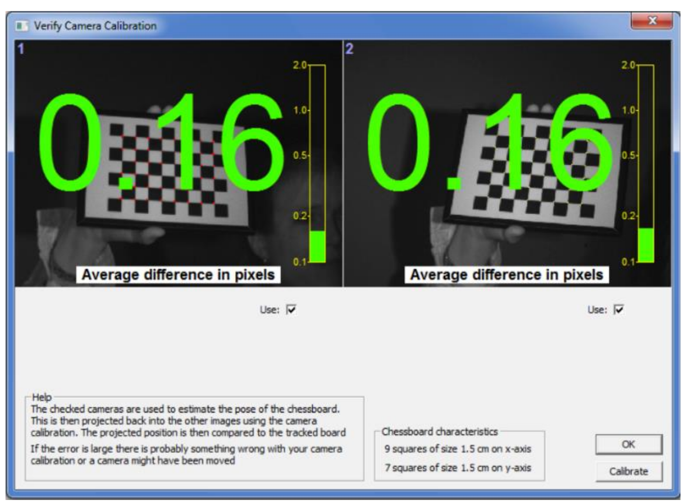
24. *"Nous allons à présent calibrer les caméras. Nous allons poser un tableau carrelé devant votre face pendant quelques secondes »*

24.1. Cliquer sur *Calib* en haut au centre.

24.1.1. Positionner le Chessboard devant le visage du participant.



24.1.2. Bouger et incliner dans toutes les directions le Chessboard jusqu'à ce que la calibration des caméras soit complétée (des chiffres apparaîtront en vert à l'écran).



24.1.3. Cliquer Ok.

25. Cliquer sur *Track* en haut à gauche.

26. Cliquer sur *Gaze* en haut au centre.

26.1. **Verbatim** *« Nous allons procéder à la calibration de l'oculomètre. Bien vouloir suivre mes instructions et bouger tes yeux uniquement quand je te le* *demanderai. Il est important que tu ouvres les yeux aussi grands que possible durant la calibration. Les points de calibration vont apparaître dans un ordre particulier et tu devras fixer du regard 9 points au total, l'un après l'autre*. » (montrer au participant l'ordre pour qu'il sache où regarder pendant la calibration –Ordre : le premier point est en haut à gauche, en haut au centre, en haut à droite, au milieu à gauche, en plein centre de l'écran, au milieu à droite, en bas à gauche, en bas au centre, en bas à droite).

26.2. Cliquer sur Screen1.C1.

26.3. Dire au participant de *« Bien vouloir fixer du regard le point violet»* et cliquer sur *Train*.

26.4. Répéter les deux étapes précédentes (26.2. et 26.3) pour les huit points restants.

26.5. Cliquer sur *Calibrate*.

26.6. Cliquer sur Screen1.C1 et vérifier que les points verts, des deux yeux, sont au centre de leur cible respective.

26.6.1. Si les points verts sont au centre des cibles, OK.

26.6.2. Si les points verts ne sont pas au centre de chaque cible cliquer sur Clear pour chaque mauvais point et répéter les étapes 26.2., 26.3..

26.7. Répéter l'étape 26.6. pour les huit points restants.

26.8. Cliquer sur *Calibrate*.

26.9. Cliquer sur Ok.

27. **Verbatim pour le deuxième participant (participant B):** *« Participant [nom du participant] : Avant de commencer la tâche, je vais continuer la calibration de mes outils sur ton poste. Je vais devoir ajuster tes positions assises au besoin »*
28. Effectuer la calibration SmartEye pour le participant B.

Procédure pour débuter l'expérience

---

29. **Verbatim** *« Je dois d'abord démarrer mes outils, ça ne sera pas long. »*
30. **ObserverXT :**

30.1. Vérifier que la syncbox soit bien réglée à 120s. Ne pas cliquer sur OK mais plutôt cliquer sur « Cancel » pour fermer la fenêtre.

31. **Media Recorder :**

 31.1. Les 3 caméras s'affichent.

 31.2. On voit la syncbox.

32. <u>GO ! : Lancer l'observation dans Observer XT</u>
33. S'assurer que Media Recorder a démarré l'enregistrement.
34. S'assurer qu'Observer XT a démarré l'enregistrement.
35. **Camtasia :**

 35.1. Cliquer Record

36. **SmartEye**

 36.1. Partir enregistrement pour participant 1

  36.1.1. Créer le "Log file" en cliquant sur « log file » (dans la barre d'outils), et sauvegarder le « log file ». Puis cliquer sur le bouton "Log" pour démarrer l'enregistrement des regards.

 36.2. Partir enregistrement pour participant 2 de la même manière.

Première partie : Tâche 1

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37. **Verbatim**: « *Nous allons maintenant commencer l'étude. Cette première tâche consistera à suivre du regard un cercle mobile à l'écran, en deux temps. Des instructions s'afficheront à l'écran avant la tâche. Nous vous demandons de les lire et de procéder à la tâche seulement lorsque vous avez tous les deux fini de lire les instructions. Dans un premier temps, il vous sera demandé à tous les deux fixer le cercle **bleu** mobile en tout temps, ignorant le cercle rouge. Pour commencer, je vous demande à tous les deux de fermer les yeux. À mon signal dans quelques instants vous ouvrirez les yeux pour commencer la tâche.* »
38. Dans l'ordinateur E-prime, double-cliquer sur l'icône de l'exécutable E-prime nommé «117_Milla »

39. *À la fin de cette première tâche, dites :*

« Nous vous demandons de lire les autres instructions à l'écran. À mon signal vous regarderez l'écran pour attendre le nouvel affichage des deux cercles, puis vous appuierez la touche « espace » sur le clavier. Le ***participant A*** *(contrôlant la souris) fixera à nouveau le cercle* ***bleu*** *mobile, tandis que le* ***participant B*** *(sans contrôle de la souris) fixera plutôt le cercle* ***rouge*** *mobile »*

Tâche 2:

---

40. **Verbatim**: « *Nous allons maintenant commencer la deuxième partie de l'expérience. Il est important de bien lire les instructions à l'écran. Nous vous demanderons de collaborer pour choisir la bonne réponse à la question qui vous sera posée suite aux différentes présentations d'images. Il est important que la décision soit prise ensemble. Attendez mon signal pour appuyer sur la touche « espace » et lire les instructions. Pour chaque exercice, après avoir choisi une réponse commune, vous répondrez chacun séparément à une question dans la tablette qui est posée près de vous.»*
41. <u>Vérifier la qualité de toutes les données à travers l'expérience.</u>
42. **Questionnaires en ligne sur la tablette :**
    - 42.1. Ouvrir le questionnaire « 117_Milla_tâche_2 » dans chacune des tablettes
    - 42.2. Entrer les numéros respectifs du participant « pXX » dans chacune des tablettes
        - 42.2.1. Déposer la tablette en veille sur le poste de chaque participant.

Tâche 3:

---

43. **Questionnaires en ligne sur la tablette :**
    - 43.1. Ouvrir le questionnaire « Milla_tâche_3 » dans chacune des tablettes
    - 43.2. Entrer les numéros respectifs du participant « pXX » dans chacune des tablettes

43.2.1. Déposer la tablette en veille sur le poste de chaque participant.

44. **Verbatim**: « *Nous allons maintenant commencer la troisième et dernière partie de l'expérience. Ensemble, il vous sera demandé de parcourir des offres de films dans l'objectif fictif d'en visionner un ensemble. Vous devrez alors ensemble décider du film à regarder ensemble. Votre temps de choix est limité. Vous ferez ensuite votre choix en répondant à une question à l'écran. De plus, il vous sera demandé vos impressions par rapport au choix fait ensemble. Ainsi, dans la tablette vous répondrez à 2 questions après chaque choix de film fait ensemble. Les questions seront les mêmes après chaque choix de film fait ensemble. Lisez les instructions et presser sur la touche 'espace' uniquement lorsque vous êtes prêts tous les deux.* »
45. <u>Vérifier la qualité de toutes les données à travers l'expérience.</u>
46. **Questionnaires DE FIN en ligne sur la tablette :**
    46.1. Ouvrir le questionnaire « Milla_Fin » dans chacune des tablettes
    46.2. Entrer les numéros respectifs du participant « pXX » dans chacune des tablettes
        46.2.1. Déposer la tablette en veille sur le poste de chaque participant.
47. Dites : « Les tâches sont à présent terminées. Nous vous demandons à chacun de remplir le questionnaire de fin sur votre tablette. Une brève entrevue suivra. »

Entrevue de fin

---

48. Conduire l'entrevue avec chacun des participants, en prenant des notes écrites.

Pour fermer les outils (après l'entrevue) :

---

49. **Observer XT:**
    49.1. Stop observation.
    49.2. Save Project « 117_Milla ».
50. S'assurer que MediaRecorder ait arrêté d'enregistrer.

51. **Camtasia :**

   51.1. Peser F10

   51.2. Renommer l'enregistrement « camt_177_pXX »

52. Arrêter les enregistrements SmartEyes en cliquant sur l'outil « Log ».

Pour terminer avec le participant

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53. Remplir la fin du Session Log avec le participant.
54. Faire compléter et signer le Formulaire de compensation et remettre la compensation de **30$** en coupon COOP au participant.
55. Mettre les formulaires de consentement et de compensation signés dans le cartable
56. Raccompagner le participant jusqu'à la porte de sortie**.**

Après que le participant ait quitté

---

57. Finaliser le Session Log et le Workflow du participant.
58. S'assurer que tous les fichiers ont bien été enregistrés

   58.1. Incluant les 4 vidéos Media Recorder.

59. Ranger vos choses et préparer la prochaine collecte
60. Ranger les documents dans le classeur dans l'ordre suivant : formulaire de compensation, formulaire de consentement, session log, protocole.

<u>À la fin de la journée :</u>

- Faire un back-up des données SmartEye sur le disque dur Jaune
- Éteindre tous les ordinateurs.
- Éteindre la souris sans fil mac.
- Éteindre le panneau « ne pas entrer »
- Éteindre les lumières.
- Amener l'ordinateur SmartEye dans la salle 3.15

Appendix F. Essay 5 measurement scales – self-reported

Table 5.F55. Construct items (1).

Construct	Items	Source
Effort for consensus	It was very hard to reach a consensus together on the final buying decision It took a lot of effort to agree on the final buying decision.	New scale
Involvement	Shopping online with my partner for vacation packages is very important to me. For me, shopping online with my partner for these products or services does not matter. It is not a big deal if we make a mistake when we jointly shop online for vacation packages. It's hard to make a bad choice when you engage in such online shopping activity together. I can't say that I particularly like shopping online for these products or services with my partner. You can really tell about a person by the vacation packages he or she picks out.	Laurent and Kapferer (1985)
Satisfaction with role	I wish I had much MORE control over the actions on the screen. I wish my partner had a lot LESS control over the actions on the screen.	New scale
Satisfaction with product choice	I am totally satisfied with the choice we made. The choice made is a good one for me.	New scale
User overall satisfaction	I was very satisfied with the online shopping experience done with my partner. I was pleased with shopping with my partner online. The online shopping with my partner was a frustrating experience. I had a terrible experience shopping online with my partner.	Bhattacharjee (2001)

Appendix G. Essay 5 detailed results

Table 5.G56. Univariate test results – ANCOVA (1).

Independent variables	Dependent variables	df	df (error)	MSE	F-value	p-value
Scrolling	EDA	1	27	10.269	2.111	0.158
	Valence (****)	1	46	0.353	25.56	<0.0001
	Cognitive load (****)	1	46	0.717	51.331	<0.0001
	Effort (**)	1	46	9.010	8.420	0.006
	SatisChoice (***)	1	46	23.885	17.893	<0.001
IDC	EDA (*)	1	263	1497.508	4.013	0.046
	Cognitive load (**)	1	263	1.712	9.439	0.002
	SatisChoice (*)	1	263	5.622	4.044	0.045
	SatisRole (***)	1	263	24.595	11.349	<0.001
	Valence	1	263	0.018	0.728	0.394
Display sharing	EDA	1	27	14.271	2.541	0.123
	Valence	1	46	000	0.013	0.908
	Cognitive load	1	46	0.042	2.996	0.090
	Effort	1	46	0.923	0.821	0.370
	SatisChoice	1	46	2.982	3.364	0.073
Pre-agreement	EDA	1	27	1.268	0.24	0.628
	Valence	1	46	0.022	3.950	0.053
	Cognitive load	1	46	0.011	2.246	0.141
	Effort	1	46	0.778	0.883	0.352
	SatisChoice	1	46	1.236	1.264	0.267
Display sharing* Pre-agreement	EDA	1	27	18.615	0.955	0.337
	Valence	1	46	0.017	2.725	0.105
	Cognitive load	1	46	0.003	0.915	0.344
	Effort	1	46	1.988	1.837	0.182
	SatisChoice	1	46	0.331	0.263	0.611

(*) = significant at α = 0.05; (**) = significant at α = 0.01; (***) = significant at α = 0.001; (****) = significant at α=0.0001.

Note. IDC = Input device control; Effort = Effort for reaching consensus; EDA = Electrodermal activity.

Table 5.G57. Univariate test results – ANCOVA (2).

Independent variables	**Dependent variables**	**df**	**df (error)**	**MSE**	**F-value**	**p-value**
Display sharing*Scrolling	EDA	1	27	0.196	0.181	0.674
	Valence	1	46	0.009	0.931	0.340
	Cognitive load	1	46	0.005	0.83	0.367
	Effort	1	46	0.291	0.269	0.607
	SatisChoice	1	46	0.07	0.105	0.747
Pre-agreement*Scrolling	EDA	1	27	29.515	1.284	0.267
	Valence	1	46	0.004	0.843	0.363
	Cognitive load	1	46	0.002	0.315	0.577
	Effort	1	46	0.081	0.083	0.774
	SatisChoice	1	46	1.694	2.025	0.161
Pre-agreement*IDC	EDA	1	27	10.451	1.977	0.171
	Valence (*)	1	46	0.024	4.41	0.041
	Cognitive load	1	46	0.000	0.043	0.837
	Effort	1	46	2.153	2.443	0.125
	SatisChoice	1	46	0.716	0.732	0.377
Scrolling*IDC	EDA	1	27	7.24	1.488	0.233
	Valence	1	46	0.003	0.197	0.659
	Cognitive load	1	46	0.000	0.002	0.963
	Effort	1	46	0.208	0.195	0.661
	SatisChoice	1	46	0.625	0.468	0.497

(*) = significant at $\alpha = 0.05$.

Appendix H. Essay 5 experimental protocol - couple online shopping experiment

In this appendix, we detail the experimental protocol we followed after setting up the hardware and software infrastructure. The protocol is based on dual eye-tracking technique similar to that implemented by Tchanou et al. (2020a) but it uses Tobii Pro Nano eye-trackers and accompanying software. Included are the detailed setup steps prior to welcoming participating couples, during their installation, during experimental tasks, and after the experiment. The protocol is presented in its original language, that is, in French.

Ordre des tâches[27] :

1. Calibration et pose des outils physiologiques
2. Pré-questionnaire
3. Baseline Vanilla
4. Tâche E-Prime
5. Condition **1** OU Condition **2**
    a. Chaque condition inclut 6 tâches
6. Condition **2** OU Condition **1**
    a. Chaque condition inclut 6 tâches (total de 12 tâches)
7. Questionnaire de fin

Voir l'ordre des tâches et la timeline Tobii à sélectionner pour le participant à la dernière page du protocole.

[27] The experiment's protocol and proceeding were done in French.

Procédure avant l'arrivée du participant

1. Mettre son masque
2. Se laver les mains avec de l'eau chaude et du savon, pour minimum 20 secondes
3. La salle aura été désinfectée par l'équipe de nettoyage du HEC depuis le dernier participant
4. Allumer les ordinateurs : Observer + Media Recorder, Tobii 1 et Tobii 2
5. Ouvrir Interservice, et s'assurer que l'appel 24 heures avant la participation a été complété et que les participant.e.s sont éligibles.
6. **Media Recorder**
    a. Ouvrir le raccourci Media Recorder "232_Manu"
    b. Vérifier que les deux (**2**) caméras s'affichent
    c. La lumière de syncbox est visible pour les deux (**2**) caméras
7. **Tobii Pro (1)**
    a. Ouvrir Tobii Pro Lab
        1. **Mettre la fenêtre Tobii Pro dans l'écran de droite**
        2. Open Existing Project > 232_Manu
    ii. Aller dans l'onglet "Record" :
        1. Choisir la timeline selon la condition du participant indiquée dans le fichier de randomisation sur le bureau de l'ordinateur Observer "Randomisation_Manu".
    iii. Copier et coller la nomenclature dans la case 'Recording Name'
    iv. Vérifier que l'écran "**3**" est selectionné dans l'onglet en bas à gauche
        1. Cliquer sur "Identify" pour vérifier que c'est bien l'écran du participant
    v. Vérifier que Tobii reconnaît l'oculomètre : la vue de l'oculomètre, et son nom, son dans un encadré en haut à gauche.

            1. Si ce n’est pas le cas, cliquer sur l’encadré, et dans le menu déroulant, selectionner le eye-tracker (il ne faut pas que Mouse Tracker soit selectionné).
    - vi. Vérifier que Screen Moderator est sélectionné dans l’onglet en bas à droite
    - vii. Créer le participant avec la nomenclature “tobii_232_p1XX”, et cliquer “New”
  - b. Ouvrir le document PDF sur le bureau “Consentement_Manu”
    - i. Cliquer « Remplir et Signer »
    - ii. Cliquer « Signer »
    - iii. S’il y a lieu, supprimer la signature du participant précédent en cliquant le « - » à côté de sa signature

8. Tobii Pro (<u>2</u>)

  - a. Ouvrir Tobii Pro Lab
            1. **Mettre la fenêtre Tobii Pro dans l’écran de droite**
            2. Open Existing Project > 232_Manu
  - b. Aller dans l’onglet “Record” : choisir la timeline selon la condition du participant indiqué dans intersevice
    - i. Créer le participant avec la nomenclature “tobii_232_p2XX”, et cliquer “New”
    - ii. Copier et coller la nomenclature dans la case ‘Recording Name’
    - iii. Vérifier que l’écran “**<u>1</u>**” est selectionné dans l’onglet en bas à gauche
            1. Cliquer sur “Identify” pour vérifier que c’est bien l’écran du participant
    - iv. Vérifier que Tobii reconnaît l’oculomètre : la vue de l’oculomètre, et son nom, son dans un encadré en haut à gauche
            1. Si ce n’est pas le cas, cliquer sur l’encadré, et dans le menu déroulant, selectionner le eye-tracker (il ne faut pas que Mouse Tracker soit selectionné).

v. Vérifier que Screen Moderator est sélectionné dans l’onglet en bas à droite

c. Ouvrir le document PDF sur le bureau “Consentement_Manu”

i. Cliquer « Remplir et Signer »

ii. Cliquer « Signer »

iii. S’il y a lieu, supprimer la signature du participant précédent en cliquant le « - » à côté de sa signature

d. **Switch Ecran Participant 2** (mettre sur **PC2**) :

i. Sur le boitier StarTech, peser le bouton SELECT.

1. **PC2** devrait être vert

9. Bitalino (physiologie)

a. Déposer les Bitalinos sur les postes respectifs des participants, avec lingettes d’alcool et tape médical

b. Découper le nombre approprié de senseurs

c. Attacher les électrodes aux senseurs collants (EDA et ECG)

d. S’assurer que le bitalino a le monde éteint

e. S’assurer qu’il y a une carte mini SD dans le bitalino

f. S’assurer que le bitalino est éteint

10. Bluebox Synchronisation

a. Brancher la Bluebox de synchronisation dans l’ordinateur Tobii 1 dans le port de SYNC de la bluebox

i. S’assurer que l'interrupteur de lumière est allumé

ii. S’assurer que l’interrupteur de power est éteint

a. Brancher la Bluebox de synchronisation dans l’ordinateur Tobii 2 dans le port de SYNC de la bluebox

iii. S’assurer que l'interrupteur de lumière est allumé

iv. S’assurer que l’interrupteur de power est éteint

11. Lumière de sync (dans la salle d’expérimentation)

a. Placer la lumière de sync dans le bras accroché au plafond

b. S’assurer que la lumière est visible par les deux caméras Media Recorder

c. S’assurer que l’interrupteur d’ampoule est allumé

d. **Allumer la lumière de sync**

12. **Dans la salle du participant**
    a. Ajuster les deux (**<u>2</u>**) chaises des participant.e.s au plus haut
    b. Ouvrir les formulaires de consentement sur les deux ordinateurs, et les placer sur le bureau, devant les participant.e.s
13. Allumer le panneau “Ne pas entrer”
14. Fermer la lumière de la salle d’observation
15. Ouvrir la porte de la salle du participant
16. Ouvrir la porte d’entrée de la salle individuelle, et la bloquer ouverte à l’aide du tien-porte (? is this a word?)

Accueil du Participant

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17. Lorsque les participant.es appellent pour signaler leur arrivée, ouvrir la porte en cliquant le **<u>9</u>** sur le téléphone
18. S’assurer de porter son masque
19. Rejoindre les participant à l’entrée en maintenant 2 mètres de distance
20. Si les participant.es ne portent pas de masque, leur demander d’en mettre un
    a. Il y a des masque jetables disponibles sur le dispenseur à gel pour main désinfectant
21. **Verbatim** : “*Bonjour, je m’appelle XXXX, merci de vous être déplacés pour participer à l’étude. Merci de porter un masque jusqu’à ce que je vous signal que vous pouvez vous l’enlever. Je vous demanderai de me suivre jusqu’à la salle de bain et de vous laver les mains avec de l’eau chaude et du savon, pour un minimum de 20 secondes. Vous pouvez ensuite suivre les flèches au sol, et vous asseoir sur les chaises dans la salle d’expérimentation*”
22. Accompagner les participant.e.s aux toilettes du rez-de-chaussé, et leurs pointer les flèches qui mène à la salle de collecte

23. Aller dans la salle d'observation, et fermer la porte qui relie la cuisine de la salle individuelle, au hall d'entrée de la salle individuelle
24. Lorsque les participants entrent dans la salle :
    a. Vérifier sur la feuille des randomisation (bureau de l'ordinateur Observer) qui de la femme ou l'homme sera le participant 1 qui aura le contrôle de la souris en affichage partagé. S'il s'agit d'un couple homme-homme ou femme-femme, alors choisir au hasard qui sera participant actif (Participant 1).
        i. **Verbatim** : "*Merci de suivre les précautions sanitaires. Je suis de l'autre coté de la vitre teintée, je vous vois et je vous entends, donc vous pouvez me poser des questions à tout moment. Je vous demanderai de fermer les deux portes derrières vous* (entrée salle individuelle, et porte salle du participant.)"
        ii. Asseoir le participant actif sur le poste étiqueté "Participant 1" et le participant passif sur le poste étiqueté "Participant 2"
25. Une fois que les deux portes sont fermées :
    a. **Verbatim** : "*Merci. Vous pouvez maintenant retirer vos masques. L'expérience d'aujourd'hui va durer 2h00, et vous serez compensé pour votre temps par une carte cadeau Best Buy de 50$ chacun. L'expérience sera composée de plusieurs tâches, chacune suivie d'un questionnaire. En participant à cette étude, vous courrez la chance de gagner une carte cadeau de 200$. Nous vous demandons de choisir librement vos préférences de produit.*
    Les outils utilisés sont l'oculomètre, ce que vous voyez accroché en bas de l'écran devant vous. Cet outil enregistre le déplacement de votre regard sur l'écran de l'ordinateur. Vous serez aussi filmés avec les webcams. Finalement, nous allons enregistrer votre rythme cardiaque et la sueur dans la paume de votre main à l'aide de senseurs que vous vous installerez. Avez vous des questions?

    Merci. Avant de poursuivre, je vous demanderais d'éteindre vos téléphones ou de les mettre en mode silencieux"

26. Signature du formulaire de consentement :

   a. **Verbatim** : "*Sur le bureau de l'ordinateur devant vous se trouve un fichier nommé "Consentement Manu", veuillez l'ouvrir et le lire attentivement. Ensuite, à l'aide de l'option "Remplir et signer", veuillez répondre aux questions en cochant les cases, et apposer votre signature à la fin. Vous pouvez m'indiquer quand vous avez terminé. Ce formulaire vous sera envoyé par courriel à la fin de votre participation.*"

27. Lorsque les participants ont terminé et signé :

   a. Compléter le formulaire de consentement à l'aide de l'option "remplir et signer"

   b. Enregistrer sous dans Données C > Données d'expérimentation > Consentement, avec la nomenclature suivante "consentement_232_pXXX"

28. Poser les questions du Session Log

29. Guider la pose des senseurs (répéter les étapes pour les deux participant.e.s)

30. Sur le torse

   a. Enlever tous ses bijoux

      i. **Verbatim**: *"S'il vous plaît, enlevez tous vos bijoux. Donc chaînes, montres, bracelets, bagues, etc.*

   b. Déballez une lingette d'alcool, et passez là dans la paume de votre main non dominante, sous vos clavicules et sur vos côtes du côté gauche.

      *i. [*Au besoin*: si vous laissez votre bras gauche pendre, cela correspond à l'endroit sur vos côtes juste en haut de votre coude.]*

   c. Vous pouvez jetez la lingette et son emballage. Une poubelle se trouve à côté [du participant 2].

   d. Devant vous, vous avez trois collants circulaires. Prenez celui qui a un fil ayant un collet noir au niveau de la pince, et placez le sous votre clavicule gauche, soit l'endroit où vous avez passé la lingette d'alcool. Le collant devrait être sous votre os, pas par-dessus.

e. *À présent prenez celui qui a un fil ayant un collet blanc et placez le sous votre clavicule soit, soit l'endroit où vous avez passé la lingette d'alcool. Le collant devrait encore une fois être sous votre os, pas par-dessus.*

f. Prenez le collant restant et faites le passer sous votre chandail, en passant par le col de votre chandail. Vous pouvez également faire passer le fil rouge à l'intérieur de votre chandail de la même manière.

g. En passant par le dessous de votre chandail, prenez le collant restant, et collez le sur vos côtes du côté gauche.

31. Dans la paume de sa main

*a. Il vous reste deux senseurs de forme rectangulaire à placer. Ceux-ci vont aller dans la paume de votre main non dominante. Prenez celui ayant un collet rouge, et placez le dans la paume de votre main de sorte à ce qu'il pointe vers votre pouce. Le collant en entier devrait être collé à votre paume et ne pas dépasser. [*Au besoin: *le côté court avec une petite bosse devrait pointer vers votre pouce.]*

b. Prenez maintenant le collant restant, et collez-le dans la paume de votre main du côté de votre petit doigt.

i. Pouvez vous me montrer votre main pour que je vérifie le placement des senseurs?"

ii. Vérifier le placement des senseurs

c. **Verbatim:** *"Appuyez sur chacun des cinq collants pour vous assurer qu'ils collent bien à votre peau.*

i. *Au besoin, ajoutez du tape médical. Il ne devrait pas toucher à la pince sur le collant.*

d. À présent, prenez le fil rouge, celui connecté à votre torse, et branchez le dans le port A2 du boîtier bleu qui est en avant de vous.

e. Prenez le fil vert, celui connecté à la paume de votre main, et branchez-le dans le port A1 du boîtier bleu.

32. Vérifier la pose des outils physiologiques

a. **ECG** :

   i. Demander au participant de vérifier que le câble noir est sur sa clavicule gauche, sans toucher l'os
   ii. Demander au participant de vérifier que le câble blanc est sur sa clavicule droite, sans toucher l'os
   iii. Demander au participant de vérifier que le câble rouge est sur ses côtes gauches
   iv. Demander au participant de peser sur chacun des senseurs pour s'assurer qu'ils adhèrent bien à la peau
   v. S'assurer que le câble ECG est dans l'entrée A2
b. **EDA** :
   i. Demander au participant si les senseurs sont bien dans sa main non-dominante (celle qui ne sera pas utilisée pour la souris)
   ii. Demander au participant de s'assurer que les collets de couleurs sont bien placés
   iii. S'assurer qu'ils adhèrent bien à la peau
   iv. Dire au participant de mettre le gant et le serre poignet
   v. Vérifier que le câble EDA est dans l'entrée A1

33. Vérifier que la SwitchBox d'écran indique que c'est PC2 le display
34. Calibrer l'oculomètre Participant <u>**1**</u>
    a. Cliquer sur Start Recording
    b. Vérifier que les yeux sont bien encadrés
       i. Si non, lui demander de s'ajuster en avançant ou en reculant sa chaise, ou en changeant la hauteur de son siège à l'aide de la manette sous son siège
35. Calibrer l'oculomètre Participant <u>**2**</u>
    a. Cliquer sur Start Recording
    b. Vérifier que les yeux sont bien encadrés
       i. Si non, lui demander de s'ajuster en avançant ou en reculant sa chaise, ou en changeant la hauteur de son siège à l'aide de la manette sous son siège

36. **Verbatim** : "*Nous allons maintenant procéder à la calibration de l'oculomètre. Il y aura un point gris qui se déplacera aux extrémités et au centre de l'écran. Je vais vous demander de suivre attentivement le point avec vos yeux. Par contre, vous pouvez bouger la tête naturellement pour suivre le point, et cligner des yeux quand vous en ressentez le besoin*"
37. Calibrer les oculomètres
    a. Cliquer Start Calibration sur l'ordinateur Tobii 1
    b. Cliquer Start Calibration sur l'ordinateur Tobii 2
38. Vérifier que les deux calibrations sont adéquates
39. Ne **PAS** accepter la calibration tout de suite, sinon ca part l'enregistrement
40. **Démarrer les outils :**
    a. **Media Recorder :**
        i. Vérifier qu'on voit la lumière de syncbox dans les deux caméras
        ii. **Débuter l'enregistrement**
    b. **Bluebox :**
        i. Demander aux participants de s'assurer que le mode Cloud est éteint
        ii. **Demander aux participants d'allumer leurs Bluebox**
    c. **Syncbox Bluebox :**
        i. Allumer la Syncbox connectée à Tobii 1
        ii. Allumer la Syncbox connectée à Tobii 2
    d. **Tobii 1 :**
        i. Accepter la calibration et débuter l'enregistrement
    e. **Tobii 2 :**
        i. Accepter la calibration et débuter l'enregistrement
41. En même temps :
    a. Cliquer F10 sur Tobii 1
    b. Cliquer F10 sur Tobii

Baseline

42. Demander au participant de compter le nombre de carrés blancs à l'écran
43. Cliquer F10 sur Tobii 1
44. Cliquer F10 sur Tobii 2
45. Attendre que la Baseline termine
46. Demander aux participants combien de carrés blancs ils ont vu.

Questionnaire

47. **Pré-questionnaire** :
    a. Demander aux participants de prendre leur iPad
    b. Leurs demander de cliquer l'icône "Quest 1"
        i. Leur demander d'entrer leur numéro de participant
            1. p1XX et p2XX
    c. Compléter le questionnaire
    d. Quand les deux participants ont indiqué avoir terminé la tâche, appuyer **F10** sur les deux claviers

Tâche E-Prime

L'écran du participant 1 doit être en miroir sur l'écran du deuxième participant

48. **Verbatim**: "*Tout au long de l'étude, Participant 1 désignera vous qui êtes assis face à la vitre teintée. Participant 2 désignera vous qui êtes assis de biais par rapport à la vitre teintée.*"
49. **Switch Ecran Participant 2** (mettre sur **<u>PC1</u>**) :
    a. Sur le boitier StarTech, peser le bouton SELECT.
        i. PC1 devrait être vert

50. S’assurer que Tobii Pro (vue de l’assistant.e de recherche) est bien dans l’écran de droite de l’ordinateur tobii 1
51. **Verbatim:** *“Pour cette tâche, uniquement le clavier du participant 1 fonctionne. Je vous demanderai également de ne pas communiquer entre vous pour la durée de cette tâche. Merci de m’indiquer à voix haute quand la tâche sera terminée.”*
52. **Lancer E-Prime** (sur l’ordinateur Tobii Participant **1**) :
    a. Double cliquer sur le fichier E-Prime ChangeBlindness.ebs3 (raccourci est sur le bureau)
    b. Entrer le numéro du participant 1 (1XX) et cliquer Enter
    c. Entrer session number 01 et cliquer Enter
    d. Cliquer Enter pour partir la tâche
    e. *“Vous pouvez suivre les instructions qui apparaissent à l’écran”*
53. Lorsque le stimuli E-Prime termine :
    a. Ordinateur Tobii 1 : cliquer **F10**
    b. Ordinateur Tobii 2 : cliquer **F10**

Pour les timeline 1 et 2, commencer par la condition 2.

Pour les timelines 3 et 4, commencer par la condition 1.

Condition 1

(pour la condition 2, aller à la page 12 du protocole)

Dans cette condition, l’écran de chacun.e des participant.e.s sera indépendant. Les participant.e.s magasinent et choisissent des produits seuls, à leur rythme, chacun sur son ordinateur.

54. **S’assurer que l’écran du Participant 2 est indépendant** (mettre sur **PC2**) :
    a. PC2 devrait être vert, si non:

i. Sur le boitier StarTech, peser le bouton SELECT.

ii. PC2 devrait maintenant être vert. Si l'écran affiche des couleurs et rien d'autre, rappuyer deux fois sur le bouton SELECT

55. Pour passer aux instructions de la tâche :
    a. Ordinateur Tobii 1 : cliquer **F10**
    b. Ordinateur Tobii 2 : cliquer **F10**
56. Dire aux participants de peser Espace lorsqu'ils ont fini de lire les instructions
57. À l'instruction Tobii demandant aux participants d'ouvrir le questionnaire "Quest Tâche":
    a. **Verbatim**: "Veuillez chacun entrer votre numéro de participant et suivre les instructions du questionnaire."
        i. p1XX et p2XX
58. Pendant la tâche :
    a. Suivre la tache sur les deux ordinateurs Tobii
    b. Appuyer sur **F10** à l'ordinateur Tobii 1 et Tobii 2 quand ils ont tous les deux indiqué avoir fait leur choix puis attendre qu'ils complètent le questionnaire et la tâche suivante pour un total de 6 tâches dans cette condition.
    c. Vérifier le Track Status et demander aux participants de se replacer au besoin
    d. S'assurer que les flash de Syncbox sont visibles dans les caméras
59. Questionnaires pendant les tâches : avant et après chacune des tâches, les participants complètent un questionnaire sur le iPad
60. Lorsque les 6 tâches de cette condition sont complétées (lorsque la slide commençant par "Nous allons maintenant changer de type d'affichage à l'écran..." ou la slide "Pour terminer l'expérience..." s'affiche):
    a. Passer à l'autre condition si elle n'a pas déjà été faite. **Voir page 13**
    b. Si les deux conditions ont été complétées,
        i. Aller à la page 13 du protocole pour le questionnaire de fin.

Condition 2

(pour la condition 1, aller à la page 11 du protocole)

Dans cette condition, l'écran du participant 2 sera le miroir de l'écran du participant 1. Les participant.e.s magasinent et choisissent des produits ensemble, avec un seul ordinateur représenté sur les deux écrans

61. **S'assurer que l'écran du Participant 1 est affiché sur celui du Participant 2** (mettre sur **PC1**) :
    a. PC1 devrait être vert, si non:
        i. Sur le boitier StarTech, peser le bouton SELECT.
        ii. PC1 devrait maintenant être vert. Si l'écran affiche des couleurs et rien d'autre, rappuyer deux fois sur le bouton SELECT
62. Pour passer aux instructions de la tâche :
    a. Ordinateur Tobii 1 : cliquer **F10**
63. Dire aux participants de peser Espace lorsqu'ils ont fini de lire les instructions
64. À l'instruction Tobii demandant aux participants d'ouvrir le questionnaire "Quest Tâche":
    a. **Verbatim**: "*Veuillez chacun entrer votre numéro de participant et suivre les instructions du questionnaire*."
    b. p1XX et p2XX
65. Pendant la tâche :
    a. Suivre la tâche sur l'écran de l'ordinateur du participant **1**
    b. Appuyer sur **F10** à l'ordinateur du participant 1 uniquement quand ils ont tous les deux indiqué avoir fait leur choix puis attendre qu'ils complètent le questionnaire et la tâche suivante, pour un total de 6 tâches dans cette condition.
    c. Vérifier le Track Status sur chacun des ordinateurs et demander aux participants de se replacer au besoin
    d. S'assurer que les flash de Syncbox sont visibles dans les caméras

66. Questionnaires pendant les tâches : avant et après chacune des tâches, les participants complètent un questionnaire sur le iPad
67. Lorsque les 6 tâches de cette condition sont complétées (lorsque la slide commençant par "Nous allons maintenant changer de type d'affichage à l'écran..." s'affiche ou qu'il n'y a plus d'instructions à l'écran):
    a. Passer à l'autre condition si elle n'a pas déjà été faite. **Voir page 11**
    b. Si les deux conditions ont été complétées,
        i. **S'assurer que l'écran du Participant 2 est indépendant** (mettre sur **PC2**) :
            1. PC2 devrait être vert, si non:
                a. Sur le boitier StarTech, peser le bouton SELECT.
                b. PC2 devrait maintenant être vert. Si l'écran affiche des couleurs et rien d'autre, rappuyer deux fois sur le bouton SELECT
        ii. Aller à la page 13 du protocole pour le questionnaire de fin

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Questionnaire de fin

Chacun des participants répondra au questionnaire de fin son ordinateur.

68. **Verbatim** : *Pour terminer l'expérience, sans vous parler, veuillez compléter le questionnaire de fin sur votre ordinateur. À l'affichage du questionnaire, vous entrerez chacun votre propre numéro de participant, puis à la 2ème question Participant 1 choisira l'option "Participant 1" et Participant 2 choisira l'option "Participant 2".*
69. Pour afficher le questionnaire de fin:
    a. Ordinateur Tobii 1 : cliquer **F10**
    b. Ordinateur Tobii 2 : cliquer **F10**
    c. Ouvrir Chrome et sélectionner le questionnaire dans la barre de favoris
    d. p1XX et p2XX

Terminer avec le participant

70. **Tobii 1** :
    a. Arrêter l'enregistrement
71. **Tobii 2** :
    a. Arrêter l'enregistrement
72. **Media Recorder :**
    a. Arrêter l'enregistrement
    b. Renommer les vidéos avec les numéros de participant :
        i. mr_232_p1XX
        ii. mr_232_p2XX
73. Éteindre les syncbox
74. **Bluebox** :
    a. Demander aux participant.e.s d'éteindre leur Bluebox
    b. Guider les participants pour qu'ils s'enlèvent les senseurs
75. Completer le session log
76. S'assurer que le questionnaire "Quest Tache" est à la page de fin de questionnaire. Sinon, taper le bouton pour avancer à la page finale, ce qui terminera le questionnaire.
77. Demander aux participant.e.s de signer le formulaire de compensation sur l'ordinateur
    a. Sur le bureau, ouvrir le document pdf "Compensation_Manu"
    b. Demander aux participants de le compléter en utilisant l'option "Remplir et signer"
        i. S'assurer qu'ils utilisent le stylet
    c. Enregistrer sous Données C > Données d'expérimentation > Compensation_Manu
78. Demander aux participants leur adresse courriel si elle n'est pas dans le formulaire de compensation

Retrait d’une ou des pages pouvant contenir des renseignements personnels

86. Brancher les deux syncbox dans leurs ports de chargement
    a. S’assurer qu’ils soient éteints
87. Mettre les deux bitalino physiologiques à charger, et la lumière de syncbox
    a. S’assurer qu’ils soient éteints
88. Sortir de la salle avec tous ses effets personnels, jusqu’à 30 minutes avant l’arrivée des prochains participant.e.s

(dernière page : table des participants, condition, et ordre des taches)