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HEC MONTRÉAL
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Toward Inclusive Information Systems Research: Advancing Theory and Methods to Understand IT Use by People with Disabilities

par
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Résumé

Cette thèse fait avancer les théories et les méthodes dans la recherche en systèmes d'information (SI) en évaluant des solutions afin d’améliorer la conception inclusive et l'utilisation efficace des technologies de l'information (TI) par des personnes en situation de handicap. Les personnes en situation de handicaps sont souvent confrontées à l'exclusion numérique en raison de l'absence de pratiques de conception inclusive des TI et de soutien pour s'adapter et (ré)apprendre à utiliser les TI de manière efficace. Face aux lois en vigueur sur l'accessibilité, ainsi que les politiques d'équité, de diversité et d'inclusion, il devient de plus en plus impératif d'assurer l'inclusion des personnes en situation de handicap dans notre société numérique. Le domaine des SI se doit de contribuer à la recherche sur l’inclusion numérique pour des raisons juridiques, économiques et éthiques.

Cependant, les théories existantes en SI ne sont généralement pas développées en tenant compte des personnes en situation de handicap, ce qui limite leur caractère inclusif. De plus, les défis méthodologiques associés à la recherche participative avec les personnes en situation de handicap ont conduit les chercheurs à s'appuyer sur des mesures psychologiques quantitatives (par ex. questionnaires) sujettes à des biais positifs. Cette thèse tente de réduire la fracture numérique excluant les pesronnes en situation de handicap en (1) développant des théories inclusives en SI afin d’étudier l'utilisation des TI par des personnes en situation de handicap, (2) en testant la validité de mesures psychologiques des TI, et (3) en testant la validité de l'évaluation des TI par des participants soumis à une simulation de handicap. Ces objectifs de recherche sont examinés dans trois essais complémentaires. Le premier essai contextualise la théorie de l'utilisation efficace des TI et affine le concept de performance individuelle à l'aide d'une étude de cas exploratoire en contexte de réadaptation numérique suite à un accident vasculaire cérébral (AVC). Les chapitres suivants utilisent un modèle étendu d'attente-confirmation pour évaluer le biais positif dans les mesures psychologiques des TI. Dans le deuxième essai, nous évaluons si les expériences et les attentes antérieures avec une technologie influencent le biais positif dans les mesures psychologiques des TI par des participants en situation de handicap post-AVC ou soumis à une simulation de handicap moteur. Le troisième essai évalue si les expériences et les attentes antérieures des TI avant un handicap (c'est-à-dire avant la perte de capacités) influencent le biais positif dans les mesures psychologiques par des participants atteints de cécité et de basse vision congénitale ou acquise, permanente ou simulée. Les deuxième et troisième essais explorent aussi la validité des participants soumis à une simulation de handicap pour identifier des problèmes d'utilisabilité ou d'accessibilité en context de test utilisateur. Dans l'ensemble, cette thèse contribue au développement de théories inclusives en SI, en plus d'améliorer notre compréhension du biais positif dans les mesures psychologiques par les personnes en situation de handicap, ainsi que le rôle des participants soumis à une simulation de handicap pour améliorer l'efficacité et l'efficience de la conception inclusive des TI dans la recherche et l'industrie.

Mots clés: inclusion numérique, personnes en situation de handicap, conception inclusive, réadaptation numérique, théorie inclusive, NeuroIS

Méthodes de recherche: Étude de cas exploratoire, expérience en laboratoire

Abstract

This thesis advances theories and methods in Information Systems (IS) research by testing solutions to improve inclusive design and effective use of information technology (IT) by people with disabilities (PWD). People with permanent, temporary, or even situational disabilities often face digital exclusion due to the lack of inclusive IT design practices and support to adapt and (re)learn to use IT (i.e., digital rehabilitation). With current laws on accessibility, as well as equity, diversity, and inclusion policies, it is becoming increasingly imperative to ensure the inclusion of PWD in our digital society and workplace. The field of IS can and should contribute to research involving PWD for legal, economic, and ethical reasons. However, existing IS theories are generally not developed with PWD in mind, which limits their inclusiveness or applicability to certain contexts. Moreover, methodological challenges associated with participatory research involving PWD have led to the overreliance on psychological measures, which are prone to a positive bias. This thesis addresses the disability digital divide by (1) developing inclusive IS theories for studying IT use by PWD, (2) testing the validity of psychological measures of IT by PWD, and (3) testing the validity of able-bodied participants with simulated disability to evaluate IT in user testing context. These research objectives are examined in three complementary essays. The first essay extends the theory of effective use and refines the conceptualization of individual performance in theories of use with an exploratory case study in post-stroke digital rehabilitation settings. Building on the previous conceptualization of individual performance, subsequent essays use the expectation-confirmation and post-acceptance models to test the positive bias in psychological measures of IT. We conducted two experimental studies with novel NeuroIS approaches based on neurophysiological data recorded during participants' interaction with IT. In the second essay, we test whether experiences and expectations with a familiar technology influence the positive bias in psychological pointing performance and motor function efficiency by stroke patients with acquired physical disability and able-bodied participants with simulated physical disability. Building on the second essay, the third essay tests whether experiences and expectations of IT with healthy abilities (i.e., before ability loss) influence the positive bias in psychological measures of perceived usefulness and ease of use of an online banking website by users with congenital or acquired, permanent or simulated, blindness and low vision. The second and third essays further explore the validity of able-bodied participants with simulated disability for identifying usability or accessibility issues in user testing. Overall, this thesis contributes to the development of more inclusive IS theories for PWD, which may promote research involving PWD. In addition, the second and third essays enhance our understanding of the positive bias in psychological measures by PWD, as well as the role of able-bodied participants with simulated disability for improving the effectiveness and efficiency of user testing for inclusive design of IT in research and in industry.

Keywords: digital inclusion, people with disabilities, inclusive IT design, digital rehabilitation, inclusive IS theory, NeuroIS

Research methods: Exploratory Case Study, Laboratory Experiment

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AT	Assistive Technologies
BCI	Brain-Computer Interface
DAQ	Device Assessment Questionnaire
ECG	Electrocardiography
ECT	Expectation Confirmation Theory
EEG	Electroencephalography
HCI	Human-Computer Interaction
HRV	Heart Rate Variability
IS	Information Systems
IT	Information Technologies
LMC	Leap Motion Controller
LMM	Linear Mixed Model
MoCA	Montreal Cognitive Assessment
MFE	Motor Function Efficiency
PAM	Post-Acceptance Model
PU	Perceived Usefulness
PEOU	Perceived Ease of Use
PP	Pointing Performance
PWD	People With Disabilities
TEE	Task Effort Efficiency
TEU	Theory of Effective Use
TP	Task Performance
WCAG	Web Content Accessibility Guidelines

À ma famille,

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Preface

This thesis, authored by Félix Giroux, is an original unpublished work conducted under the guidance of Dr. Pierre-Majorique Léger and Dr. Sylvain Sénécal.

Introduction

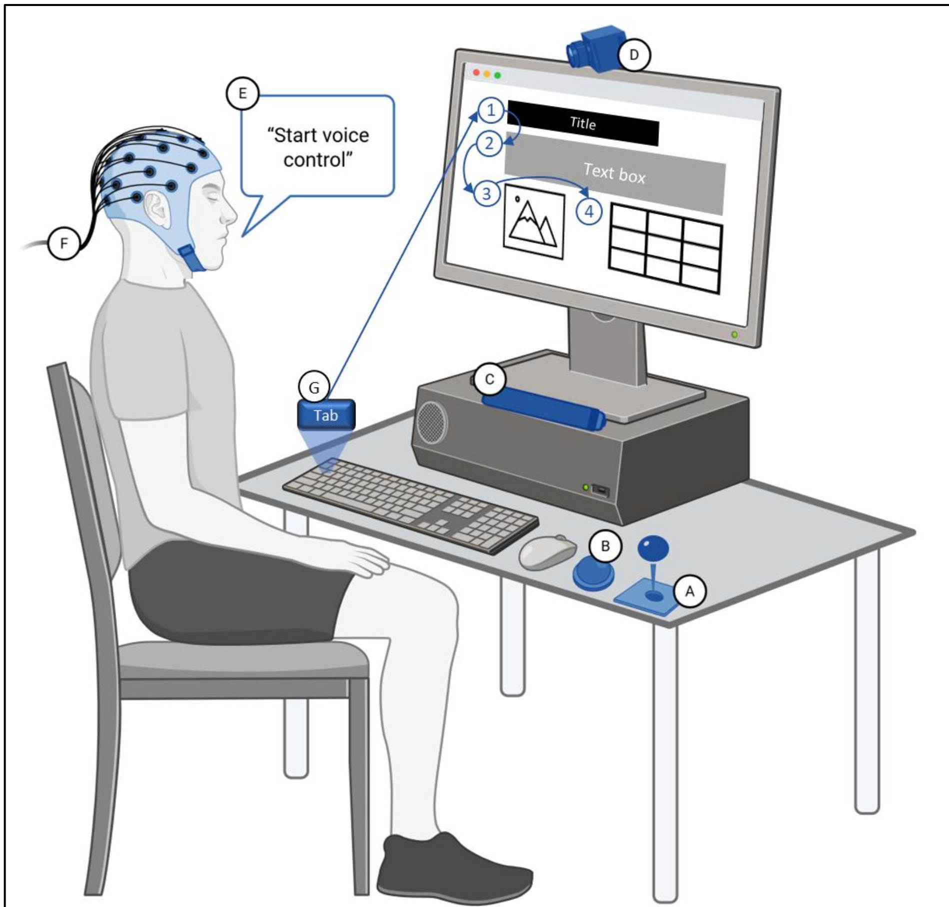
Thesis Motivation

This thesis advances theories and methods to study the use of information technologies (IT) by people with disabilities (PWD) in Information Systems (IS) research. Over one in six people globally have some form of permanent or temporary disability (WHO, 2022). More importantly, the number of PWD is also expected to double by 2050 due to the aging population (WHO, 2024). Over the last decades, PWD have consistently used less IT than able-bodied people (Duplaga, 2017; Naqvi et al., 2021; Scanlan, 2022; Vicente & López, 2010). For instance, in Canada, up to 20% of adults with a disability, which is more than twice the proportion of able-bodied adults, do not use the Internet due to digital accessibility issues (Choi, 2021). This digital divide between PWD and able-bodied people has important economic costs related to low online participation (e.g., shopping, banking, learning, politics), high unemployment rates, as well as healthcare and rehabilitation services (Ayabakan et al., 2024; Bastien et al., 2020; French-Lawyer et al., 2021; Owolabi et al., 2022; Perez et al., 2023; Puli et al., 2024; Raja, 2016; Sieck et al., 2021; Weil, 2001).

The digital divide can be explained by the fact that the design of most IT or websites is not accessible for PWD (Malik et al., 2024; WebAIM, 2025). For instance, in 2025, 94.9% of websites failed to conform to the Web Content Accessibility Guidelines (WCAG 2.0), due to accessibility issues such as the lack of contrast between the text content and background of a webpage (WebAIM, 2025). Other accessibility issues can be related to the compatibility between IT and assistive technologies (AT), which is defined by the

Assistive Technology Act of 2004 as any item, piece of equipment, or product system, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities (ATA, 2004). For example, blind people can rely on AT known as screen readers to interact with a digital interface by inputting keyboard shortcuts (e.g., Tab key) to navigate linearly by section title, text boxes, images, forms, tables or other objects that are spoken to the user in real time (Figure 1, G). Therefore, websites with empty links or buttons, missing labels or text alternative for image content can cause accessibility issues that prevent blind people from using IT effectively (WebAIM, 2025).

For users with physical disabilities, there exists a wide range of other AT like assistive pointing devices (e.g., joystick), assistive keyboards, switch devices, gesture-based interfaces (e.g., video camera), eye-tracking systems, or brain-computer interfaces, which respectively allow controlling the cursor or type with their limited motor functions, speech, eye gaze, or even their own brain signals (Koester & Arthanat, 2018; Rashid et al., 2020; Simpson, 2013). For example, similar to screen readers, switch devices allow to navigate through the objects of a digital interface by pressing a button or using any other body movement (e.g., blink, foot, mouth) to stop and select objects in the digital interface or a letter in a virtual keyboard. Figure 1 below illustrates some examples of AT for computer access, including (A) a joystick, (B) a switch device, (C) an eye gaze tracker, (D) a gesture-based interface via camera, (E) a voice controller, (F) an electroencephalography-based brain-computer interface, or (G) a screen reader.



The figure was created using BioRender.

Figure 1: Illustration of different assistive technologies for computer access.

Despite the growing number of new AT, the literature has typically reported that many PWD do not benefit from them for several reasons. First, it can be challenging to access funding for AT, which are often expensive and specialized equipment (Senjam et al., 2023; WHO & UNICEF, 2022). Moreover, access to funding from the government may depend on the nature of disabilities or injuries. For example, people who experience stroke injuries have typically lower access to funding than other disability causes like road accidents or war injuries (Demain et al., 2013; WHO, 2023). Fortunately, there is a growing number of accessibility features integrated into mainstream IT devices' operating systems, although these features are generally unknown by IT device owners (Franz et al., 2019; Wu et al., 2021).

Secondly, research has consistently reported that PWD who have access to AT have significant abandonment rates due to the lack of AT usability, insufficient user's knowledge, skills, training, support, and even stigma consciousness (Howard et al., 2022; Pethig & Kroenung, 2019; Phillips & Zhao, 1993). Consequently, researchers have argued for more participatory research involving PWD in the design and evaluation of AT (Quintero, 2022). Moreover, according to upcoming web accessibility guidelines (WCAG 3.0), organizations will be encouraged or even forced to test the compatibility of their IT with AT (Spellman et al., 2021). Indeed, with current laws and initiatives like the Accessible Canada Act 2040 and the United Nations 2030 Agenda, organizations are increasingly facing legal pressures to design and provide accessible IT to their customers, employees, or citizens (Babin & Kopp, 2020; Blanck, 2020; H. K. Kim & Park, 2020; Scott Kruse et al., 2018; Tsalis et al., 2020).

User testing is a crucial step in the iterative development of AT or IT where the performance or usability of the technology is evaluated based on research participants' use, perceptions, or attitudes toward the technology (Bastien, 2010; Tao et al., 2020). With the advent of personal computing, user testing has become an important practice of the 21st century in organizations developing digital products and services (Mortazavi et al., 2024; Wichansky, 2000). User testing is also central to the development of IT artifacts in IS and Human-Computer Interaction (HCI) research (Hevner et al., 2010; Hevner et al., 2004; Venable et al., 2016). A user test typically involves a series of structured or standardized tasks, on which participants' performance is assessed with different measures, and insights are derived to improve future design iterations. Despite the growth of user testing in organizations and in research, it is well known that conducting user testing with PWD is logistically challenging, more time-consuming, and expensive, leading to small sample sizes (Lazar et al., 2017; Mack et al., 2021; Sinabell & Ammenwerth, 2024; Turner et al., 2006; Wilson et al., 2022). For similar reasons, organizations generally fail to include PWD in user testing, which may contribute to the digital design marginalization of this underrepresented population (Šumak et al., 2023).

To address the above challenge and to improve the efficiency of inclusive IT design, research in HCI and accessibility has extensively used able-bodied participants as comparison, baseline, or to complement smaller samples of PWD for improving statistical power (Brulé et al., 2020; Mack et al., 2021). Many studies simulated disabilities in able-bodied participants of user tests for identifying preliminary usability and accessibility issues with AT or inclusive IT design (Chen et al., 2009; Kwan et al., 2014; Palani and Giudice, 2017; Meena et al., 2018; Menges et al., 2019; Manresa-Yee et al., 2019). Examples of disability simulations used in HCI research include splints or gloves that limit motion or dexterity, low vision simulation glasses, blindfolds, earplugs, or even impairment simulator software and augmented/virtual reality that alters interface quality or trigger random mouse motion and key errors (Cardoso & Clarkson, 2012; Choo et al., 2019; Giakoumis et al., 2014; Keates & Looms, 2014; Petrie & Bevan, 2009; Pinheiro et al., 2021; Sears & Hanson, 2011). Simulating disabilities has great potential to increase the pool of participants to recruit for user testing, which may allow significantly improving their efficiency.

Nevertheless, research has also reported an asymmetry in psychological measures of IT (e.g., scales and surveys), in contrast with behavioral performance with IT, between PWD and able-bodied participants (Bajcar et al., 2020; Ming et al., 2021; Pascual et al., 2014; Trewin et al., 2015). This asymmetry was in part attributed to PWD who tend to report higher levels of satisfaction with IT, despite having lower performance, in contrast with able-bodied participants. In user testing contexts, the positive bias in the psychological measures of IT can negatively impact the effectiveness of design recommendations, which may be misleading or hide areas for improvement. Yet, research has still not investigated whether able-bodied participants with simulated disability can overcome the above methodological issue by providing psychological measures that are more aligned with their behavioral performance and free of positive bias. Consequently, able-bodied participants with simulated disability may allow improving both the efficiency and effectiveness of user testing in the design of AT and inclusive IT.

The other contributing factor to the digital divide is that PWD have insufficient access to solutions and skills for adapting and improving their effective use of IT (Senjam, 2021; Brunner et al., 2022; Wilson et al., 2022). Learning or relearning to use IT with familiar technologies or new AT after a permanent or temporary disability can be considered as a form of digital rehabilitation, which has been broadly defined as the use of digital technologies during the recovery process (Arntz et al., 2023). Despite the growing development of solutions to improve IT access and use, matching those solutions with PWD and helping them develop the necessary skills to use IT effectively remain an important challenge in rehabilitation practices (Davies et al., 2010; Enríquez et al., 2024; Mavrou et al., 2017; Perfect et al., 2019; Senjam et al., 2021; Tannous & McGrew, 2021).

Researchers in rehabilitation science have developed guidelines and tools to assist health professionals (e.g., occupational therapist) in the assessment of their patients' IT access needs (Koester et al., 2007; Simpson et al., 2010 Koester et al., 2013; Koester and Mankowski, 2014; Koester and Mankowski, 2015). Yet, these tools often focus on limited performance metrics like pointing and typing speed and accuracy, and on a small range of IT devices (e.g., computer) and IT access needs (e.g., physical disability). Moreover, recent literature reviews highlighted the lack of guidelines and training to assist health professionals in the provision of AT to their patients (Layton et al., 2024; Manship et al., 2024). With the current paradigm shift toward the assessment of IT-based activities of daily living in rehabilitation science (Quamar et al., 2020), there is a need for more interdisciplinary research to better understand how PWD can use IT more effectively.

Therefore, ensuring the digital inclusion of PWD is a twofold research problem caused by non-inclusive IT design practices and the lack of awareness, resources, and support of PWD for improving their effective use of IT. This thesis in IS research is primarily motivated by the above challenges, which are highly relevant and timely for our field based on recent initiatives and special issues on diversity, equity, and inclusion (Aanestad et al., 2021; Burton-Jones & Sarker, 2021), as well as a call for future Human-Centric Healthcare (Bardhan et al., 2025). Furthermore, with current laws, policies, and initiatives for improving the inclusion of PWD and rehabilitation services in our digital society and workplace, the field of IS can and should contribute to the above areas of research (Babin & Kopp, 2020; Blanck, 2020; Gimigliano & Negrini, 2017; Vaughn & Cournan, 2024).

In summary, it is not only more ethical and moral, but also economically sustainable to bridge the disability digital divide. Interdisciplinary academic research is required, along with industry practices influenced by government laws and policies, to develop AT and inclusive IT, as well as to make sure that they are provided and used effectively by PWD. Addressing the twofold disability digital divide can drive PWD's online participation and employment (Albala et al., 2021; Garg et al., 2021), as well as their disability management and recovery (Baffert et al., 2023; Gentili et al., 2022; Shambushankar et al., 2025), all of which can contribute to economic sustainability goals. The next section explores how the field of IS, specifically, has contributed to research addressing the disability digital divide.

Previous Work in IS Research

Recent literature reviews about PWD and IT published in the field of IS have drawn on the literature in HCI, rehabilitation, and even urban studies (Mäkipää et al., 2022; Zhou et al., 2024). Indeed, as noted by a recent literature review, there is a low number of publications in IS addressing the disability digital divide (Vassilakopoulou & Hustad, 2023). In this research, we conducted a scoping literature review to have a broader view of research on PWD and IT published in core IS research (i.e., Association for Information System basket of 11 journals). The review revealed that only 29 articles studying the development or impact of IT for PWD were published between the years 2000 and 2025 (see Appendix A for details). This small body of literature is also highly fragmented, from design science to behavioral studies, investigating IT for management and treatment of disabilities, or for social and workplace inclusion by PWD. Table 1 presents the sample of 29 articles, from which we extracted (1) the IT artifact designed or studied, (2) the use of foundational theory, and (3) the type of data collected from PWD.

Articles	IT artifact design (principles) or impact	Foundational Theory (example)	Data Collected from PWD
Liang et al. (2006)	Medication adherence IT	Transtheoretical Model	Survey and interviews
Miscione (2007)	Telemedicine	New Institutional Theory	Interviews
Cho & Mathiassen (2007)	Telehealth Innovation	Van de Ven's Framework	No
Tulu & Chatterjee (2008)	Telemedecine	No	No
Michopoulou et al. (2013)	Tourism IT	Design Theory	User tests
Bourois et al. (2014)	Disease detection IT	No	No
Liang et al. (2017)	Online health information	IS Success Model	Survey
Liang et al. (2017)	Hospital IT	Service Fairness Theory	Survey
Rodriguez-S. al. (2017)	AT (wayfinding)	None	User tests
Newman et al. (2017)	Digital inclusion	Bourdieu's critical theory	Interviews
Heath & Babu (2017)	IT workplace inclusion	Theories of Fit	No
James et al. (2017)	Social media	Need-to-belong Theory	Survey
Tuunanen et al. (2018)	Mobile device	Systems Theory of Disability	Interviews
Karaca et al. (2019)	Stroke management app	No	Secondary data
García et al. (2019)	Stroke detection app	No	No
Pethig & Kroenung (2019)	AT adoption	Technology Acceptance Model	Survey
Savoli et al. (2020)	Self-management IT	Theory of Effective Use	Interviews
Liu et al. (2020)	Online health community	Illness Theory	Survey
Yu et al. (2022)	Analytic model	No	No
Hwang et al. (2022)	Teleconsultation	Network Theory	Secondary data
Randolph et al. (2022)	AT (communication)	Media Synchronicity Theory	Interviews
Jia et al. (2022)	Intrinsic interest in IT	Cognitive Theory of Autism	Survey
Mettler et al. (2023)	AT (smart home)	No	Field experiment
Wass et al. (2023)	App development	None	Interviews
Goodarzi et al. (2023)	Social media	Selection Optimization Compensation	Survey
Ayabakan et al. (2024)	Telehealth	Process Virtualization Theory	No
Turel & Bechara (2024)	IT decision making	Avoidance Theories	Survey
Gao et al. (2024)	AT use	Fraser's Social Justice Theory	Survey and interviews
Abramova al. (2025)	Inclusive IT workplace	None	Interviews

Table 1: Sample of articles on PWD published in the AIS basket of 11 between (2000-2025) by year of publication

Most articles in the sample (15 of 29) designed or studied IT in the context of healthcare for telemedicine, telehealth, teleconsultation, and other services aiming to detect, manage and treat disabilities. In six articles, researchers designed or studied AT for wayfinding (Rodriguez-Sánchez & Martinez-Romo, 2017), communication (Randolph et al., 2022), or to assist with daily living activities (e.g., Gao et al., 2024; Pethig & Kroenung, 2019), while the other articles focused on the inclusive design of IT and workplaces (e.g., Abramova et al., 2025; Michopoulou & Buhalis, 2013; Tuunanen & Peffers, 2018). Studies using a behavioral research approach have typically used theories from IS and/or borrowed from other fields like disability studies to extend their theoretical framework. For instance, studies in our article sample have extended the Technology Acceptance Model and the IS Success model with constructs from the social identity theory in AT adoption (Pethig & Kroenung, 2019) or from the rational choice theory in online health information use by PWD (Liang et al., 2017). Although these extended theories can be relevant for studying people with certain disabilities or certain types of IS, the resulting theoretical development may not be generalizable to other conditions or to able-bodied people, which stresses its inclusiveness.

Regarding methodological approaches, most articles in the sample report on survey studies or phone interviews (Liang et al., 2006; Tuunanen & Peffers, 2018), which is aligned with the challenge of in-person participatory research in the HCI and accessibility literatures (Brulé et al., 2020; Mack et al., 2021). Few studies have conducted user testing, case studies, or in-person interviews with PWD, although their sample sizes are limited to a small number of participants (Mettler et al., 2023; Randolph et al., 2022; Rodriguez-Sánchez & Martinez-Romo, 2017). These studies have even supplemented their smaller samples of PWD with able-bodied participants for proof-of-concept (Randolph et al., 2022) or for usability comparison (Rodriguez-Sánchez & Martinez-Romo, 2017), which is also aligned with HCI and accessibility research (Brulé et al., 2020; Mack et al., 2021). Therefore, our scoping review support recent literature reviews in IS calling for more participatory research with PWD (Mäkipää et al., 2022; Zhou et al., 2024).

In summary, the scoping review highlights two interconnected areas for future IS research involving PWD. First, there is a need to develop IS theories that are inclusive, meaning that they can be applied to people of all abilities. In other words, instead of developing extended or adapted IS theories that can only be applied to a specific population of users, our field should develop theories that can be applied to both PWD and able-bodied people, which would encourage inclusive samples of participants in research. Second, our review stresses the need for more participatory research with PWD to better understand their needs and their experience of IT use. Despite the well-known challenges related to in-person participatory research with PDW in the HCI and accessibility literatures, research needs to develop strategies for encouraging the inclusion of PWD in participatory research. Consequently, we believe that the development of inclusive IS theories, along with guidelines for including PWD in participatory research, can conjointly contribute to research addressing the disability digital divide.

Research Objectives

Based on the practical issues and the scientific shortcomings identified in the previous sections, this thesis aims to advance theories and methods for encouraging and improving research with PWD in IS and other fields, while also contributing to the development of inclusive IT design and digital rehabilitation practices. In the present section, we elaborate on three research objectives, which include (1) developing inclusive IS theory, (2) testing the validity of psychological measures of IT by PWD, and (3) testing the validity of participants with simulated disabilities in user testing of AT and inclusive IT design.

Research Objective 1: Developing Inclusive IS Theories

The results of the scoping review presented in the previous section highlight that IS researchers studying PWD have either extended IS theories with constructs from theories outside of IS (Liang et al., 2017; Pethig & Kroenung, 2019), or they have adapted theories from other fields into IS contexts (Jia et al., 2022). The resulting theoretical development risks poor generalizability to other disabilities or to able-bodied populations, which goes against the idea of inclusive theories. Therefore, this thesis first addresses the following overarching research question: ***To what extent can we adapt IS theories that are inclusive for people of all abilities?***

We propose approach to make IS theories more inclusive by refining their constructs and models to improve their precision and scope. In the first essay, we challenge the common assumption that efficiency is determined by both the time and effort resources spent, in the conceptualizations of individual IT performance in theories of use (Ringeval et al., 2025). Specifically, this essay argues that researchers need to distinguish and consider both time and effort efficiency when measuring IT use performance by PWD. Building on the Theory of Effective Use (TEU) by Burton-Jones and Grange (2013), as well as data from 37 semi-structured interviews with stroke patients, therapists, and caregivers, we develop an adapted TEU model that considers both time and effort efficiency separately. Applying our data to the adapted model, we show that stroke patients can experience trade-offs between time and effort efficiency dynamically throughout their recovery. This essay further offers propositions predicting the impact of adaptation and learning actions on IT use performance and digital rehabilitation outcomes of PWD and even able-bodied users, thereby enhancing the inclusiveness of the theoretical development.

In the second and third essays drawing on the Expectation-Confirmation Theory (ECT) (Brown et al., 2014), we propose that users can have experiences pre- and post-disabilities, both of which may influence the confirmation of their expectations of IT performance. The second essay of this thesis, currently in a second round of revision at the *Journal of the Association for Information Systems (JAIS),* is driven by the methodological issue of asymmetry in psychological measures of IT, in relation to behavioral performance measures, between PWD and able-bodied participants in user testing. Since able-bodied participants are extensively used to complement PWD in user testing of AT or inclusive IT design, it is important to better understand the validity of psychological measures of IT. Using a mixed-method experiment with 15 stroke patients with physical disability and 21 able-bodied participants with physical disability simulation, the second essay sheds light on the above asymmetry and provide theoretical explanations for its underlying mechanism through the ECT lens. Specifically, our data suggest that a positive bias in psychological measures may occur because of the novelty of IT, with which both PWD and able-bodied participants have little to no expectations. The data further suggest that able-bodied participants with a simulated disability affecting their ability to use familiar IT, with which they have expectations, can provide psychological measures that are more aligned with their behavioral performance measures.

Building on the second essay, the third essay further investigates the mechanisms explaining the positive bias in psychological measures, as well as solutions to mitigate this bias. A mixed-method experiment involving 70 participants with situational (simulated) and permanent congenital (i.e., since birth) or acquired low vision and blindness was conducted to test the role of ability loss experience (i.e., acquiring a disability) on the positive bias in psychological measures of IT. We found that both participants with acquired blindness or low vision and able-bodied participants with acquired simulated low vision exhibited a positive bias in their psychological measures of IT, but not participants with congenital blindness and able-bodied participants without simulated disability. This finding supports the idea that the positive bias can be influenced by the permanent or situational ability loss experience. Moreover, our second and third essays provide theoretical explanations through the ECT lens for the positive bias of people with acquired disabilities. Specifically, we argue that PWD have experiences and expectations about IT performance before their disability onset, and that these expectations may influence their satisfaction with the IT post-disability experience.

Research Objective 2: Testing the Validity of Psychological Measures

Quantitative and qualitative evaluations of IT are important methods to assess IT performance both in research and in industry. As discussed in the previous section, psychological measures are crucial for the design of AT or inclusive IT. To develop and test theories, IS research often use survey methods, as shown by our scoping review. Survey methods can be particularly relevant for populations that are difficult to access for participatory research. However, as previously discussed, psychological measures by PWD may suffer from a positive bias, which can affect their validity (Bajcar et al., 2020; Ming et al., 2021; Trewin et al., 2015). Yet, the underlying mechanism and contributing factors of the positive bias are still unclear in HCI and accessibility research (Bajcar et al., 2020), which does not allow the development of strategies to mitigate its impact on the validity of psychological measures of IT.

The second research objective of this thesis is to test the effect of technology familiarity (Essay 2) and disability experience (Essay 3) on the asymmetry in psychological measures of IT, in contrast with behavioral/neurophysiological measures, between PWD and able-bodied participants with simulated disability. From a practical point of view, understanding the effect of technology familiarity on psychological measures is relevant since novel AT development requires testing by users who are likely to have little to no experience with the technology. Moreover, insights on how the experience of permanent, temporary, or situational (i.e., simulated) ability loss may shape psychological measures can be relevant for effective and efficient sampling of participants in user testing of AT and inclusive IT design. Therefore, the next research objective investigates whether the positive bias in psychological measures of IT is influenced by users' experiences with the technology (Essay 2), and their experiences before their ability loss (i.e., disability onset) (Essay 3). Building on the above research objective, we address the following research questions: ***To what extent does the technology experience (Essay 2) / ability loss experience (Essay 3) influence the positive bias in psychological measures of IT?***

The positive bias in psychological measures can be assessed based on behavioral/neurophysiological measures of IT. Traditional measures like task completion time and task success or accuracy provide a relevant and even direct index of constructs like task time efficiency or effectiveness (Koester & Arthanat, 2018; MacKenzie & Isokoski, 2008). Moreover, advances in neurophysiology and growing access to neurophysiological measurement tools in HCI and IS show great potential for real-time and non-intrusive assessment of constructs (e.g., cognitive state) that would be difficult to assess otherwise (Dimoka et al., 2012; Kosch et al., 2023; Zaki & Islam, 2021).

The use of neurophysiological measures or NeuroIS approaches can also allow researchers to enhance the internal validity of psychological measures collected via surveys (Kirwan et al., 2023). In this thesis, our aim is not to validate our psychological measures with neurophysiological measures. Instead, we use neurophysiological measures to test whether their relationships with corresponding psychological measures differ across groups of participants, or between different IT. Our experiments and NeuroIS approach benefit from high ecological validity as we used similar test procedures, tasks, and measurement methods to those typically used in digital rehabilitation interventions (e.g., computer access assessment) (Essay 2) and user testing (Essay 3) (Balapour & Riedl, 2025).

Research Objective 3: Testing the Validity of Participants with Simulated Disability

Complementing our previous research objective, our third objective aims to test the validity of able-bodied participants with simulated disability in user testing of AT or inclusive IT. As discussed, PWD are difficult to access and recruit for conducting participatory research like user testing. Therefore, using able-bodied participants with simulated disability is a popular practice in HCI research to identify usability and accessibility issues in user tests (Chen et al., 2009; Choo et al., 2019; Jenko et al., 2010; Meena et al., 2018; Petrie & Bevan, 2009; Pinheiro et al., 2021). With our third research objective, we state the following research question: ***How does the disability experience (i.e., congenital or acquired permanent, temporary, and situational) influence the usability/accessibility issues identified in user testing context?***

In Essay 2, we show that participants with post-stroke disabilities, who can recovery some or most of their abilities with time or exercising, may see value in an AT that encourages them to use and exercise their affected functions. In contrast, able-bodied participants with simulated disability did not realize this added value and instead focused on the device performance by contrasting it to familiar alternative technologies. Nevertheless, able-bodied participants with simulated disability mentioned some relevant usability issues with the AT. In Essay 3, our results suggest that the nature of accessibility issues identified by participants may depend on disability experience. For example, participants with acquired and congenital blindness identified different types of accessibility issues, although this may be caused by the different level of skill between the two groups. Nevertheless, we found that participants with acquired situational (i.e., simulated) visual disability experienced and mentioned accessibility issues that were also experienced and mentioned by participants with acquired permanent visual disability.

The following figure illustrates how the above research objectives are addressed in this essay-based thesis. The first objective of inclusive IS theory development is addressed in all three essays. Essay 1 introduces a more inclusive conceptualization of individual IT performance that is used in the following two essays. Specifically, we propose to distinguish between time and effort efficiency when conceptualizing and evaluating individual IT performance by PWD. Moreover, Essay 1 extends the TEU framework in post-stroke digital rehabilitation settings. Essays 2 and 3 also make the distinction between time and effort efficiency in the framework and theories used to assess technology usability or acceptance in HCI and IS. In addition, the second and third essays propose to extend the ECT framework by considering users' pre- and post-disability expectations about technology performance.

We address the second and third objectives in Essays 2 and 3, in which we respectively investigate the effect of familiarity with the technology, and the effect of experiences before disability onset, on the validity of psychological measures of IT. Simultaneously, the second and third essays allow us to test the validity of able-bodied participants with simulated disability to improve the effectiveness and efficiency of user testing of AT and inclusive IT design. While the second essay contrasts participants with acquired situational (i.e., simulated) and permanent/temporary (i.e., post-stroke) physical disability experience, the third essay contrasts participants with acquired situational (i.e., simulated) and permanent, as well as congenital permanent, visual disability experience.

Research objectives by essay	**Essay 1** (In preparation for *ISR*)	**Essay 2** (In 2nd round of revision at *JAIS*)	**Essay 3** (In preparation for *MISQ*)
Research Objective 1 Developing inclusive IS theory	Adapting the conceptualiztion of **individual IT performance** (distinguish time from effort efficiency)		
	Extending the **TEU** in post-stroke digital rehabilitation	Extending the **ECT** with pre- and post-disability expectations	
Research Objective 2 Testing the validity of psychological measures		Effect of **technology experience** on validity of psychological measures	Effect of **ability loss experience** on validity of psychological measures
Research Objective 3 Testing the validity of participants with simulated disability		Simulated physical disability **vs.** Acquired permanent/temporary physical disability	Simulated visual disability **vs.** Acquired and congenital permanent visual disability

Note: ISR: Information Systems Research; JAIS: Journal of the Association for Information Systems; MISQ: Management Information Systems Quarterly; TEU: Theory of Effective Use; ECT: Expectation Confirmation Theory

Figure 2: Thesis framework by research objective and essay

Through the above research questions, the three essays investigate how the disability experience influences IT use and design. The disability experience can be distinguished by (1) its body function affected, or whether it is physical, sensory (e.g., vision or hearing), or cognitive, (2) its onset, or whether it is acquired or congenital (i.e., since birth), and (3) its duration, whether it is permanent, temporary, or situational. This classification of disability experience is inspired by the medical and social models of disability. The medical model is guided by the WHO International Classification of Functioning, Disability and Health, which broadly classifies disabilities into physical and speech (e.g., paralysis, dysarthria, apraxia), sensory (e.g., low vision, blindness, hearing loss), and cognitive functions (e.g., memory deficits, executive dysfunction) (WHO, 2001). The medical model also considers the onset and duration of disability (e.g., congenital vs. acquired) in diagnosis, treatment, and prognosis.

Meanwhile, the social model of disability views disabilities as a permanent, temporary, or situational barrier imposed by a social environment (Oliver, 2013; Oliver et al., 2012; Siebers, 2008). Therefore, the social model also considers that able-bodied people can have situational (e.g., simulated) disabilities. The next chapter presents the first essay of this thesis focusing on post-stroke disabilities, which are acquired permanent or temporary disabilities that typically affect physical, visual, and/or cognitive functions. The following second chapter also investigates post-stroke disabilities, and specifically physical disabilities, along with situational (i.e., simulated) physical disability in able-bodied individuals. The third chapter focuses on congenital and acquired permanent visual disability, as well as situational (i.e., simulated) visual disability. The figure below summarizes the different disability experiences investigated in each essay (Figure 3).

Essay 1

Body Function	Disability Onset	Disability Duration
Physical **Visual** **Cognitive**	Congenital	**Permanent**
	Acquired	**Temporary**
		Situational

Essay 2

Body Function	Disability Onset	Disability Duration
Physical	Congenital	**Permanent**
	Acquired	**Temporary**
		Situational

Essay 3

Body Function	Disability Onset	Disability Duration
Visual	**Congenital**	**Permanent**
	Acquired	Temporary
		Situational

Figure 3: Disability experience studied by essay

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Appendix A: Scoping Literature Review

Research in disability and health studies have developed a strategy for searching publications on disabilities in electronic databases. These strategies suggest that, with modern models and conceptualizations of disabilities, researchers should avoid narrow search strategies with condition-specific terms such as stroke, traumatic brain injury, or ADHD (Walsh et al., 2014). However, research also argues that a large proportion of articles about disabilities are not captured by only using general terms like disability or impairment, and that condition-specific terms should also be included (Ioerger et al., 2019).

Based on keywords suggested by previous guidelines for literature reviews related to PWD (Ioerger et al., 2019; Walsh et al., 2014), we searched for a wide range of general and condition-specific terms. We also added other terms based on the literature focusing on specific types of impairments (Martin Ginis et al., 2016; Pascolini & Mariotti, 2012). Finally, to also include articles adopting a social perspective rather than a medical perspective of disabilities, we added terms access- (access, accessible, accessibility) and inclus- (inclusive, inclusion) based on past literature review on accessibility (Mack et al., 2021). Our list of keywords can be found in the next table (Table 2).

Keywords suggested by previous guidelines (Ioerger et al., 2019; Walsh et al., 2014)	activities of daily living, ADHD, amputation, amyotrophic lateral sclerosis, autism spectrum disorder, blindness, cerebral palsy, concussion, dependent ambulation, developmental disabilities, disabled persons, Down syndrome, hearing impaired, hearing loss, mental disorders, mobility limitation, multiple sclerosis, muscular dystrophy, myopathy, paraplegia, peripheral neuropathy, quadriplegia, self-help devices, spina bifida, spinal cord injury, spinal muscular atrophy, stroke, traumatic brain injury, visually impaired, vision disorders

<table>
<tr><td>Keywords added based on other literature reviews</td><td>(General): access*, inclus*, rehabilitation, disab*, impair*, disorder*, syndrome, deficit, ill, illness
(Visual): vision loss, glaucoma, cataract, macular degeneration, diabetic retinopathy, Retinitis pigmentosa, color blindness, myopia, hyperopia
(Cognitive) dyslexia, dyspraxia, dyscalculia, Alzheimer’s Disease, Dementia, Schizophrenia, depression, neurodiver*
(Physical): Parkinson’s, osteoarthritis, rheumatoid arthritis, ataxia, tetraplegia, hemiplegia, hemiparesis, fibromyalgia
(Speech): Aphasia, Dysarthria, Apraxia, Dysphonia, stuttering,
(Hearing): Deaf</td></tr>
<tr><td colspan="2"><u>Example of search query in the abstracts of the basket of 11 journals:</u>

(SO= ("Decision Support Systems" OR "European Journal of Information Systems" OR "Information Management" OR "Information and Organization" OR "Information Systems Journal" OR "Information Systems Research" OR "International Journal of Information Management" OR "Journal of Management Information Systems" OR "Journal of Strategic Information Systems" OR "Journal of the Association for Information Systems" OR "MIS Quarterly"))
AND
(AB= ("access*" OR "inclus*" OR "rehabilitation" OR "activities of daily living" OR "ADHD" OR "Alzheimer’s Disease" OR "amputation" OR "amyotrophic lateral sclerosis" OR "Aphasia" OR "Apraxia" OR "Ataxia" OR "autism spectrum disorder" OR "blindness" OR "cataract" OR "cerebral palsy" OR "color blindness" OR "concussion" OR "deaf" OR "deficit" OR "dementia" OR "dependent ambulation" OR "developmental disabilities" OR "diabetic retinopathy" OR "disab*" OR "disabled persons" OR "disorder*" OR "Dysphonia" OR "Down syndrome" OR "dysarthria" OR "dyscalculia" OR "dyslexia" OR "dyspraxia" OR "glaucoma" OR "hearing impaired" OR "hearing loss" OR "Hemiparesis" OR "Hemiplegia" OR "hyperopia" OR "ill" OR "illness" OR "impair*" OR "macular degeneration" OR "mental disorders" OR "mobility limitation" OR "multiple sclerosis" OR "muscular dystrophy" OR "myopathy" OR "myopia" OR "neurodiver*" OR "Osteoarthritis" OR "Parkinson’s disease" OR "paraplegia" OR "peripheral neuropathy" OR "quadriplegia" OR "Rheumatoid arthritis" OR "Retinitis pigmentosa" OR "schizophrenia" OR "self-help devices" OR "spina bifida" OR "spinal cord injury" OR "spinal muscular atrophy" OR "stroke" OR "stuttering" OR "syndrome" OR "Tetraplegia" OR "traumatic brain injury" OR "vision disorders" OR "vision loss" OR "visually impaired"))</td></tr>
</table>

Table 2: Keyword search terms and query example

We searched, in the Web of Science and the AIS eLibrary databases, the above keywords in the title, abstract, and author keywords of articles published between the years 2000 and 2025 (March). This date range was chosen based on the introduction of the web and its accessibility standards (WCAG 1.0) in 1999, as well as the consequent traction of legal frameworks like the Americans with Disability Act (ADA) to address the disability digital divide. A literature search was performed in the AIS basket of 11 journals on the 1st of March 2025. The goal of this search was to map the top IS research involving PWD and IT. We further aimed to categorize the articles according to the purpose for which IT is developed or used, which can include health-related or digital inclusion purposes. Finally, we extracted, from each article, the research paradigm, foundational theories used, and the type of data collected from PWD, to better understand how IS research has contributed to our understanding of IT phenomenon related to PWD.

The search of all articles published in the AIS basket of eleven journals since 2000 revealed 178 articles, of which we excluded those that were not related to PWD. We also focused on articles that collected data or designed an IT artifact, thereby excluding literature reviews and conceptual papers. Finally, we excluded studies that developed IT artifacts or analytic models that were targeting clinician use. We focused on articles that studied or designed an IT artifacts intended to be used by PWD or patients.

Chapter 1
Essay 1 - Rethinking IT use Performance with Disabilities: A Case Study in Post-Stroke Digital Rehabilitation

Abstract

The development of theories of use like the theory of effective use (TEU) in information system (IS) research has offered rich frameworks to study and improve how people use information technologies (IT) in everyday contexts. However, the current view of theories of use like the TEU oversimplifies the multifaceted nature of efficiency by combining time and effort input, which may not be appropriate for people with temporary disabilities like stroke patients who can recover with time and by exercising their affected functions. We propose an extended TEU framework based on an exploratory case study involving three rounds of semi-structured interviews with 37 stroke patients, health professionals, and caregivers. Our results show evidence that adaptation and learning actions to improve IT use can independently influence time efficiency and effort efficiency. More importantly, our data shows that time and effort efficiency evolve dynamically throughout the recovery process of stroke patients who face trade-offs when implementing adaptation and learning actions. Finally, we find that adaptation and learning actions can have a competing influence on digital rehabilitation outcomes, such as professional reintegration and functional recovery. The paper concludes with contributions of the theoretical development to study IT use by PWD and able-bodied people, as well as implications for rehabilitation practice.

Keywords: Theory of effective use, individual performance, digital rehabilitation, post-stroke disabilities, exploratory case study

1.1 Introduction

More than 1.3 billion people worldwide have a form of disability (WHO, 2022), of which a third can recover some or most of their abilities with time and/or treatment like physiotherapy in a time frame of up to 12 months (Ward et al., 2017). The support and care of people with permanent or temporary disabilities represent an important global economic cost linked to productivity loss, low participation in the society, invalidity compensation for unemployment, as well as healthcare and rehabilitation services (Owolabi et al., 2022; Weil, 2001). Despite the benefits of information technologies (IT) for promoting online participation, professional reintegration, and health or recovery (Ayabakan et al., 2024; Bastien et al., 2020; Perez et al., 2023; Raja, 2016; Sieck et al., 2021), research has consistently reported disparities in IT usage between PWD and their able-bodied counterparts (Duplaga, 2017; Scanlan, 2022; Vicente & López, 2010). Although there are many solutions to improve the use of IT by PWD, including third-party assistive technologies (e.g., adapted mice and keyboards) and accessibility features (e.g., speech recognition) integrated in operating systems (Davies et al., 2010; Perfect et al., 2019; Senjam et al., 2021; Simpson, 2013) PWD and their support network generally lack awareness and resources (Howard et al., 2022; Pugliese et al., 2018; Spits et al., 2024; van Ommeren et al., 2018). While designers, health professionals, managers, and policy-makers increasingly face legal pressure to ensure that their customers, patients, employees, or citizens can use IT services effectively (Babin & Kopp, 2020; Blanck, 2020; Kim & Park, 2020; Scott Kruse et al., 2018), there is a need to better understand how to improve IT use by PWD.

Research in IS has developed various theories to study how individuals use IT, and how different types of use or contextual factors shape performance outcomes (Burton-Jones & Straub Jr, 2006; Ringeval et al., 2025). However, the literature shows that IS research has generally developed conceptualizations of performance with constructs of effectiveness and efficiency in terms of time (Ringeval et al., 2025; Trieu et al., 2022), which may not be adapted for PWD. Specifically, theories in disability studies have challenged the modern societal expectations about productivity shaped by capitalist and chrononormative values (Kafer, 2013). For instance, research has argued against the use of time efficiency as a performance metric for PWD in the workplace or academia (Cosenza, 2014; Katzman et al., 2020; Rodgers et al., 2023; Soklaridis et al., 2021). Furthermore, theories of IT use tend to overlook the construct of efficiency in terms of effort in their operationalization, despite conceptualizing efficiency as both time and effort input combined (Barki et al., 2007; Burton-Jones & Grange, 2013; Ringeval et al., 2025). While the effort required to use an IT may be less important for able-bodied users in the post-adoption stage (Karahanna et al., 1999), research has shown that perceived ease of use may still be important for people with post-stroke or chronic impairments (Broderick et al., 2023; Kerr et al., 2018; Klaic & Galea, 2020; Tian & Wu, 2022). This is in line with the model of selection, optimization, and compensation used rehabilitation science to explain how patients adapt to acquired disabilities or declining abilities by managing their resources through different strategies such as compensating or optimizing their effort (Baltes & Rudolph, 2013; Blok et al., 2020; Donnellan & O'Neill, 2014).

In this research, we propose making theories of IT use more inclusive for PWD by distinguishing between time efficiency and effort efficiency for better capturing the performance associated with IT use. We explore this idea with Burton-Jones and Grange's (2013) theory of effective use (TEU) in the context of digital rehabilitation, which we define as the process of improving IT use during recovery. The TEU was chosen as our theory of IT use due to its emphasis on the goal for which IT is used, which may differ according to people's disability experience or recovery potential (Dobkin, 2004;

Ownsworth & Shum, 2008). For instance, patients may need IT to return to work, complete an online banking transaction, or recover their abilities through telerehabilitation. Additionally, the context of digital rehabilitation is highly relevant due to the current paradigm shift toward the assessment of IT-based functional activities in rehabilitation science (Quamar et al., 2020) and the World Health Organization initiative calling for more interdisciplinary efforts to scale up rehabilitation services globally by 2030, notably using IT (Bernhardt et al., 2020; Gimigliano & Negrini, 2017).

Our work addresses the two following research questions: (1) *What is effective use of IT by PWD in a digital rehabilitation context?* (2) *How does PWD's effective use of IT influence digital rehabilitation outcomes?* We investigate these research questions at the individual level of analysis by drawing on insights from the literature on digital rehabilitation post-stroke, as well as three rounds of semi-structured interviews. Our interviewees included 16 stroke patients with various post-stroke disabilities, of which six were accompanied by caregivers to give their point of view or to assist with the patient's communication, as well as 15 health professionals including occupational, speech/language, and physical therapists. We used deductive thematic analysis to code the qualitative data according to the TEU framework with our *a priori* changes based on the literature on digital rehabilitation post-stroke. Based on our findings, we added *ex-post* changes to our extended TEU framework and developed testable research propositions.

Our findings contribute by first proposing that neglecting the distinction between time and effort efficiency in theories of IT use risks oversimplifying the multifaceted nature of efficiency and thus may not allow for conceptualizing and measuring individual IT performance by PWD appropriately. Our results show that performance conceptualization can be more inclusive for people with temporary disabilities by using a more granular view of efficiency. Overall, we contribute to calls for future IS research on human-centric healthcare (Bardhan et al., 2025) by suggesting that improving the use of IT during rehabilitation process may accelerate or facilitate the recovery of patients, while also enhancing their quality of life and professional development. The remainder of the article is structured as follows. First, we provide background information about the literature on digital rehabilitation and the TEU (Section 1.2). Based on the background literature, we then present *a priori* changes to the original TEU and our approach to identify *ex-post* changes through a qualitative study (Section 1.3). Our findings are then presented (Section 1.4) and discussed along with our contributions and future research avenues (Section 1.5).

1.2 Background

1.2.1 Digital Rehabilitation

The World Health Organization defines rehabilitation as a set of interventions designed to optimize functioning and reduce disability in individuals with health conditions in interaction with their environment (WHO, 2024). According to the WHO International Classification of Functioning, Disability and Health (ICF), rehabilitation practices require an interdisciplinary approach that aims at restoring or compensating for lost abilities, as well as to improve people's independence and participation in daily living. The above classification implies that rehabilitation can assist people with temporary disabilities (e.g., broken limbs, concussions, or post-stroke disabilities), who have the potential to recover most or all their abilities with time and/or exercise (e.g., physiotherapy) in a time frame of up to 12 months (Ward et al., 2017), or those with permanent disabilities that require compensating for disabilities with little to no recovery potential.

People with temporary disabilities like stroke patients who have the potential to recover their abilities can face a trade-off between recovery (e.g., engaging and exercising their impaired functions) and compensation (e.g., compensating for their affected functions with non-affected functions or AT). According to the model of selection, optimization, and compensation used in research on stroke rehabilitation (Baltes & Rudolph, 2013; Donnellan & O'Neill, 2014) and IT use by PWD (Blok et al., 2020), users can decide to stop performing an activity, to continue performing the activity by optimizing their affected functions, or by compensating for their affected functions. While compensatory strategies can increase stroke patients' independence in daily activities, they risk negatively impacting the long-term recovery of their affected functions, which requires them to be engaged and exercised to recover or to maintain. Consequently, research has developed solutions like constraint-induced therapy to encourage patients like stroke patients to use their affected function by restraining their unaffected function, thereby avoiding further deterioration of their affected function (Taub et al., 1999, 2006). Therefore, while experiencing challenges (e.g., effortful task) in daily activities may have negative outcomes on stroke patients' enjoyment and engagement, they can be beneficial for their recovery of functional abilities (Gomes et al., 2025).

In the past years, increasing evidence has shown that digital technologies can play a crucial role in assessing, exercising (optimizing), or compensating for disabilities (Gustavsson et al., 2018, 2020; Lemke et al., 2020; Marwaa et al., 2020). Digital rehabilitation has been broadly defined as the use of digital technologies (e.g., robotics, virtual reality, tablet) as a part of the rehabilitation process (Arntz et al., 2023). Most research on digital rehabilitation has focused on the therapeutic benefits of digital technologies like virtual reality for improving functional recovery (e.g., physiotherapy) or improving independence in non-IT-based activities of daily living (Chen et al., 2019; Longley et al., 2024; van Ommeren et al., 2018; Zhang et al., 2022). However, research found much evidence of barriers to the adoption of IT for rehabilitation and general purposes, including the lack of usability and accessibility of technology, the lack of knowledge and ability to use technologies, and the lack of support and training by healthcare professionals and caregivers to learn technologies (Howard et al., 2022; Pugliese et al., 2018; Spits et al., 2024; van Ommeren et al., 2018). Therefore, to fully harness the benefits of IT for rehabilitation, it is critical that PWD can use IT effectively.

Improving the access and use of IT by PWD is a form of digital rehabilitation that has received less interest in the literature. More commonly known as computer access in rehabilitation science (Simpson et al., 2010), this form of digital rehabilitation focuses on improving PWD's access to computers, tablets, or mobile devices via assistive technologies for IT access (e.g., adapted mouse or keyboard, eye tracker, brain-computer interface) and accessibility features (e.g., customizable mouse pointer speed, size, and color) (Davies et al., 2010; Perfect et al., 2019; Senjam et al., 2021; Simpson, 2013). Guidelines and tools for clinicians have been developed to assess computer access (e.g., pointing, typing, or scanning speed and accuracy) and select appropriate adapted input devices (Jenko et al., 2010; Koester et al., 2013, 2023). In sum, digital rehabilitation can be understood from two interconnected perspectives: 1) improving ability recovery using IT and 2) improving IT use during the recovery process. In this research, we are mostly interested in the second perspective, which has received less attention in research. We further argue that this second perspective can contribute to more effective use of IT (e.g., rehabilitation app or telehealth) for recovery purposes (i.e., first perspective) (Sieck et al., 2021).

1.2.2 Theory of Effective Use

Drawing on the Representation Theory (Wand & Weber, 1995), the TEU proposed by Burton-Jones and Grange (2013) suggests that an IS allows a user to access and interact with the representation of a domain via three structures. First, the physical structure refers to the machinery that supports an IS, including the input and output devices (e.g., keyboards and monitors). Second, the surface structure involves the features of a user interface (e.g., menu, layout) that allow users to access and interact with the representations. Third, the deep structure refers to the domain represented by the IS, which allow users to access and interact with information (Burton-Jones and Grange 2013, p. 642). The TEU posits that effective use of an IS requires transparent interaction with the surface and physical structures, which allows users to obtain representations from the system that faithfully reflect the domain being represented, and consequently take informed action to achieve their goals (Burton-Jones and Grange 2013).

According to TEU, effective use of an IS can be improved via adaptation and learning actions. Adaptation actions aim at improving a system's representation of the domain or users' access to the representation via the physical and surface structures (e.g., using a larger monitor, split-screen feature, or changing the textual information in a word processing system) (Burton-Jones & Grange, 2013). Learning actions allow users to learn the different structures of an IS, its represented domain, its fidelity, and how to leverage the representations obtained by the IS (Burton-Jones & Grange, 2013). The TEU also suggests that the dimensions of effective use influence performance, which is determined by effectiveness, defined as the extent to which a user has attained the goals of the task for which the system was used, and efficiency, defined as the extent of goal attainment for a given level of input (such as effort or time) (Burton-Jones & Grange, 2013).

The TEU framework can be approached from different perspectives by studying its drivers (i.e., adaptation and learning actions to improve effective use), its influencing factors (i.e., people, system, task, organizational factors), its dimensions (i.e., transparent interaction, representational fidelity, informed action), and its performance (i.e., effectiveness and efficiency) (Burton-Jones & Grange, 2013). Burton-Jones and Volkoff (2017) have also proposed an approach to study effective use by looking at how the actualization of affordances contributes to achieving users' or organizations' goals. The development of TEU has offered a broad research framework to study the use of IS in various contexts, including big data, wearables, virtual reality-based education, health IT, or crisis management, at the individual and organizational level (Abouzahra & Ghasemaghaei, 2022; Fromm et al., 2024; Guo & Chan, 2025; Ringeval et al., 2025; Ruoff et al., 2023; Savoli et al., 2020; Trieu et al., 2022).

Research using the effective use framework has conceptualized and measured efficiency inconsistently (Guo & Chan, 2025). Some studies using the TEU framework measured performance of IT artifacts (e.g., self-management system or wearables) based on chronically ill patients' level of effort in exercising or taking medications (Savoli et al., 2020), or seniors' perceived physical capability (Abouzahra & Ghasemaghaei, 2022). However, most studies measured efficiency in terms of time to complete a task with IT artifacts like conversational dashboard in crisis response (Ruoff et al., 2023) mobile health apps (Choi & Tulu, 2017), or business intelligence systems (Trieu et al., 2022).

Trieu et al. (2022) measured decision-making efficiency with the four following items: (1) *I make decisions without taking up too much time.* (2) *My process for making decisions is efficient.* (3) *I find that I make decisions very efficiently.* (4) *I make decisions speedily when I need to*. Although their definition of efficiency, borrowed from Burton-Jones and Grange (2013), includes both effort and time, the effort or resources spent is not explicit from the items. Likewise, using the same items of efficiency as Trieu et al. (2022), Ringeval et al. (2025) defined the construct as the extent to which resources such as time, effort, and energy are used to achieve goals. The combination of time and effort into the efficiency construct may stem from the broad definition and operationalization of efficiency in past research on IT use and effective use (Barki et al., 2007; Burton-Jones & Grange, 2013). In sum, the current development of TEU may not allow us to study effective use with PWD, and especially those with temporary disabilities who can recover with time and effort through rehabilitation. Therefore, in such contexts, it seems necessary to consider the influence of both time and effort efficiency and their interplay on IT use performance and outcomes.

1.3Methodological Approach

This section presents our methodological approach to develop our extended TEU framework based on the literature and an exploratory case study.

1.3.1 TEU Framework's a Priori Adaptations

Building on the interconnected research gaps identified in our introduction, we draw on Trieu et al. (2022) extension of previous guidelines (Hong et al., 2014) for contextualizing TEU in digital rehabilitation settings. This section presents the proposed *a priori* changes to the original TEU framework (Hong et al., 2014; Trieu et al., 2022). First, we are interested in the drivers of effective use, including PWD's adaptation and learning actions to improve their effective use of IT in a digital rehabilitation context. Furthermore, we study how influencing factors related to users' abilities impact the dimensions of effective IT use and their performance in terms of digital rehabilitation outcomes.

1.3.2 Refining the Theory by Focusing on Transparent Interaction

Unlike previous studies contextualizing TEU with specific IT artifacts (Abouzahra & Ghasemaghaei, 2022; Ruoff et al., 2023; Trieu et al., 2022), our work considers different IS involved in digital rehabilitation, including online communication tools for telerehabilitation, rehabilitation apps, or banking apps for online independence. Instead of focusing on the IS domain, we focus on the transparent interaction with the physical and surface structures that give access to the domains involved during digital rehabilitation. Specifically, we focus on the different assistive technologies for IT access and accessibility features that allow users to improve their performance with IT, which can influence digital rehabilitation outcomes. Therefore, we focus on the effect of transparent interaction with the physical, surface, and deep structures on IT performance (Figure 4). We also removed the actions of learning fidelity, learning representations, and how to leverage them, since they require specific representation domains (Burton-Jones & Grange, 2013), which is not our focus.

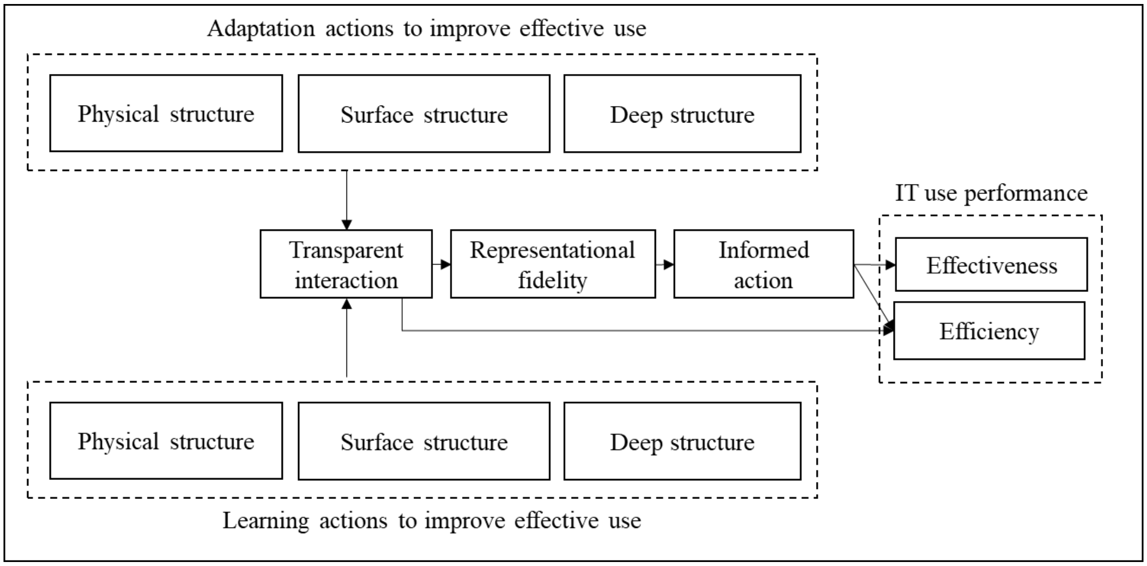

Figure 4: Adapted from Burton-Jones and Grange's (2013) TEU framework

1.3.3 Antecedents and Outcomes of Effective Use in Digital Rehabilitation Settings

Antecedents of effective use of IT in digital rehabilitation settings include the users' abilities and adapting and learning actions to improve IT use. First, digital rehabilitation after a stroke implies that users have one or multiple functions affected, for a certain amount of time based on their recovery potential, which needs to be considered in the framework.

We chose the WHO International Classification of Functioning, Disability and Health, which broadly classifies disabilities into physical and speech (e.g., paralysis, dysarthria, apraxia), sensory (e.g., blindness, hearing loss), and cognitive disabilities (e.g., memory deficits, executive dysfunction) (WHO, 2001). The above model was chosen among other classifications because it is closer to the theory of affordances in HCI (cognitive, physical, sensory, and functional) (Hartson, 2003) on which the TEU builds upon (Burton-Jones & Grange, 2013). Physical/speech and sensory disabilities mostly affect the physical structure of an IS. For example, physical disabilities affect the ability to control the cursor with a standard mouse or to input information via a standard keyboard, while speech disabilities may affect the ability to use a speech-to-text device, and visual or auditory disabilities impede the processing of information output by a monitor. Cognitive disabilities like short-term memory loss can impede access to the surface and deep structures, such as navigating in a user interface or understanding textual information at the representation level. In addition, cognitive disabilities may impede the learning of adapted physical or surface structures.

Other than the functions affected, the disability temporariness and recovery potential are other antecedents of effective use that should be considered. Disability temporariness can be defined as the time living with the disability, whereas the recovery potential is the extent to which functions can be recovered with exercising. Secondly, PWD can benefit from various adaptation and learning actions that can improve their access to an IS physical, surface, and deep structures. Regarding outcomes of effective use in the context of digital rehabilitation, we need to consider the goals or intended outcomes of IT use.

The literature on digital rehabilitation highlights two important goals that can be achieved: Functional recovery and online independence. Functional recovery after a stroke has been defined as the process by which patients regain lost abilities through a combination of biological, neurological, and behavioral mechanisms (e.g., optimization or compensation strategies) (Kwakkel et al., 2004). This definition is different than the process of restoring the ability to accomplish tasks with the same level of success as before injury since compensatory strategies can be used (e.g., using alternate limb or assistive technology). Functional recovery can be promoted through telerehabilitation services or apps and games, but also through daily IT interactions like manipulating a pointing device, typing, or speaking through a microphone. Access to IT via adaptation and learning strategies also allows patients to improve their independence in online activities such as banking, shopping, or social media. Based on the concept of independence in rehabilitation science (Mlinac & Feng, 2016), we define online independence as the ability to perform online activities of daily living without assistance from other people.

1.3.4 Refining the Construct of Efficiency into ''Time Efficiency'' and ''Effort Efficiency''

The literature on TEU has conceptualized and operationalized efficiency inconsistently as time or effort (Guo & Chan, 2025; Ringeval et al., 2025). When studying IT use by people with temporary disabilities, it is relevant to consider both time and effort to investigate their roles and the interplay between them. For instance, for users with temporary disabilities who can recover their abilities with time or by exercising them, effort efficiency may be less important and even detrimental, compared with users with permanent disabilities, when assessing IT performance. Indeed, users with temporary disabilities may need to engage their affected functions to promote their recovery even if it requires exerting greater levels of effort. Conversely, permanent disabilities may require users to compensate for their affected functions to maximize both effort and time efficiency. Therefore, we propose to split the construct of efficiency into two specific constructs, time efficiency and effort efficiency, along with effectiveness, when conceptualizing IT use performance. Based on the original definition of efficiency (Burton-Jones & Grange, 2013), we derive two separate definitions. Time efficiency can be defined as the extent to which an individual achieves a given goal using the least amount of time. We define effort efficiency as the extent to which an individual achieves a given goal using the least amount of human effort and computing power consumption.

1.3.5 Exploratory Case Study

We classify our qualitative research genre as an exploratory case study (Sarker et al., 2018) since we started our investigation with an existing theory, the TEU, which guided the interview questions development and data coding. We also used inductive reasoning to let themes emerge from the data as observed patterns, which allowed us to identify new variables and relationships that were not originally accounted for in the theory. Finally, our focus was not on testing predefined hypotheses, but rather on developing new testable propositions for future research, grounded in both the theory and the empirical evidence. We conducted three rounds of semi-structured interviews with 37 stroke patients, therapists, and caregivers in Canada and the United Kingdom. The three rounds of interviews were conducted over 15 months with three months between the first and second rounds, and seven months between the second and third rounds. The time between the interview rounds allowed us to reflect on insights, revisit our sampling strategy and interview guide for subsequent rounds (Figure 5).

The first round of interviews with 10 therapists, including four occupational therapists, four physiotherapists, one speech therapist, and one nurse, was exploratory (Figure 5). Health professionals can provide rich experiences and best practices in digital rehabilitation as they have been exposed to a set of challenges and solutions (Renjith et al., 2021). We used a snowball sampling method to recruit health professionals with experience working with stroke patients. In a second round, we interviewed 16 stroke patients, of which their caregivers accompanied six. Caregivers can be particularly useful to give their opinion or to complement the answers of stroke patients with cognitive or speech disabilities (Reimer et al., 2024). This round of interviews focused on the challenges of IT use and solutions from the perspective of stroke patients with a wide range of disabilities. Finally, a third round of interviews was needed to hear from the perspective of health professionals who had experience with digital rehabilitation interventions. Guided by interviewees of our first round, we recruited five professionals, including three occupational therapists, one speech therapist, and one technician, who had experience with improving access to IT for their patients. This third round aimed to investigate how adaptation and learning actions can influence rehabilitation outcomes. Interviews lasted between 27 and 96 minutes, and the transcripts were coded in NVivo 12. The interviews were part of a study approved by the Ethics Review Board of our institution (Ethics Approval: 2023-5345).

We used a primarily deductive thematic analysis method (Braun & Clarke, 2006) to analyze our data through the lens of our extended TEU framework. Like previous research extending the TEU with qualitative data (Trieu et al., 2022), we used a predefined coding template and allowed new codes to emerge (Fereday & Muir-Cochrane, 2006). This top-down approach was chosen to adapt a pre-existing theory and to explore the relationship between pre-existing concepts by applying them to the data. The codes were derived from the concepts of the a priori changes of our extended TEU. The coding began with a familiarization phase, followed by an initial coding phase allowing new codes to emerge. For example, predefined codes were linked to adaptation actions, learning actions, IT performance (e.g., effectiveness, effort efficiency, time efficiency), goals of IT use (functional recovery, online independence). Then, we performed a targeted exploration of the data for empirical evidence of links between the concepts of our framework. Finally, we identified themes, from which we derived propositions that predict the relationship between the concepts of our extended TEU framework. We followed guidelines for developing theory and formulating propositions that suggest explanations of the relationship between the constructs (Rivard, 2014; 2021). An example of data analysis procedures can be found in Table 3 in Appendix A.

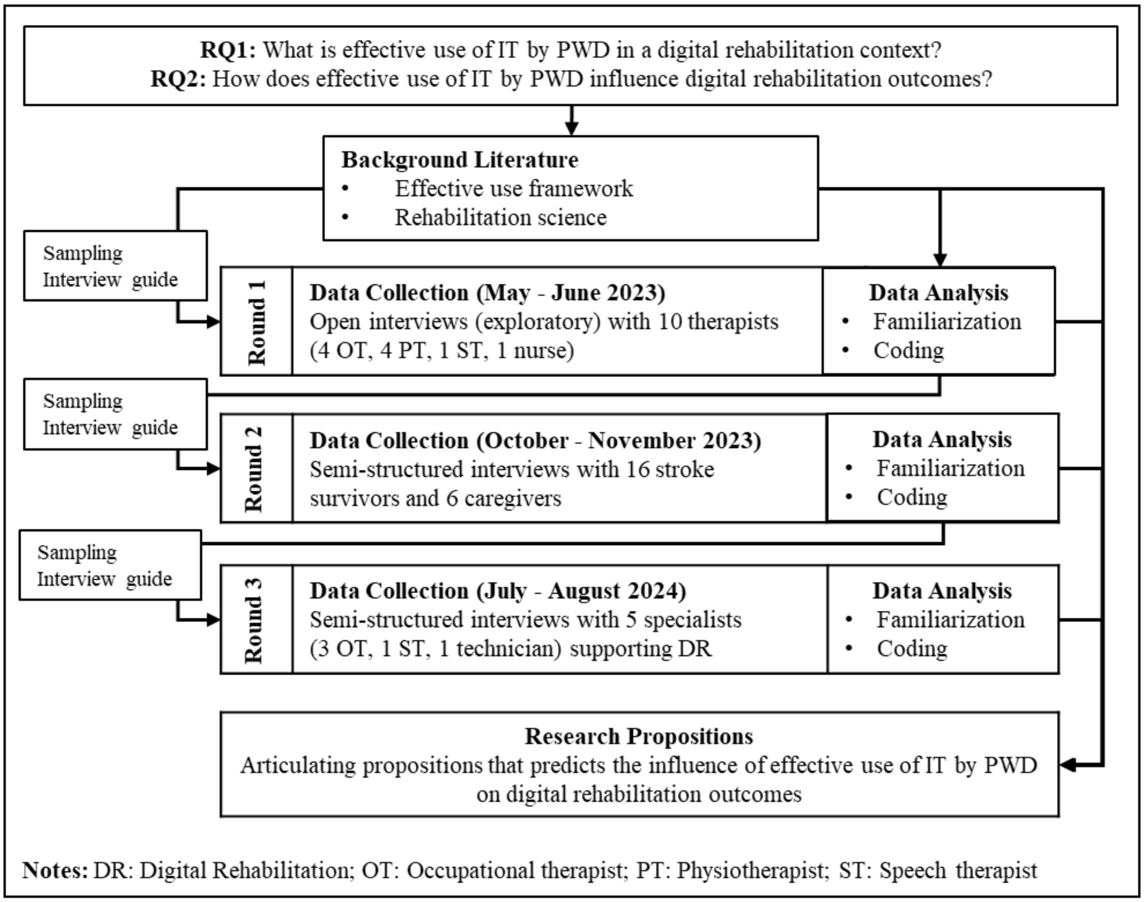

Figure 5: Diagram of data collection process

1.4Results

This section presents insights drawn from our qualitative data analysis. First, we provide examples from our data illustrating accessibility issues, adaptation and learning actions at the physical, surface, and deep structures of an IS in digital rehabilitation after a stroke. Second, we present evidence from our interviews showing the influence of adaptation and learning actions on IT performance and digital rehabilitation outcomes. Building on this evidence and the literature in rehabilitation after a stroke, we develop research propositions that link our framework concepts together.

1.4.1 IT Access Barriers and Solutions After a Stroke

Stroke patients in our sample had a wide range of impairments affecting their physical, speech, cognitive, and even visual abilities. Because stroke injury affects different brain functions, many stroke patients have comorbidities (i.e., two or more functions affected). The interviews revealed that patients with post-stroke disabilities can experience accessibility issues with different structures of an IS. For instance, speech, physical, and visual disabilities can affect the ability to access the physical structure, including standard computer mice, keyboard, monitor, or microphone. Cognitive disabilities can affect the ability to access and navigate the surface structure, including the user interface. For instance, some stroke patients mentioned that they do not like system updates because they have to re-learn a new user interface layout. Stroke patients also typically face difficulties when following steps to open online video sessions in telerehabilitation, for example. Finally, cognitive disabilities can affect the ability to input information that represents their mind, as well as the ability to process information accurately. This can lead to data input errors or misunderstanding of IS representation, leading to poor online decision-making.

Stroke patients may need to adapt the physical or surface structures to improve their access to IS representations and ability to take informed actions. Adaptations of the physical structure of an IS include various physical and virtual adapted pointing and typing devices to improve the ability to control a cursor and to type. Fortunately, many strokes affect only one side of the body (e.g., hemiplegia), which means that stroke patients can use their non-affected side to accomplish daily activities. For example, using the mouse with the non-affected side can be an effective solution that requires more or less adaptation and learning depending on users' handedness. Therefore, depending on the severity of their stroke and the side(s) affected, stroke patients may use a wide range of adapted pointing devices like an ergonomic mouse, trackball, joystick, eye-tracking device, and adapted typing devices including ergonomic, one-handed, on-screen keyboards or braille keyboards.

While adapting the physical structure may require additional hardware, the surface structure can be adapted with device settings and accessibility features that are already built into the operating systems of IT. For example, accessibility features for keyboard include sticky keys' function, which allow using modified keys with one hand by hitting the keys one after the other. Other features allow for increasing the contrast and size of the text and mouse pointer, as well as using a virtual screen magnifier or screen readers controlled via keyboard shortcuts. Finally, an IS's deep structure or representations may also be adapted using tools like artificial intelligence (AI)-based text auto correction or simplification tools to allow users inputting truthful information or taking more informed actions.

While adaptation actions often require a learning curve, learning actions alone can improve IT performance. Learning the physical structure of an IS may include learning a new keyboard layout, learning to touch-type (i.e., typing with all fingers without looking at the keyboard) (Cambridge University Press, 2025), or learning to use the non-dominant hand to control a mouse. The above learning actions would take time and effort to improve IT performance due to a learning curve. Likewise, stroke patients can learn about the IT functionalities (e.g., user interface features, accessibility features, keyboard shortcuts) to improve their navigation in the surface structure. Finally, actions to learn the deep structure or representations of IS may include learning digital literacy skills to identify malicious information and make better decisions related to online shopping, banking, or social media use.

1.4.2 Theoretical Development

This section presents propositions that link the adaptation and learning actions to IT performance and digital rehabilitation outcomes. Our theoretical development aims to predict, but not explain, how the antecedents of effective use influence its outcomes in digital rehabilitation settings (Gregor, 2006). We developed testable propositions based on the themes identified in the data, informed by the literature on digital rehabilitation after a stroke.

Dynamic Impact of Adaptation Actions on IT Use Performance

First, most stroke patients recover some or most of their abilities within the first six months (Dobkin, 2005). Therefore, less severe post-stroke disabilities can be considered as temporary, meaning that they can be recovered with time and/or exercises. As stroke patients' abilities recover, adaptation actions that were first used with affected functions may not offer the same IT task time efficiency improvements compared to pre-disability devices and settings. In the following excerpt, a stroke patient mentions that the temporariness of post-stroke disabilities influences the relevance and need for adaptation strategies (e.g., adapted mice and keyboards) over time.

But after a while, let's say six months in… things start changing. So now I have to reevaluate, maybe what I thought would work doesn't work anymore. So… I can't talk for others and because I can't even talk for myself at this moment because I don't even know what's gonna happen, you know, three months from today. Now, whatever I bought five months ago may not work.... ''The (split) keyboard layout was a little awkward… it's kind of like re memorizing where the keys are, you know, from scratch. So, it slowed down significantly and now that my right side is as good as before, I don't see how it's going to help me. p01 (stroke patient)

Therefore, stroke patients need to constantly reevaluate their condition to identify relevant adaptation strategies. While access to and funding for assistive technologies can be challenging for stroke patients, they may benefit from rental services to test and try assistive technologies, and as increased awareness of accessibility features that may improve their use of IT throughout their recovery. The following excerpt presents a therapist who mentioned that accessibility features should be known by stroke patients, especially because their condition can change.

Yes, I think the person himself (should) know how to use them and change them (accessibility features), because his condition can change. The first approach is to go and use the accessibility options... or even general options like cursor size and color. p10 (therapist)

With the above evidence on the impact of ability recovery on the relevance of adaptation actions over the recovery process, we make the first following proposition.

PROPOSITION 1: *Adaptation actions dynamically influence IT task time efficiency and effort efficiency, with positive effects during early recovery stages and diminishing returns as functional abilities improve.*

Dynamic Impact of Learning Actions on IT use Performance

Stroke patients using learning actions to improve IT performance also face a trade-off between short-term and long-term effort and time efficiency due to a learning curve. For instance, in the following excerpt, learning to touch type was mentioned as a learning action that would benefit a stroke patient with visual disabilities, although learning to touch type would represent a significant challenge. Indeed, learning to touch type requires additional time and effort that can negatively impact short-term efficiency, resulting in frustration. Nevertheless, touch typing has long-term benefits on time (i.e., typing speed) and effort efficiency by optimizing upper body biomechanics (Callegari et al., 2018; Qin et al., 2011).

> *Yeah, generally I'm still a one- or two-finger typer... To be honest, I think it would be absolutely fantastic for me if I had the patience to sit down and learn how to type properly... Since my stroke, my levels of anxiety have been quite high. And when ... things go wrong... I become quite frustrated quite quickly, you know, of doing it... So I have to kind of just do it very slow over time and time… Which is quite a nice thing about that, when typing now I've noticed more and more is, is the predictive text is much more sophisticated and it can binge sentences for you rather than, you know, just getting the wrong word... But you know, that is very helpful as long as you are able to utilize it and realize it's there and just click and expecting it. p19 (stroke patient)*

Similar to touch-type, learning a new keyboard layout (e.g., ergonomic, split, or one-handed keyboards) also presents a short-term and long-term time and effort efficiency trade-off. A stroke patient mentioned that relearning the layout of a split keyboard would slow them down and require cognitive effort, which could be challenging for stroke patients with cognitive disabilities.

> *The problem with a keyboard like that is you'd have to be learning everything on it and I don't know that your brain could cope with that because I mean, it's not a QWERTY keyboard ... so it's just going to add to your challenges... I think it would be helpful for people who have no cognitive impairment... p05 (stroke patient)*

Likewise, another stroke patient mentioned that learning to type on a braille keyboard can be challenging for blind users, especially when their ability to touch is affected.

> *Well, I can't really feel the braille properly with my left hand. And you've got, you know, I can vaguely remember in my memory where certain letters are, but whether you actually hit that one or not is another thing, isn't it? So it makes it a lot slower and then to kind of concentrate... p02 (stroke patient)*

Therefore, stroke patients can face a trade-off between short-term and long-term time and effort efficiency of learning actions with a steep learning curve, and other physical or cognitive impairments may negatively influence the rate of IT performance improvement.

> PROPOSITION 2: *Learning actions dynamically influence IT task time efficiency and effort efficiency, with negative effects during early learning stages and positive effects as learning improve.*

Impact of Adaptation and Learning Actions on IT Use Performance (Time and Effort Efficiency)

The effect of adaptation and learning actions on time efficiency and effort efficiency are not necessarily the same. In our data, we found several examples of adaptation and learning actions that may have a positive effect on time efficiency and a negative effect on effort efficiency, and vice versa. For instance, voice command can have a positive effect on effort efficiency by allowing stroke patients to control IT without having to interact with mice and keyboards physically. However, as mentioned by a stroke patient in the following excerpt, a voice command would significantly slow her down, thereby negatively affecting time efficiency. Unlike speech-to-text, voice command is used as an alternative to a pointing device for navigating in the user interface.

> *If I don't use my fingers, then...I will have to say (voice command) zoom in, zoom in, left, left, and then I get to finally say like one alphabet that takes more than 10 seconds sometimes. And I'm just not sure how efficient that will be... p01 (stroke patient)*

Many stroke patients have screen fatigue. As recommended by the therapist of the stroke patient in the next excerpt, one adaptation action to cope with screen fatigue is to take frequent breaks from looking at the screen. Thereby, patients can improve their effort efficiency, although at the expense of time efficiency according to the frequency of breaks.

> *She (therapist) recommended to break it up to 50 minutes on the screen and then 10 minutes or 20 minutes off type thing. She said it's really important to get those*

> *sorts of breaks in. So I'm not sort of like overloaded my brain, I guess with, you know, just being on the screen. p18 (stroke patient)*

In the next excerpt, the read aloud function was mentioned by a stroke patient as another adaptation action to reduce screen time, thereby increasing effort efficiency by resting visual functions, without affecting time efficiency as much as a screen break,

> *There is a function I found on the laptop called read aloud and it just reads out the whole document. So, I've been doing that just to reduce that sort of screen time. p18 (stroke patient)*

Another stroke patient mentioned that zoom functionalities or screen magnifiers can have a positive effect on effort efficiency by reducing the visual effort required to see the user interface but in turn can have a negative impact on time efficiency as users spend more time looking for information or features in the user interface.

> *I've never really use them (zoom functionality) because I always find that there's always a kind of a trade off (...) I made the letter too big (increased page zoom) or it reduced the sort of functions... So instead of seeing your icons like here on the left, you would see them bigger here... It sounds a bit silly, but you have less icons available in the first screen and then you would end up searching for your icons, your apps. p19 (stroke patient).*

Therefore, our data suggest that we cannot assume that adaptation and learning actions will influence time and effort efficiency the same way. Therefore, it is important to consider both time and effort efficiency, and potentially their trade-offs when assessing the impact of adaptation and learning actions.

PROPOSITION 3: *Adaptation and learning actions can influence time and effort efficiency jointly or independently depending on the trade-off between the two.*

Impact of Adaptation and Learning Actions on Digital Rehabilitation Outcome (Functional Recovery)

Adaptation and learning actions can either compensate or optimize patients' affected functions. Actions that optimize patients' affected functions can consequently contribute to the recovery or maintenance of their functions. For instance, the therapist in the following excerpt mentioned that mice with adapted shape (e.g., ball) have the opportunity to stretch the spastic hand of stroke patients, which gives them the same therapeutic benefits as a ball used in physiotherapy.

> *Sometimes I see users who refuse to wear hand orthoses or ball in their hand (to stretch), and then I see computer users who accept to have a ball in their hand (joystick) to get (access) to the computer, then you can really open the hand at the same time, it's great. P16 (therapist)*

Based on this idea, adaptation actions can positively impact ability recovery by encouraging stroke patients to exercise simultaneously while performing IT tasks. For stroke patients with speech disabilities, speech recognition tools can be used as a way to exercise. As mentioned by a therapist, a voice activation system encourages the repetition of words until pronounced correctly, which can contribute to their recovery of speech functions.

> *Yeah, the whole point of the voice-activated devices here is to, is to encourage repetition and encourage the patient (speech impairment), you know, to keep*

practicing on his pitch here… It's like a child learning to speak here. P08 (therapist)

However, another therapist also suggested that, with new technological advancements in speech detection, these tools will be even more accurate in predicting slurred speech from patients with speech disabilities who may not have to put in as much effort to use speech-to-text effectively.

With artificial intelligence, we come up with even more sophisticated technologies. You know, like for example, voice recognition, it was all very well, but it didn't work for people with speech disorders, so you know, it made it ineffective for someone who really needed it. P04 (therapist)

Thus, adaptation and learning actions can engage and even exercise stroke patients' affected functions, thereby contributing to its recovery and maintenance.

PROPOSITION 4: *Adaptation and learning actions that involve an affected function facilitate its recovery or maintenance.*

However, adaptation and learning actions also can compensate for stroke patients' affected function, which can have detrimental effects on their recovery or maintenance. For instance, stroke patients with hemiplegia could benefit from a one-handed keyboard to use their non-affected hand more effectively, thereby improving their typing time efficiency in the long term. Yet, this adaptation action may discourage the use of patients' affected function, which may result in slower recovery and even recovery loss according to the learned non-use phenomenon (Taub et al., 2006). This can be illustrated in the next excerpt by a stroke patient with hemiplegia.

If it (right hand) just didn't work at all, then I think I'd be really interested in using a one-handed keyboard… Because I still got some function in my right (hand)… I think if you don't use it, you lose it and I don't want to lose, you know, more function than I've lost already. P07 (stroke patient)

Likewise, novel AT and future input devices that tend to minimize effort input with micro-movements or gestures, eye gaze, or even brain activity may represent a threat for users who need to engage their affected functions to recover or maintain them.

Eye control… You don't have to have anything physical anymore because just the webcam can tell if you're looking… After that, it's the knowledge of what's out there or what's in. p12 (therapist)

For the above reason, the therapists supporting digital rehabilitation tend to focus on compensatory strategies mainly when stroke patients have no recovery potential. For instance, one therapist mentioned that communication apps should not be introduced when patients are willing to recover or maintain their speech abilities.

We tried out one of the communication devices, which are voice synthesis devices. So, you press on a worded message or type a message on the keyboards and there's a voice that says your message… However, what we often find is that for people who have just had a stroke… what they often want to do is recover, and it's not always the right time to introduce a communication device. P15 (therapist).

As long as stroke patients have the potential to recover their abilities, they should engage or optimize their affected functions in daily activities, including IT-based tasks. The following excerpt by a therapist illustrates the trade-off between compensatory and optimization strategies depending on patients' recovery potential. Moreover, the therapist raises the idea that adaptation actions could be designed to maximize both time efficiency and ability recovery.

> *There's always this balance between compensation and recovery… but therapists are very much focused on promoting recovery as much as possible, as long as there's potential. Then we'll go for compensatory techniques at that point when we're thinking only of compensating… Sometimes both will be at the same time, there's a keyboard that's going to make it easier, but we're also going to do all the activities to promote the use of the arm… It's not black and white. P06 (therapist)*

Therefore, as mentioned by the therapist above, adaptation and learning actions with compensatory strategies are only used once stroke patients have no more recovery potential to make sure that all potential gains are recovered. Nevertheless, compensating for affected functions can also hinder the maintenance of abilities that can degrade even further if they are not used.

> PROPOSITION 5: *Adaptation and learning actions that compensate for affected functions hinder their recovery or maintenance due to the non-use of those functions.*

Impact of Adaptation and Learning Actions on Digital Rehabilitation Outcome (Professional Reintegration)

Our results showed much evidence of professional reintegration as a goal of digital rehabilitation. Specifically, many stroke patients and therapists mentioned about the objective of returning to work using computers, which we added as a third digital rehabilitation outcome (Figure 6). Professional reintegration in occupations that require interacting with IT also requires better IT performance than simply being able to access online services independently (i.e., online independence). Research in rehabilitation science has defined professional reintegration as the overall process of enabling patients to access, return to, or remain in employment (Tyerman et al., 2017). For employment in jobs that require interacting with IT, users need adaptation and learning strategies to maximize their productivity (i.e., time efficiency). For instance, some therapists mentioned the need for adaptation strategies to maximize time efficiency for returning to work.

> *The first thing we're going to look at is using the mouse with the left hand, because that's likely to be the easiest solution for the person to access... When the stakes aren't speed, that simplifies things too. If it's a question of getting back to work at that point, then maybe we're going a little further for it to become a little more efficient to use the keyboard and mouse. p13 (therapist)*

A stroke patient also mentioned about the importance of the speed at which she could accomplish a task for her manager.

> *I'm not going to compare myself now to, you know, before the stroke because obviously I had a stroke… therefore... I am slower now, but I think there's a degree, you know, let's say I used to be able to do this job in like five minutes, right? If I can deliver in like 7-8 minutes or even 10 minutes, I think I can live with it or even my manager will be ok. But just not 15, 20 minutes for example. p01 (stroke patient)*

Therefore, our data suggest that adaptation and learning actions with the goal of returning to work using computers require patients to be able to accomplish tasks quickly.

PROPOSITION 6: *Adaptation and learning actions that maximize time efficiency facilitate professional reintegration in occupations that require interacting with IT due to expectations of productivity in organizations.*

The next figure presents our extended TEU framework's *a priori* and *ex post* changes, along with our six propositions (Figure 6).

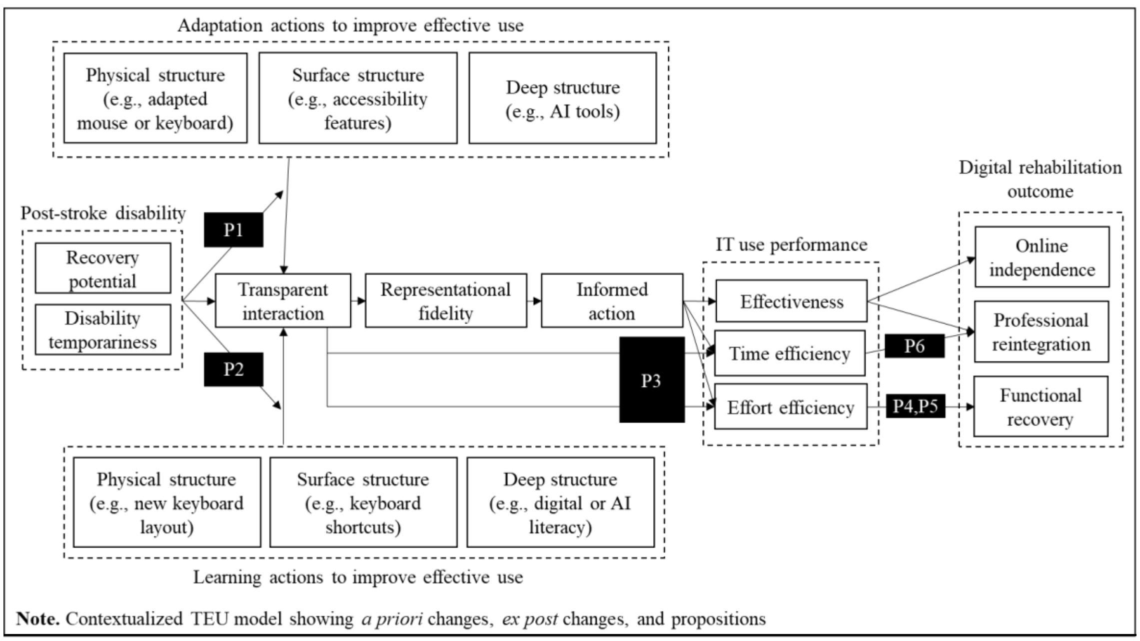

Figure 6: Theory of Effective Use model in post-stroke digital rehabilitation context

1.5Discussion

This section discusses the contributions and boundaries of our theoretical development. We then conclude with the study's practical implications, limitations, and future research avenues.

1.5.1 Theoretical Contributions

Our study makes three theoretical contributions to the field of IS. First, we address Burton-Jones et al. (2017) call for exploring new perspectives that will allow IS research to better understand effective use of IT. Our extended TEU framework in the context of digital rehabilitation, along with our propositions, contributes to the stream of research on the TEU. Secondly, while recent research on theories of use in IS suggested to enhance the precision of the conceptualization of individual IT performance by distinguishing between general performance, efficiency, and effectiveness (Ringeval et al., 2025), our study proposes to refine the construct of efficiency by distinguishing between time and effort efficiency. This theory elaboration method (i.e., construct splitting) can contribute to improving the construct validity and its scope (Fisher & Aguinis, 2017). Specifically, we show evidence that users with post-stroke disabilities can potentially face trade-offs between time and effort efficiency when using adaptation and learning actions. It is hoped that future research will consider both time efficiency and effort efficiency, as well as their interplay, when studying effective use of IT by PWD. Third, more broadly, this study contributes to the development of IS theories that are inclusive for people of all abilities, which may lead to more inclusive sampling of participants in IS research (Olbrich et al., 2015; Randolph & Hubona, 2006; Tarafdar et al., 2023; Windeler et al., 2023). The following section discusses how the extended TEU framework presented in this study can be applied to able-bodied users and even organizations.

Generalizing the Extended TEU Framework to Able-Bodied People

Our extended TEU framework in digital rehabilitation settings can be generalized to people with any abilities who adapt or learn components of their IS. For instance, learning to touch type, using a vertical mouse, ergonomic keyboard, or other future input devices are forms of digital rehabilitation that can influence users' IT performance and functional recovery or maintenance. Future technologies will allow users to automate and thus compensate for their physical and cognitive abilities. For instance, with generative artificial intelligence tools, basic tasks like drafting an email can be achieved with simple written or even audio prompts. However, users who over-rely on such compensatory mechanisms may lose the ability to write and develop sentences or may accelerate the decline of their physical or cognitive abilities, which are less solicited in IT-based interactions. Indeed, according to the phenomenon of learned non-use (Taub et al., 1999, 2006) and the Use-It-Or-Lose-It Theory (Hultsch et al., 1999), skills or neural pathways that are not actively used or reinforced can degrade or weaken over time.

Instead, IT users should have the opportunity to optimize their abilities via adaptation and learning actions. For instance, learning to touch type, with all of one's fingers on a standard or, even better, an ergonomic keyboard, can have long-term benefits for the upper limb of people who spend much time on the computer (Callegari et al., 2018; Qin et al., 2011). Studies have reported the benefits of typing with as many fingers as possible to limit upper extremity range of motion and velocity (Qin et al., 2011), thereby allowing the hands and wrists to rest on a keyboard (Callegari et al., 2018). Other studies have also shown relationships between the ability to touch type and text quantity and quality in university exams (Sperl et al., 2024). Moreover, touch typing allows users to benefit from autocomplete features, which can also improve the time efficiency of typing tasks. Yet, research shows that more than half of keyboard users report typing with one to eight fingers, and a quarter of users typing with fewer than four fingers (Dhakal et al., 2018).

This can be explained by other research on touch-typing training suggesting that people tend to choose typing strategies that give immediate performance (Yechiam et al., 2003).

Moreover, we cannot assume that humans will interact with IT using mice and keyboards forever. In the future, humans will have the ability to control a cursor or input textual information using micro-gestures or even their thoughts using brain-computer interface systems (Zhu et al., 2023). These new adaptation actions may also have important implications on humans' time and effort efficiency in IT-based tasks. Therefore, with current and future ways to interact with IT, humans with any abilities can face a trade-off in terms of short-term and long-term time and effort efficiency, which should be explored in future research.

Applying the Extended TEU Framework at the Organizational Level

Our work focuses on the individual level of analysis, although we suggest that the distinction between time and effort efficiency is also relevant at the group or organizational level of analysis. For instance, time efficiency can represent the time to deliver a project, whereas the effort efficiency can represent the number of employees or non-human resources assigned to the project. With new tools like generative artificial intelligence, tasks that used to require several hours to accomplish by a group of workers can now be automated and/or supervised by a single worker, which can boost organizations' productivity (Al Naqbi et al., 2024).

However, the continuously evolving power of generative artificial intelligence tools can represent a significant investment in license cost and employee training. For instance, research has shown that effective prompting or prompt engineering can enhance the output quality of generated content (White et al., 2023). Therefore, effective use of generative artificial intelligence may require users to learn new software and app functionalities and prompting skills or basic deep learning knowledge (i.e., next word prediction techniques). Generative artificial intelligence in organizations may also require employees to develop skills such as critical thinking to make informed decisions with output generated for business email, presentations, or reports.

Furthermore, with critical discussions about sustainable development of generative artificial intelligence, the efficiency of these tools in terms of model training and computing power is more relevant than ever. Therefore, managers may face trade-offs between decreased short-term effort and time efficiency associated with business process reorganization, employees' training, or large model training investments, and increased long-term effort and time efficiency of business operations. In summary, our extended TEU framework may allow IS researchers to better understand the individual effects and interplay between time efficiency (e.g., time to deliver a team report) and effort efficiency (e.g., number or cost of human resources, computing energy) on IT performance outcomes in organizations.

1.5.2 Practical Implications

Although our findings are at the individual level of analysis, we found insights relevant to healthcare professionals and organizations. First, depending on their objectives, health professionals may have contradictory goals in digital rehabilitation. For example, physiotherapists may encourage patients with hemiplegia to use their affected upper limb to control a computer mouse or to type on the keyboard to keep engaging the muscles and promote recovery. Speech therapists may encourage patients with aphasia to practice their speech as much as possible in daily activities, including communicating via IT.

Conversely, health professionals with compensatory goals like occupational therapists may propose adaptation and learning actions that maximize the time efficiency of their patients who have less potential to recover their abilities. Our findings revealed that health professionals with recovery or compensatory objectives do not typically work together for digital rehabilitation purposes.

Combined with the insights from interviews with stroke patients, our data suggest that digital rehabilitation strategies are often compensatory for stroke patients with little to no recovery potential. Unfortunately, stroke patients who have less severe impairments or who have the potential to recover their abilities seem overlooked by health professionals or their recovery is the priority. Based on our findings, we argue that stroke patients could benefit from adaptation and learning actions that optimize their affected function while using IT during their recovery process, and especially in the early recovery phases. To achieve this, we suggest that there is a need for multidisciplinary health professional teams with both compensatory and recovery objectives to navigate between adaptation and learning strategies based on the progression of temporary disabilities.

The above idea aligns with the World Health Organization's Rehabilitation 2030 initiative (Gimigliano & Negrini, 2017), which calls for more interdisciplinary research and rehabilitation network to improve and scale up rehabilitation services worldwide. Furthermore, our study suggests that improving the use of IT during rehabilitation process can improve recovery via health IS use (e.g., telerehabilitation), but also while interacting with IT in general by engaging their affected functions. Thus, this finding suggests that digital rehabilitation may not only accelerate and improve the quality of functional recovery, but also their reintegration in the digital society and workplace, which is aligned with recent calls for future IS research on human-centric healthcare (Bardhan et al., 2025).

1.5.3 Limitations and Future Research

This research has limitations. First, our proposed extended TEU framework was developed based stroke patients who had different disabilities ranging from more temporary to more permanent depending on their recovery potential. Although the complex and varied conditions of stroke patients allow reaching a broad representation of IT access needs due to physical, visual, speech, or cognitive disabilities, our framework should be tested with other populations.

Secondly, we drew conclusions based on data collected in Canada and the United Kingdom, which have similar healthcare systems challenges such as the lack of time and resources to improve patients' use of IT. However, PWD in low-income countries may suffer even more from a lack of resources for assistive technologies. Therefore, those PWD rely on accessibility features, if they own a modern IT device, and if they are aware of them, which is generally not the case (Franz et al., 2019; Wu et al., 2021). Future research should identify strategies and tools to ensure that lack of awareness does not prevent people from using their accessibility features that could improve their IT performance.

Third, our findings are based on qualitative measures, which can be biased. Future research should investigate the interplay between time and effort efficiency in a controlled environment. Although time efficiency can be straightforward to assess objectively (e.g., task completion time), effort efficiency can be more challenging. It may require the use of more sophisticated measurement methods like neurophysiological measures (Dimoka et al., 2012; Kosch et al., 2023).

1.6 Conclusion

In this study, we extended the TEU framework in digital rehabilitation settings. Our work highlights the need to consider both time and effort efficiency as well as to distinguish between them when studying effective use by people temporary disabilities. We hope that ideas presented in this article stimulate research exploring the role and interplay between time and effort efficiency in personal, group, or organizational use of IT.

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1.8 Appendix A

Step 1: Extract keyword from quotes reflecting stroke patients' use of IT	*Step 2: Assign codes to keyword (inductive and deductive coding)*	*Step 3: Develop overarching themes with patterns in codes*	*Step 4: Develop propositions articulating the themes*
Keywords	**Codes (deductive*)**	**Overarching Themes**	**Propositions**
Keyboard layout; Re-memorizing; Slowed down; Function as good as before;	***Physical structure**** ***Adaptation action**** ***Learning action**** ***(Time) Efficiency**** *Disability temporariness*	**Theme 1:** Short term-Long term Efficiency Tradeoff	**P1:** Adaptation actions dynamically influence IT task time efficiency and effort efficiency, with positive effects during early recovery stages and diminishing returns as functional abilities improve. **P2:** Learning actions dynamically influence IT task time efficiency and effort efficiency, with negative effects during early learning stages and positive effects as learning improve.
Voice activated devices; encourage repetition; keep practicing; learning to speak	*Active recovery potential* ***Learning action****	**Theme 2:** Effort-Time Efficiency Tradeoff	**P3:** Adaptation and learning actions can influence time and effort efficiency jointly or independently depending on the trade-off between the two.
One-handed keyboard; some function; don't use it lose it	***(Effort) Efficiency**** *Functional Recovery*	**Theme 3:** Effort optimization instead of compensation	**P4:** Adaptation and learning actions that involve (optimize) an affected function facilitate its recovery or maintenance. **P5:** Adaptation and learning actions that compensate for affected functions hinder their recovery or maintenance due to the non-use of those functions.
Speed; Back to work; More efficient; Slower; my manager will be ok	***(Time) Efficiency**** *Professional reintegration*	**Theme 4:** Professional reintegration time efficiency expectations	**P6:** Adaptation and learning actions that maximize time efficiency facilitate professional reintegration in occupations that require interacting with IT due to expectations of productivity in organizations.

Table 3: Qualitative data analysis procedures

1.9 Appendix B

Semi-Structured Interview Guide

Introduction: *Thank you for taking part in this study. You have been recruited because you have had upper limb physical impairments following a stroke* ***(Stroke patients) /*** *You have been recruited because you live close to a stroke survivor who have or have had upper limb physical impairments* ***(Caregiver) /*** *You have been recruited because you work close to a stroke survivor who have or have had upper limb physical impairments* ***(Therapist).*** *For the following 45 minutes, we will have a discussion about your Internet and computer use, as well as your knowledge about assistive technologies and accessibility features to improve access to Internet and computers for people with physical disabilities.*

Questions to people with disabilities (stroke patients)

Internet or computer apps use

- Do you use Internet and computer apps?
    - What frequency?
    - Via what type of computer (PC, tablet, mobile)?
    - For what purposes?
- How has your use of Internet and computer apps changed after / since your stroke?
    - What are the main issues that you face when trying to use Internet and computer apps?

Assistive technologies or accessibility features knowledge, use, and learning

- To what extent are you familiar with assistive technologies or accessibility features?
  - How did you learn about it? What do you think about it?

If the respondent is not aware or familiar with the terms of assistive technologies or accessibility features, explain what they are: Assistive technologies are alternatives to traditional mice, keyboards, and display. They allow people with sensory, physical, and cognitive disabilities to access computers and use them more effectively. Today's computers also offer accessibility features to change the size or color of the text or mouse cursor in the interface, for example.*

- Have you / do you use any assistive technology or accessibility features for yourself?
  - How did you learn it? What did you think about it?
  - Have you ever learned about an assistive technology or accessibility feature from a relative?
  - Have you ever learned about an assistive technology or accessibility feature from a therapist / specialist?
- Who among your caregivers or therapist would be the most suited to keep you aware of and teach you about AT? Why?

Questions to therapists (e.g., specialists)

Internet or computer apps use

- Do you use Internet and computer apps?
  - What frequency?
  - Via what type of computer (PC, tablet, mobile)?
  - For what purposes?

Assistive technologies or accessibility features knowledge, use, and teaching

- To what extent are you familiar with assistive technologies or accessibility features?
  - How did you learn about it? What do you think about it?

**If the respondent is not aware or familiar with the terms of assistive technologies or accessibility features, explain what they are: Assistive technologies are alternatives to traditional mice, keyboards, and display. They allow people with sensory, physical, and cognitive disabilities to access computers and use them more effectively. Today's computers also offer accessibility features to change the size or color of the text or mouse cursor in the interface, for example.*

- Have you / do you use any assistive technology or accessibility features for yourself?
  - How did you learn it? What did you think about it?

- Have you ever taught a stroke patient about an assistive technology or accessibility feature?
    - How was it? What was difficult about it?
- Do you think that you have the knowledge to teach a stroke patient about an assistive technology or accessibility feature?
    - What would help you? Who would be the most suited person, therapist, or specialist to teach stroke patients with assistive technologies or accessibility features?

Questions to caregivers

Internet or computer apps use

- Do you use Internet and computer apps?
    - What frequency?
    - Via what type of computer (PC, tablet, mobile)?
    - For what purposes?

Assistive technologies or accessibility features knowledge, use, and teaching

- To what extent are you familiar with assistive technologies or accessibility features?
    - How did you learn about it? What do you think about it?

**If the respondent is not aware familiar with the terms of assistive technologies or accessibility features, explain what they are: Assistive technologies are alternatives to traditional mice, keyboards, and display. They allow people with sensory, physical, and cognitive disabilities to access computers and use them more effectively. Today's computers also offer accessibility features to change the size or color of the text or mouse cursor in the interface, for example.*

- Have you / do you use any assistive technology or accessibility features for yourself?
    - How did you learn it? What did you think about it?
- Have you ever taught a relative stroke survivor about an assistive technology or accessibility feature?
    - How was it? What was difficult about it?
- Do you think that you have the knowledge to teach your relative stroke survivor about an assistive technology or accessibility feature?
    - What would help you? Who would be the most suited person to teach your relative stroke survivor with assistive technologies or accessibility features?

Chapter 2
Essay 2 - Exploring the Asymmetry in Psychological Measures of Technology between Participants with Post-Stroke and Simulated Physical Disability[1]

Abstract

The development and provision of assistive technologies (AT) for information technology (IT) access (e.g., adapted pointing and typing devices) requires their evaluation by people with disabilities (PWD). To improve the efficiency of AT design evaluation practices like user testing, PWD have been complemented with able-bodied participants with simulated disability. However, the literature has stressed the effectiveness of this method due to the asymmetry in psychological measures of technology between PWD and able-bodied participants. This study advances our understanding of the validity of able-bodied participants with simulated disability in AT design evaluation by testing the influence of prior expectations, or lack thereof, with familiar and unfamiliar technologies. We conducted a mixed-method experiment in which 15 participants with post-stroke physical disabilities and 24 able-bodied participants with simulated physical disability performed a target selection task with either a familiar standard computer mouse or an unfamiliar AT (i.e., a motion sensor). Our results show that stroke participants, compared to able-bodied participants with simulated disability, exhibit a positive bias in their psychological measures of pointing performance and motor function efficiency with the AT despite poorer behavioral pointing performance and neurophysiological motor function efficiency. Furthermore, we found that able-bodied participants with simulated disability using the AT, in contrast with those using the computer mouse, had a positive bias in their psychological measures. We discuss the theoretical and methodological contributions of our findings to the fields of IS, HCI, accessibility, and rehabilitation science, as well as the implications for practice.

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[1] This chapter, co-authored with Jared Boasen, Loic Couture, Camille Lasbareilles, Melanie K. Fleming, Charlotte J. Stagg, Sylvain Sénécal, and Pierre-Majorique Léger, is currently in the second round of revision at the *Journal of the Association for Information Systems.*

Keywords: User Testing, Assistive Technology, Information Technology Access, Psychological Measures, Post-Stroke Disability, Disability Simulation

2.1 Introduction

Over the last decades, numerous assistive technologies (AT) have been developed by researchers and tech companies to improve the use of information technologies (IT) by people with disabilities (PWD). According to the Assistive Technology Act of 2004, and AT is any item, piece of equipment, or product system, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities (ATA, 2004). AT for IT access include adapted mice, keyboards, and other devices that allow input through speech, gesture, eye gaze, or even one's own thoughts with brain-computer interfaces (H. H. Koester & Arthanat, 2018; Rashid et al., 2020; R. C. Simpson, 2013).

Despite the rise of new AT on the market and in our own IT devices (e.g., accessibility features), there is a significant gap between available solutions and the realized potential for PWD due to different reasons. First, access to AT, which are often expensive and specialized equipment, is generally challenging due to insufficient government funding based on the nature of disabilities or injuries (Senjam et al., 2023; WHO & UNICEF, 2022). For PWD who can have access to AT or modern IT devices, the literature has consistently shown high abandon rate of AT due to their lack of usability, as well as users' stigma consciousness, lack of awareness, skills, or training to use AT effectively (Howard et al., 2022; Pethig & Kroenung, 2019; Phillips & Zhao, 1993). Therefore, research has stressed the importance of involving PWD in participatory research to design and evaluate AT (Quintero, 2022). Moreover, future laws and policies (WCAG 3.0) will encourage or even force organizations to test the compatibility of their IT with AT through user testing (Spellman et al., 2021). User testing is an important practice in the development of IT artifacts and AT across different fields and organizations where the performance of a technology is assessed with a research participant in a controlled environment (J. M. C. Bastien, 2010; A. R. Hevner et al., 2004; Tao et al., 2020).

However, participatory research with PWD faces important logistic challenges and costs associated with the recruitment, accessible transport, or adapted experiment protocols, which can explain the low sample sizes of PWD typically reported in HCI and accessibility research (Lazar et al., 2017; Mack et al., 2021; Šumak et al., 2023). Able-bodied participants, also referred to as healthy subjects, can play a crucial role in driving efficient participatory research across different scientific fields. For instance, studies in HCI and rehabilitation science have shown that able-bodied participants with simulated disabilities (e.g., splint to reduce mobility) allow improving the efficiency of user testing and digital rehabilitation interventions by identifying relevant usability issues with AT or by comparing different AT (H.-C. Chen et al., 2009; Manresa-Yee et al., 2019; Yesilada et al., 2010). While user testing is a crucial step in the development of AT and IT, digital rehabilitations interventions allow to match PWD with appropriate AT and improve their use of IT (Simpson et al., 2010).

However, the literature has challenged the validity of combining PWD and able-bodied participants in user testing contexts due to an asymmetry in their psychological measures of technology in contrast with behavioral measures of technology performance (Bajcar et al., 2020; Hossain, 2017; Ming et al., 2021; Trewin et al., 2015). Specifically, research has reported that, compared to able-bodied participants, PWD tend to report high satisfaction with technology despite poor performance (Bajcar et al., 2020; Trewin et al., 2015). This suggests that PWD's psychological measures of AT, skewed toward more positive ratings even when behavioral performance is low, may not allow developers or health professionals to improve the design of AT or to identify the appropriate solutions for their patients.

Meanwhile, able-bodied participants with simulated disability could provide more critical self-reported measures that better reflect the performance of a technology by PWD. This study aims to investigate whether able-bodied participants with simulated disabilities also exhibit a positive bias in their psychological measures, which is important to ensure their validity in AT design evaluation. We further test the effect of technology familiarity on the above positive bias, as newly developed AT are typically unfamiliar to participants who have little to no experience and expectation with the technology. Therefore, understanding the effect of technology familiarity on psychological measures is important for effective design and evaluation of new AT. We address the following research questions:

RQ1: *To what extent do able-bodied participants with simulated disability exhibit a positive bias in their psychological measures of AT, in contrast with participants with disabilities?*

RQ2: *How does the familiarity with a technology influence psychological measures by able-bodied participants with simulated disability?*

We conducted a mixed-method experiment in which 15 stroke participants with a physical disability and 24 able-bodied participants wearing a physical disability simulation performed target pointing tasks with either a familiar standard computer mouse or an unfamiliar AT (i.e., motion sensor) that enables on-screen cursor control with free hand input. Participants' evaluation of the technologies consisted of behavioral, neurophysiological, and psychological measures of pointing performance (PP), motor function efficiency (MFE), as well as post-task interview questions investigating the issues experienced with the device. Drawing on evidence from HCI and accessibility research (Bajcar et al., 2020; Hossain, 2017; Ming et al., 2021; Trewin et al., 2015), we predicted that, when using a novel AT, stroke participants would exhibit a positive bias in their psychological measures of PP and MFE in contrast with able-bodied participants with simulated disability. Furthermore, based on the expectation-confirmation theory (ECT) in information system (IS) research (Brown et al., 2014), we predicted able-bodied participants with simulated disability would exhibit a positive bias in their psychological measures of an unfamiliar AT, in contrast to their psychological measures of a familiar technology (i.e., standard computer mouse) with which participants have experiences and expectations.

Our results show that stroke participants had a positive bias in their psychological measures of PP and MFE, in contrast with able-bodied participants with simulated disability, when using the AT. We also show that able-bodied participants with simulated disability using the AT exhibited a positive bias in their psychological measures of PP and MFE in contrast with those using the computer mouse. We further discuss how the positive bias manifested within and across the experimental groups. Our qualitative data also provides additional complementary insights into the role of expectations with technology depending on their familiarity. Therefore, this makes theoretical and methodological contributions to the fields of IS, HCI, accessibility, and rehabilitation science, regarding the role of expectations on the asymmetry in psychological measures of participants with disability and able-bodied participants with simulated disability. The following research background section presents the challenges of participatory research with PWD, including user testing.

2.2 Research Background

Research in IS has contributed to our understanding of the design and impact of AT in society. For instance, studies have proposed design principles for AT home care (Mettler et al., 2023), wayfinding (Rodriguez-Sánchez & Martinez-Romo, 2017), communication (Randolph et al., 2022), or assistance in daily tasks (Gao et al., 2024; Pethig & Kroenung, 2019). However, the above studies have typically relied on survey data or on small sample sizes of PWD in field experiments or usability testing, which is aligned with research in HCI and accessibility (Lazar et al., 2017; Mack et al., 2021; Šumak et al., 2023). Therefore, as suggested by previous literature reviews in IS, more participatory research with PWD is needed (Mäkipää et al., 2022; Zhou et al., 2024).

However, participatory research with PWD is a well-known logistic challenge in research (Lazar et al., 2017; Mack et al., 2021; Šumak et al., 2023). The literature in HCI, accessibility, and rehabilitation science suggests that AT developers and healthcare professionals like occupational therapists can benefit from able-bodied participants with simulated disability to evaluate different AT or settings (e.g., mouse cursor speed) before testing their fit with patients. For instance, one study found that, although able-bodied participants with upper limb physical disability simulation had greater operational efficiency than participants with physical disability, they were able to identify relevant usability issues with the use of AT by people with quadriplegia (H.-C. Chen et al., 2009). Manresa-Yee et al. (2019) also simulated trunk motionless to test a head-controlled mouse with able-bodied participants and found similar usability issues (e.g., increased muscle strain, neck fatigue) than users with physical disability (Manresa-Yee et al., 2019). Another study found similar usability issues with typing devices between participants with physical disability and able-bodied participants experiencing situational reduced finger dexterity due to cold environment temperature (Yesilada et al., 2010).

While able-bodied participants with simulated disability may improve the efficiency of AT design and provision, evidence from the literature suggests that the validity of this practice may be compromised. More specifically, studies have reported an asymmetry in psychological measures of AT, in relation with behavioral performance, between PWD and able-bodied participants of user tests (Bajcar et al., 2020; Trewin et al., 2015). One study found that PWD reported psychological measures that were poorly correlated with their behavioral measures of performance, and that they seemed to be less impacted by usability issues, when contrasted to able-bodied participants (Trewin et al., 2015). Another study also found that participants with physical disabilities had a positive bias in their psychological measures of usability with an AT (i.e., head-controlled mouse), compared with able-bodied participants. In other words, despite lower behavioral performance (i.e., task completion rate and time) than able-bodied participants, those with physical disabilities affecting their upper limbs rated the AT as easier to use, more accurate, more comfortable, and generating less face muscle fatigue (Bajcar et al., 2020). The previous study further suggested that the asymmetry in psychological measures of AT can be explained by a positive bias by PWD, but also a negative bias exhibited by able-bodied participants as they mentally contrast the AT (e.g., head-controlled mouse) to a familiar and more effective technology (e.g., standard computer mouse) (Bajcar et al., 2020). Consequently, the authors suggest that future research should explore a potential underlying mechanism to the asymmetry based on cognitive, emotional, and motivational factors in both PWD and able-bodied participants (Bajcar et al., 2020).

One line of investigation can be to study the influence of technology familiarity. Since the results by Bajcar et al. (2020) are based on the evaluation of a new AT, it is unclear whether the familiarity with the technology can play a role in the asymmetry. In addition, the authors raised that the asymmetry may be explained by the simulation of physical disability, described as ‘‘the inability to use standard computer interaction systems, the artificial hand immobilization, and the use of facial muscles to control the cursor’’ (Bajcar et al., 2020; p. 1861), which may have caused excessive negative evaluations of the AT by in able-bodied participants (Bajcar et al., 2020). However, the simulation reported in the previous study was passive in the sense that it did not directly affect the use of the AT. Therefore, more research is needed to investigate the asymmetry in psychological measures between PWD and able-bodied participants experiencing a disability simulation that directly affects technology use, with both AT and familiar technologies. Resulting insights may allow the development of solutions to mitigate the above asymmetry, thereby improving both the efficiency and effectiveness of the development and provision of AT or inclusive IT design.

2.3 Theoretical Model and Hypotheses Development

To address our research question, we developed a model that predicts the relationship between behavioral/neurophysiological measures and psychological measures involved in the evaluation of pointing devices (herein; technologies) by participants experiencing post-stroke physical disabilities (herein; stroke participants) and able-bodied participants experiencing a simulated physical disability (herein; able-bodied participants) (Figure 7). The evaluation of technologies consisted of behavioral/neurophysiological and psychological measures of pointing performance (PP) and motor function efficiency (MFE). We define PP as the extent to which the technology allows to point targets with speed and accurately according to the Fitts law in HCI research (MacKenzie & Isokoski, 2008).

First, our model assumes a positive relationship between behavioral PP and psychological PP based on past research on correlations between measures of usability, including task completion rate and time or Likert scales (Hornbæk & Law, 2007; Sauro & Lewis, 2009). Building on past evidence of positive bias in psychological measures presented in the previous research background section, our model suggests the following hypothesis. **H1: The disability experience of stroke participants will negatively moderate the relationship between behavioral PP and psychological PP with the AT, in contrast to able-bodied participants. Specifically, the disability experience of stroke participants is expected to weaken the relationship between behavioral PP and psychological PP.**

Secondly, our model proposes a positive relationship between neurophysiological MFE and psychological MFE associated with task performance. Unlike behavioral PP, neurophysiological MFE is not as straightforward to assess in user testing settings. For instance, HCI research has traditionally relied on psychometric scales such as the NASA-TLX to assess cognitive workload or effort (Kosch et al., 2023). The use of neurophysiological tools as a method for real-time assessment of constructs that would be difficult to assess otherwise is growing in the fields of IS, HCI, and rehabilitation science (Dimoka et al., 2012; Ortega & Mezura-Godoy, 2022; Zaki & Islam, 2021). NeuroIS approaches draw from reference disciplines like neuroscience to inform on users' implicit indices of emotions, stress, attention, trust, learning, or workload (Riedl et al., 2020).

In research using neuroimaging techniques, MFE has been measured with brain connectivity metrics that reflect the ability to efficiently learn or adapt to a motor task (R. J. Gentili et al., 2015; Van Der Cruijsen et al., 2021) and to manage motor resources for minimizing muscle fatigue (Z. Li et al., 2022). Therefore, we define MFE as the ability to perform motor actions with minimal resource expenditure. Studies in neuroscience have shown that lower MFE in more difficult visuo-motor tasks or less experienced users can be indexed with a brain connectivity metric assessing the extent to which the brain areas are synchronized on a same frequency (e.g., theta band) or communicate together (R. J. Gentili et al., 2015; Z. Li et al., 2022; Van Der Cruijsen et al., 2021).

However, research also stresses that stroke participants exhibit different brain connectivity patterns than able-bodied participants (i.e., healthy subjects) because of a reorganization of their brain networks depending on lesion location (Fanciullacci et al., 2021). Therefore, gross metrics of interhemispheric brain connectivity (i.e., connectivity between the two hemispheres of the brain) are more appropriate to contrast between stroke participants' and able-bodied participants' brain activity. One study found that theta-band interhemispheric connectivity is a relevant index of neurophysiological MFE in motor learning tasks involving able-bodied and stroke participants (Fanciullacci et al., 2021). Therefore, based on the same assumption of positive bias as in H1, we propose the following hypothesis. **H2: The disability experience of stroke participants will negatively moderate the relationship between neurophysiological MFE and psychological MFE with the AT, in contrast to able-bodied participants. Specifically, the disability experience of stroke participants is expected to weaken the relationship between neurophysiological MFE and psychological MFE.**

Finally, since the positive bias illustrated by the moderating effects hypothesized in H1 and H2 is shaped by the expectations of participants with the technology, our model predicts that they can be strengthened by familiarity with the technology. The ECT can be used as a framework to understand the incoherence between actual performance and psychological measures based on users' past expectations. According to the ECT, IT users form expectations based on experiences before using a technology (Brown et al., 2014). After initial use of the technology, users compare their actual experience with initial expectations, leading to their confirmation or disconfirmation, which consequently influence satisfaction with and continued use of IT (Bhattacherjee, 2001). Research in IS have proposed different mechanisms by which people can positively or negatively bias their psychological measures of IT toward their previous expectations and/or experiences (Brown et al., 2014). For instance, when users have low expectations with a technology, they can still be satisfied with low technology performance as their actual experience confirms their initial expectations (Brown et al., 2014).

The literature in disability studies suggests that, since PWD have constantly experienced barriers limiting access to their offline and online environment, they have lower initial expectations of time and effort required to accomplish daily tasks, in contrast with able-bodied people (Kafer, 2013; Samuels, 2017). Therefore, despite exhibiting poorer behavioral performance with an IT, PWD may perceive similar or even higher levels of satisfaction with IT than able-bodied people, as their psychological measures of IT performance confirms their initial lower expectations. This mechanism offers a line of explanation for the positive bias in psychological measures of IT by PWD in contrast with able-bodied participants.

However, according to the ECT, the above mechanism assumes that users have initial experience and expectations with the IT, which is not always the case with new AT, for example. The literature on the ECT has emphasized that familiarity with technology plays an important role in shaping accurate expectations with IT (Lee & Kwon, 2011). Familiarity has been broadly defined as ‘‘a general feeling of having encountered a person or specific object before, without conscious access to contextual details, such as the time or place of the encounter’’ (Ecker et al., 2007). Therefore, familiarity is shaped through time and repeated exposure to a person or object. In the context of technology use, being familiar with a technology implies that users have more experience of using or observing the technology and thus more accurate expectations about its behavior and performance. For example, since the inception of first personal computers, computer mice have been deeply embedded into daily routines and work environments, becoming a standard tool in both professional and personal computer use. Even for users who do not regularly use computer mice, they may have expectations about their culturally learned ways to operate them (Nansen et al., 2014). In contrast, with less familiar technologies like newly developed AT, users may have less experience and thus less accurate expectations about their performance and level of effort required to use them (Nansen et al., 2014). Therefore, our model predicts the last two hypotheses. **H3: Technology familiarity will strengthen**

the moderating effects on the relationship between behavioral PP and psychological PP (H3a), and between neurophysiological MFE and psychological MFE (H3b) among able-bodied participants; in other words, we predict that the negative moderating effects hypothesized in H1 and H2 will be stronger for the familiar technology than the unfamiliar technology.

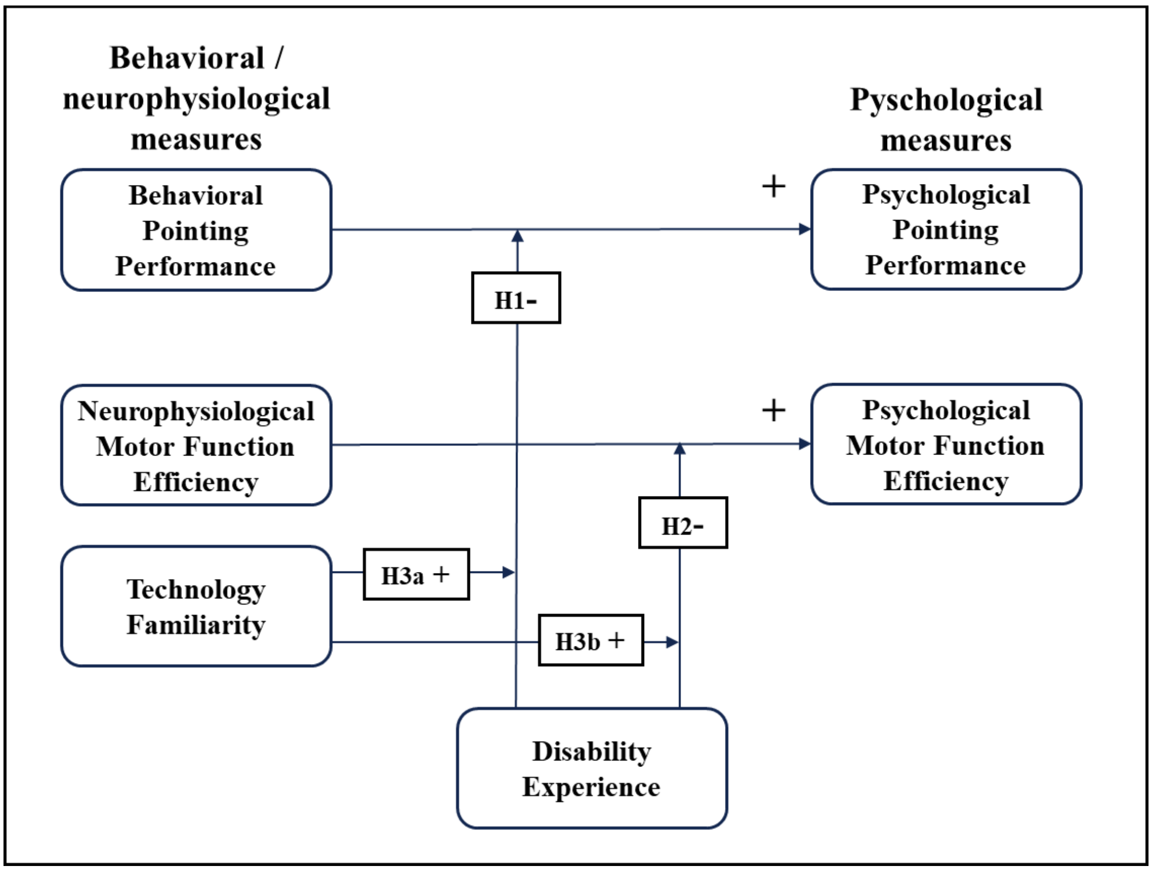

Figure 7: Research model

2.4Method

This study used a mixed method experiment to investigate the asymmetry in psychological measures, in contrast with behavioral/neurophysiological measures, between PWD and able-bodied participants with a simulated disability. We further investigate the effect of technology familiarity on the above asymmetry by testing a familiar computer mouse and an unfamiliar AT. In the first phase, we collected 24 able-bodied participants in a controlled laboratory experiment in Canada. Using a one-factor between-subjects design, 10 able-bodied participants performed the experiment with the computer mouse (i.e., familiar technology), and the 14 remaining participants with the AT (i.e., unfamiliar technology). In a second phase conducted in the United Kingdom, we collected 15 stroke participants performing the experiment with the AT in a hospital (N=10) or at their home (N=5). The location was decided based on stroke participants' preference and ability to travel to the hospital. This study was approved by the Research and Ethics Board of our institutions in North America (2022-4474) and in the United Kingdom (R78761/RE001).

2.4.1 Participants

We manipulated the disability experience by recruiting able-bodied participants experiencing a simulated physical disability and stroke patients who have lived with a post-stroke physical disability for at least one year. The particularity of post-stroke impairments is that patients typically recover some or most of their abilities over the first year with time and exercises in a time frame of up to 12 months, which can refer to temporary impairments (Ward et al., 2017). Therefore, our stroke participants had likely reached their full recovery potential and had permanent disabilities.

In the first phase, the able-bodied participants (Males: 15, Females: 9; Mean age ± Std: 24.8 ± 2.6 years) were recruited via the student panel of a North American university. To be included in the study, able-bodied participants needed to be at least 18 years old, right-handed, able to use a computer mouse, and have no diagnosed neurological or psychiatric disorder. Able-bodied participants had to wear a physical disability simulation splint designed out of 3D printed plastic attached to a wristband with rubber bands to replicate the clenched hand and wrist of typical post-stroke physical disabilities (e.g., upper limb spasticity) (Dobkin, 2005) (Figure 8). In other words, the disability simulation prevented participants from opening their right hand and use their fingers to grab objects.

We also recruited participants with a post-stroke physical disability (Males: 6, Females: 9; Mean age ± Std: 63.6 ± 11.5 years) via stroke charities (e.g., The Stroke Association and Different Strokes) and a research participants' database held at one of our institutions. Stroke participants were screened for their post-stroke impairments, which can vary extensively in their physical (e.g., muscle strength, coordination, balance), cognitive (e.g., memory, attention, and executive functions), and visual abilities (e.g., moderate to severe vision loss) (Gittins et al., 2021). We included in the second phase only stroke participants with a physical disability who did not experience visual impairment that could impede computer-based tasks (e.g., visual neglect). Our stroke participants had a wide range of physical disabilities as shown by the different scores of a shortened version of the Fugl-Meyer upper extremity scale which is out of 36 points (de Blas-Zamorano et al., 2025; Fugl-Meyer et al., 1975) (Mean Fugl-Meyer score for the right upper extremity ± Std: 30,1 ± 10.4). The average score indicates that stroke participants had mild-to-moderate right upper extremity impairment. Stroke participants also had mild cognitive impairment on average, as shown by the Montreal Cognitive Assessment (MoCA) score out of 30 (Mean MoCA score ± Std: 23.7 ± 3.3) (Nasreddine et al., 2005).

2.4.2 Technologies

To manipulate and test users' expectations with the technologies, we evaluated one familiar technology (i.e., computer mouse) and one unfamiliar AT (i.e., motion sensor).

The familiar technology evaluated in this study was a standard Logitech M100 optical USB computer mouse (Logitech, Lausanne, Switzerland) (Figure 8). According to the definition proposed by the International Organization for Standardization 9241(400) regarding principles and requirements for physical input devices, a computer mouse is an input device with one or more buttons, capable of a two-dimensional rolling motion that can control a cursor in a graphical user interface. A standard computer mouse requires users to grip and manipulate it by using fingers and wrist movements, which can be challenging for people with limited dexterity. For this study, we disabled the computer mouse buttons by placing spacers under them since clicking was not required in the task.

Our AT evaluated was a motion sensor, the Leap Motion Controller (v1) (Ultraleap, San Francisco, USA) (Figure 8), acting as a gesture-based interface, which is defined as a system that provides controls for a user to accomplish specific tasks (e.g., moving a cursor) by his/her movement or posture of the whole body or parts of the body, according to the International Organization for Standardization and the International Electrotechnical Commission 30113(1). The Leap Motion Controller has similar capabilities to other well-known commercially available technologies like the Microsoft Kinect (Microsoft Corporation, 2010), although it is not as widespread (Guzsvinecz et al., 2019). The Leap Motion Controller has three infrared LED lights and two infrared cameras that track finger or hand position and motion within a range of approximately 25 to 600 millimeters above the device (Bachmann et al., 2018). The Leap Motion Controller could be used as a gesture-based interface, although research has shown that it is less effective and generates greater psychological measures of muscle fatigue than a standard computer mouse for able-bodied users (K. S. Jones et al., 2020). Due to its relatively low cost (< $100US), the Leap Motion Controller has been extensively studied as a rehabilitation tool in research to enhance conventional therapy with more engaging exercises and games (Aguilera-Rubio et al., 2022). Motion sensors like the LMC also have great potential as an AT for people with physical disabilities like muscle weakness, spasticity, tonicity, or patterned movements (Kane et al., 2020).

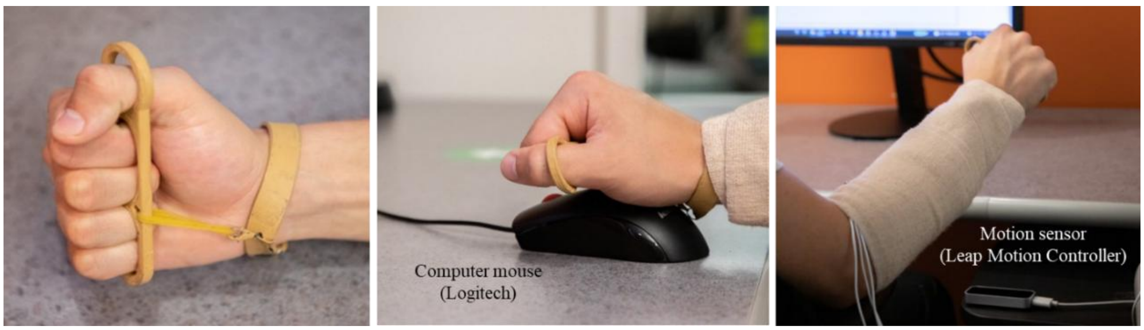

Figure 8: From left to right, the physical disability simulation splint, computer mouse, and assistive technology (motion sensor)

2.4.3 Target Selection Task

We evaluated the computer mouse and AT with a traditional standard task, the Fitts task, which has been used to assess a wide range of pointing devices like computer mice, trackpads, joysticks, or eye-tracking systems, over several decades of HCI research (Soukoreff & MacKenzie, 2004). The Fitts task is a target selection task where users attempt to move an object (e.g., mouse cursor) as fast and accurate as possible on targets. This task allows researchers and developers to assess, simultaneously, both the speed and accuracy of pointing devices. We used the GoFitts[2] Java application offering a one-dimensional and two-dimensional target selection task with real-time calculations of performance based on the Fitts Throughput, a metric that is independent of the speed and accuracy trade-off. In this study, participants performed several trials of the two-

[2] https://www.yorku.ca/mack/FittsLawSoftware/

dimensional Fitts task, which consisted in pointing and selecting 15 different targets placed in a circle by hovering over the target with the cursor for a constant duration of 3000 ms. As soon as one target is hit, starting from the one on the far right of the circle, the opposite target in a clockwise direction lights up, indicating the next target to point and select (see Figure 13 for illustration).

For all trials, we used a fixed distance between targets (i.e., movement amplitude) of 600 pixels and a fixed target width of 40 pixels. To move the cursor horizontally, both the computer mouse and the AT's tracking object (i.e., participant hand) need to be moved along the x-axis according to the three-dimensional coordinate system. While moving the cursor vertically with a computer mouse requires pushing and pulling it along the y-axis, the AT requires raising and lowering the tracking object (i.e., hand) along the z-axis (see Figure 9 for example). Finally, participants were instructed to move the cursor to select the targets as fast and accurately as possible to improve their performance score (i.e., Fitts Throughput), which was shown to them after each trial.

It should be noted that, before the above task used for the analysis, participants performed several trials of the one-dimensional Fitts task, as a warmup to familiarize themselves with the technologies. The one-dimensional Fitts task consisted in pointing and selecting two different fixed targets of 40-pixel width, positioned along the horizontal axis with 600 pixels movements amplitude, by hovering over the target with the cursor for a constant duration of 3000 ms.

2.4.4 Experiment Procedure

The experiment started by gaining written informed consent for both participants' groups. Then, with stroke participants, we performed an assessment of their upper limbs using the Fugl-Meyer upper extremity scale and their cognitive functions using the MoCA. An electroencephalography (EEG) system was used to record participants' brain activity during the tasks. The preparation began by measuring the participant's head circumference and setting up the EEG electrodes cap (actiCAP, Brain Products GmbH, Munich, Germany). The EEG cap was then placed on the participant's head and adjusted to their forehead based on a mark at 10% of the distance between the nasion and the inion. To ensure appropriate electrical conductance between each electrode and the scalp, we applied gel to reach an impedance between 25kΩ and 50kΩ as recommended by the EEG manufacturer (actiCAP, Brain Products GmbH, Munich, Germany). Before starting the experiment, participants from both groups were shown a video demonstration of the tasks. In addition, before using the AT, participants had a two-minute trial in the Windows Paint application (Microsoft Corporation, 2024) where they were instructed to familiarize themselves with the tracking area and cursor movements along the horizontal and vertical axis.

Participants from both groups started by performing practice trials of the one-dimensional Fitts task, of which the results were not included in this study. Our able-bodied participants performed 10 trials of the one-dimensional Fitts task with either the AT or the computer mouse, while the stroke participants were instructed to perform six trials with the AT only. After a five-minute break, the able-bodied participants and stroke participants respectively performed 10 and six trials of the two-dimensional Fitts task explained in Section 4.3. Between each trial, participants had a two-minute break. At the end of the two tasks, the ISO 9241-9 Device Assessment Questionnaire (DAQ) (Douglas et al., 1999) was administered verbally for all participants. Followingly, we conducted a 15-minute semi-structured interview. Then, able-bodied and stroke participants were debriefed and compensated with \$50CAD or £30, respectively, for a total experiment duration of two hours.

2.4.5 Behavioral Pointing Performance

To assess behavioral PP, we used the Fitts Throughput measured in bits per second. This metric is known to be independent of the speed-accuracy trade-off as it combines measures of movement time and task difficulty, which is determined by the distance between targets (i.e., movement amplitude) and their size (i.e., target width). The Fitts Throughput (i.e., TP) metric output refers to an index of task difficulty, determined by the movement amplitude (i.e., A) and target width (i.e., W), divided by the mean movement time (i.e., MT). Behavioral PP was measured by aggregating the Fitts Throughput score, calculated with the formula below, over trials.

$$\left(\frac{\left(\log_2\left(\frac{2A}{W}\right)\right)}{MT}\right)$$

2.4.6 Neurophysiological Motor Function Efficiency

Participants' neurophysiological MFE was calculated based on an index of interhemispheric brain connectivity in the theta band, which was measured using a 32-channel gel-based EEG system according to the Standard Cap layout for actiCAP (BrainProducts GmbH, Munich, Germany). We recorded raw EEG signals at a 500 Hz sampling frequency using the Netstation acquisition software and an EGI amplifier (Electrical Geodesics Inc). EEG data processing was performed with Brainstorm running on MATLAB 21a (MathWorks, Natick, MA, USA). Raw data was cleaned by removing noisy or dead channels as well as physiological artifacts and periodic noise identified with two independent component analyses. We then applied a band-pass filter from 1 to 30 Hz. The filtered EEG data recorded over the trials was marked at 3000ms intervals over the trials, and epoched at -1000 to 4000ms relative to these markers. We visually inspected each epoch and removed those with movement artifacts. Unfortunately, due to technical issues and data loss with EEG recording and motion sensor tracking, we could not use the data of five stroke participants and five able-bodied participants, who were excluded from the quantitative data analysis. We then decomposed the time-series data from each electrode into the theta frequency band (5–7 Hz) and calculated their envelopes using the Hilbert transform.

Interhemispheric theta connectivity was calculated between all interhemispheric electrode pair combinations, excluding the midline electrodes Fz, Cz, Pz, and Oz, as well as the electrode TP10 due to significant noise across many participants, resulting in 182 different interhemispheric electrode pairs (Figure 9). Consistent with previous studies, connectivity between electrode pairs was computed using phase locking value, which assesses the consistency of phase difference between two EEG signals without considering their amplitude (Z. Li et al., 2022; Shim et al., 2023).

However, due to the nature of their injuries, stroke patients cannot be presumed to exhibit phase locking values at similar thresholds as healthy individuals (Sebastián-Romagosa et al., 2020). Therefore, to permit a more accurate comparison of neurophysiological MFE between the stroke and able-bodied, we decided to standardize our index of interhemispheric theta connectivity by individual participants. Here, instead of using the coherence values themselves, we used the number of interhemispheric connections whose coherence values exceeded an individual threshold. This individual threshold was set as the mean + 1 standard deviation of all 182 theta-band interhemispheric coherence values for each participant separately.

However, only using the number of connections which exceed an individual threshold does not permit insight into the differences in neurophysiological strategies that underlie neurophysiological MFE in each group. Indeed, neural compensatory strategies for motor function may likely differ between stroke patients due to the fact that the characteristics and location of their brain injuries are heterogeneous between individuals (T. A. Jones, 2017; Sebastián-Romagosa et al., 2020). Correspondingly, the interhemispheric connections supporting neurophysiological MFE should also be heterogeneous. Able-bodied individuals, conversely, can rely upon fundamental neurophysiological pathways for motor signaling and should thus exhibit more homogeneity in the interhemispheric connections supporting neurophysiological MFE. We thought that this dichotomy between healthy and stroke participants concerning the commonality (i.e., homogeneous connections) or rarity (i.e., heterogeneous connections) of interhemispheric connections supporting neurophysiological MFE was important to better interpret our results. Therefore, we decided to calculate, in each participant, the rarity of each interhemispheric connection which exceeded their individual threshold. The calculation was performed as follows.

We identified all the theta-band interhemispheric coherence values that were above the participants' individual threshold (i.e., supra-threshold theta-band interhemispheric coherence values). For each pair of electrodes, we then calculated the inverse of the mean number of instances where this was above this value threshold for each technology and participant group separately. The mean number of instances highlighted the supra-threshold theta-band interhemispheric coherence values that were more commonly or rarely observed in each condition.

Then, we calculated a single metric, in each participant, which represented both the number and rarity of supra-threshold interhemispheric connections. To compute our neurophysiological MFE metric by participant and by condition, we used the sum of instances of supra-threshold theta-band interhemispheric coherence values adjusted based on the rarity of those coherence values across the condition by participant group. Specifically, for each participant, each instance of supra-threshold theta-band interhemispheric coherence values were coded as a '1' and multiplied by the inverse of the mean number of instances of supra-threshold theta-band interhemispheric coherence values by participant group and device.

We then added up all the instances of supra-threshold theta-band interhemispheric coherence instances in each participant. For example, a high resulting value would indicate a high number of supra-threshold theta-band interhemispheric connections and / or connections that are rare or heterogeneous in the sample of participants. Therefore, to make sure that the high values of our metric reflect a high level of neurophysiological MFE (i.e., low number of common supra-threshold interhemispheric connections), we computed the inverse of the previous sum. The resulting MFE value was calculated using our developed formula below.

$$\frac{1}{\sum_{l=1}^{n}\left(A_{ijk} \times \frac{1}{B_{jk}}\right)}$$

A = Instance of supra-threshold theta-band interhemispheric coherence for participant i, group j, and device k. Coded as '1' if supra-threshold is achieved, otherwise '0'.

B = Mean number of supra-threshold instances across participants in group j and device k.

2.4.7 Psychological Measures

We assessed psychological measures of PP and MFE using selected items of the ISO 9241-9 DAQ, a 13-item, seven-point Likert scale typically used in research to evaluate the performance, ease of use, comfort, effort, and upper limb muscle fatigue associated with the use of pointing devices (Douglas et al., 1999) (Appendix A). The psychological PP was assessed by aggregating the mean psychological pointing accuracy and pointing speed, which were the two objectives of the task. Indeed, the task performance metric (i.e., Fitts Throughput) combines both pointing accuracy and speed metrics, and thus reflects our aggregated psychological performance measure.

Psychological MFE was assessed with the DAQ items related to upper limb muscle fatigue. Specifically, for each participant, we identified the maximum value among items targeting fingers, hand, wrist, arm, shoulder, and neck fatigue. We chose this approach because different upper limb muscles can be involved depending on the technology and participants' strategies. Finally, to reflect the directionality of neurophysiological MFE, we used the inverse of the maximum muscle fatigue value as our metric of psychological

MFE. Figure 9 below illustrates our experiment setup with our different measures for the quantitative data analysis.

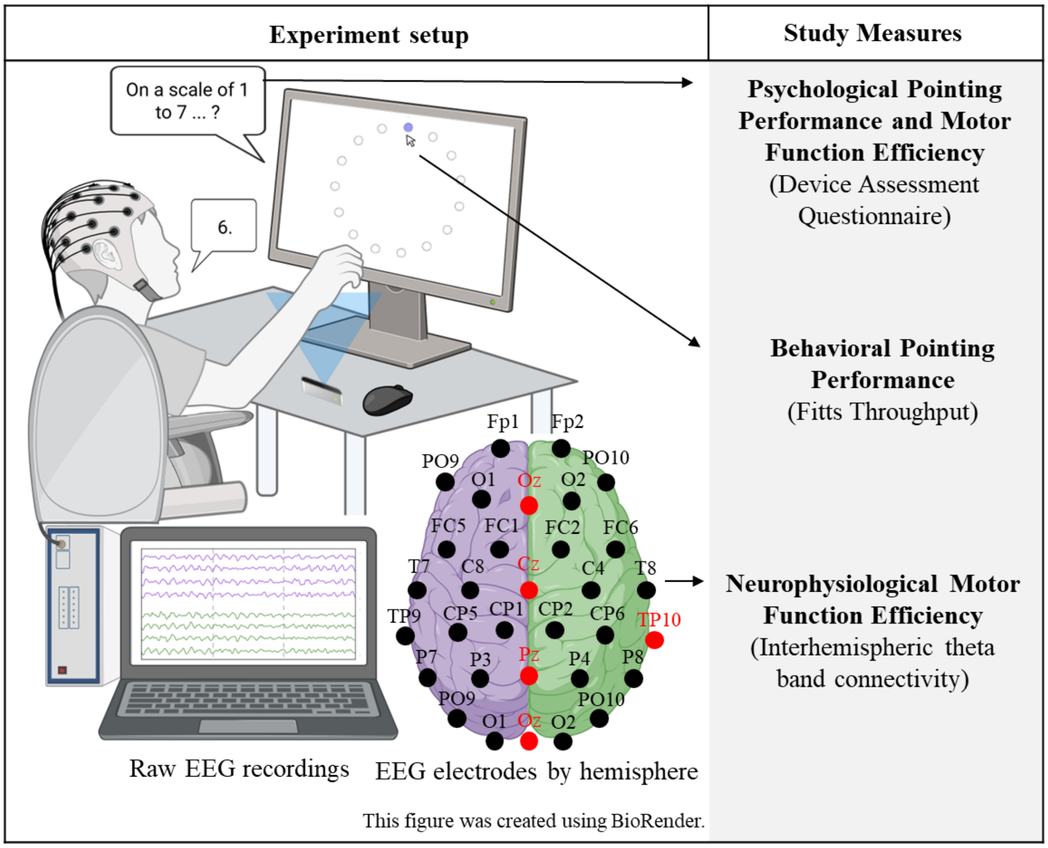

Figure 9: Illustration of the experiment setup and measures

2.4.8 Quantitative Data Analysis

Our quantitative data analysis aims to test the research model presented earlier. Specifically, we first test whether the relationship between psychological measures and behavioral/neurophysiological measures of PP and MFE differs between stroke participants and able-bodied participants using the AT (H1 and H2). We further test whether the relationship between psychological measures and behavioral/neurophysiological measures of PP and MFE differs between able-bodied participants using the AT (i.e., unfamiliar technology) and those using the computer mouse (i.e., familiar technology) (H3a and H3b).

To investigate our hypothesis, we performed a series of four multiple linear regression testing whether (1) the disability experience (stroke vs. able-bodied) or (2) the technology familiarity (computer mouse vs. AT) moderated the relationship between psychological measures and behavioral/neurophysiological measures. We conducted a separate analysis for the two dependent variables: behavioral PP and neurophysiological MFE. For each multiple linear regression, we used mean-centered values of psychological measures of PP and MFE to avoid multicollinearity and to enhance the interpretation of our main effects. We computed interaction terms as the product of the centered value of each psychological measure with the moderator (i.e., participant group or technology familiarity) coded as a categorical dummy variable (i.e., '1' or '0'). We included, in each regression model, the mean-centered value of psychological measure, the moderator variable, and the interaction term as predictors of our two dependent variables. In our results, effect sizes are reported as R^2 to illustrate the proportion of variance explained by our models. We further report, for each predictor, the unstandardized coefficients, standard errors, t-values, and p-values.

While the previous regressions test how the relationship between psychological and behavioral/neurophysiological measures differ between groups, the extent to which there is a positive bias in psychological measures is still unclear. Therefore, to address our overarching question, we performed a post-hoc analysis to compare the z-scored difference between psychological and behavioral/neurophysiological measures as a bias term. This approach allows us to quantify the positive and negative bias in psychological measures. Four independent samples t-tests were conducted to compare the mean bias term between participant groups. We used Levene's Test for Equality of Variances to assess the assumption of homogeneity of variance and used Welch's t-test when equal variance was not assumed. All statistical analyses were performed using SPSS software version 28 (IBM, Armonk, NY, USA), with statistical significance set at $p \leq .05$.

2.4.9 Qualitative Data Analysis

Post-task interviews are typically conducted in user testing to identify usability issues with thematic analysis techniques (Asghar et al., 2018; Følstad, 2017). Research in IS with PWD has also used thematic analysis approaches to identify barriers and facilitators to workplace inclusion or inclusive design requirements (Abramova et al., 2025; Tuunanen & Peffers, 2018). We conducted post-task semi-structured interviews with all of our participants. It should also be noted that the qualitative data analysis included all participants who took part in the study, including participants whose were excluded from the quantitative data analysis due to unusable data. Our post-task semi-structured interviews were transcribed in Nvivo (v12) and analyzed using a deductive thematic analysis approach (Braun & Clarke, 2006), guided by a pre-existing framework based on the ISO 9241-9 DAQ, which assesses different aspects of (1) user’s perception of technology operational performance, including its accuracy, control, smoothness, and (2) users’ attitude toward the fatigue, effort, or comfort associated with the use of the technology (Douglas et al., 1999). Specifically, we aimed to distinguish the usability issues in categories that reflected our measures of PP and MFE. The qualitative data analysis first consisted of an initial familiarization phase in which the first and third authors independently went through the transcripts several times. Then, the first and third authors generated codes with extracted keywords from statements that reflected a usability issue with the technologies. Followingly, the codes were clustered into two themes of usability issues, pointing control and device comfort, which reflects PP and MFE, respectively (see Table 4 for example). The research team reviewed the code clustering to ensure the distinction between the themes. We then calculated the proportion of participants in each participant group who mentioned a usability issue related to each theme.

Technology	Theme	Keyword examples
Assistive technology	Pointing Control	Sense of control, less stable, going up more difficult, hard to follow a path
	Device Comfort	Hard work, fatigue
Computer mouse	Pointing Control	Pull difficult, control
	Device Comfort	Exerting force, strained, tensed, discomfort

Table 4: Examples of theme and keyword coding

2.5Results

In this section, we first present the study's descriptive statistics, followed by the results of our hypothesis testing, and post-hoc analysis.

2.5.1 Descriptive Statistics

The following table presents the mean and standard deviation of our behavioral/neurophysiological and psychological measures by participant group (Table 5). The data shows that stroke participants using the AT had the lowest mean behavioral PP value (Mean ± Std: 0.967 ± 0.628), followed by able-bodied participants using the computer mouse (Mean ± Std: 2.924 ± 0.391), and those using the AT (Mean ± Std: 3.141 ± 0.303). For neurophysiological MFE measures, stroke participants using the AT also had the lowest mean value (Mean ± Std: 0.046 ± 0.007), followed by able-bodied participants using the AT (Mean ± Std: 0.076 ± 0.011), and those using the computer mouse (Mean ± Std: 0.088 ± 0.015). However, when looking at the psychological PP measures, stroke participants using the AT had the highest mean value (Mean ± Std: 4.400 ± 1.075), followed by able-bodied participants using the AT (Mean ± Std: 3.591 ± 0.801), and those using the computer mouse (Mean ± Std: 3.063 ± 1.635). Finally, stroke participants using the AT also had the highest mean value of psychological MFE (Mean ± Std: 3.300 ± 2.058), followed by able-bodied participants using the AT (Mean ± Std: 3.000 ± 1.414), and those using the computer mouse (Mean ± Std: 2.750 ± 1.035). Finally, all participants in this study declared experiencing the AT for the first time and had experience using a computer mouse.

Participant group	Study measures							
	Behavioral Pointing Performance		Neurophysiological Motor Function Efficiency		Psychological Pointing Performance		Psychological Motor Function Efficiency	
	Mean	Std	Mean	Std	Mean	Std	Mean	Std
Stroke participant (Assistive technology)	0.967	0.628	0.046	0.007	4.400	1.075	3.300	2.058
Able-bodied participant (Assistive technology)	3.141	0.303	0.076	0.011	3.591	0.801	3.000	1.414
Able-bodied participant (Computer mouse)	2.924	0.391	0.088	0.015	3.063	1.635	2.750	1.035

Table 5: Descriptive statistics of behavioral/neurophysiological and psychological measures

2.5.2 Hypothesis Testing

The figure below shows scatter plots of the relationship between psychological PP and behavioral PP, by group. Our data show a strong positive relationship between psychological PP and behavioral PP, but only for able-bodied participants using the computer mouse ($r = 0.844$, $p = 0.008$) (Figure 10). Conversely, there was a negative but moderate and non-significant relationship between psychological PP and behavioral PP for able-bodied participants using the AT (r = -0.296, p = 0.377), and for stroke participants using the AT (r = -0.420, p = 0.198). Regarding MFE, the relationship between psychological and neurophysiological measures is strong and positive for able-bodied participants using the computer mouse (r = 0.833, p = 0.010), and positive but not significant when using the AT (r = 0.493, p = 0.123). For stroke participants using the AT, the relationship between psychological MFE and neurophysiological MFE was strong and negative, but not significant (r = -0.421, p = 0.197), as shown in Figure 10.

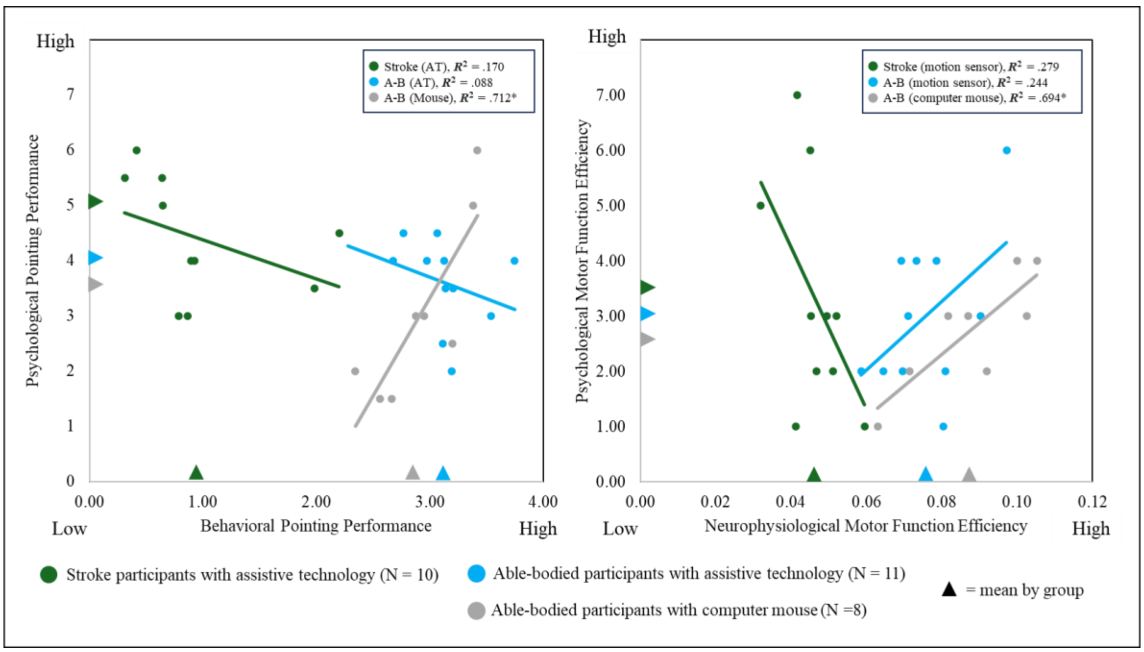

Figure 10: Scatter plots showing the relationship between behavioral PP and psychological PP of able-bodied and stroke participants with the AT and the computer mouse.

Hypothesis 1

We first hypothesized that the disability experience of stroke participants would have a negative moderating effect on the relationship between behavioral PP and psychological PP, in contrast to able-bodied participants, when using the AT (H1). Our multiple linear regression showed that the model was significant ($F(3, 17) = 38.024$, $p < .001$) and explained 84.7% (adjusted $R^2 = .847$) of the variance in behavioral PP. Participant group was a significant predictor of behavioral PP (β = -2.028, SE = 0.227, t = -8.931, p < .001), showing that stroke participants had lower behavioral PP than able-bodied participants. However, both psychological PP (β = -0.112, SE = 0.186, t = -0.602, p = .555) and the interaction between psychological PP and participant group (β = -0.128, SE = 0.237, t = -0.541, p = .595) were not significant predictors of behavioral PP. This result suggests that, although behavioral PP differed between stroke participants and able-bodied participants using the AT, the relationship between psychological and behavioral PP did not vary between the groups, which does not allow us to support H1.

Hypothesis 2

Our second hypothesis focused on the moderating effect of disability experience on the relationship between neurophysiological MFE and psychological MFE (H2). Our multiple linear regression revealed a statistically significant model (F(3, 17) = 21.50, p < .001) that explained 75.5% of the variance in neurophysiological MFE (adjusted R^2 = .755). Participant group significantly predicted neurophysiological MFE (B = –0.030, SE = 0.004, t = –7.69, p < .001), showing that stroke participants had lower neurophysiological MFE than able-bodied participants using the AT. We also found that psychological MFE was a significant predictor (B = 0.004, SE = 0.002, t = 2.00, p = .062), and that the interaction between participant group and psychological MFE significantly predicted neurophysiological MFE (B = –0.006, SE = 0.002, t = –2.40, p = .028), which suggests that the strength of direction of the relationship between neurophysiological MFE and psychological MFE is different between stroke participants and able-bodied participants using the AT. This finding supports H2.

Hypothesis 3a

Then, we hypothesized that the technology familiarity would have a positive moderating effect on the relationship between behavioral PP and psychological PP for able-bodied participants (H3a). Specifically, we predicted that the relationship between behavioral PP and psychological PP would be stronger for able-bodied participants using the familiar computer mouse than those using the unfamiliar AT. The multiple linear regression was statistically significant ($F(3, 15) = 4.616$, $p = .018$) and explained 37.6% (adjusted $R^2 = .376$) of the variance in behavioral PP. We found that psychological PP was a significant predictor of behavioral PP ($\beta = 0.202$, $SE = 0.064$, $t = 3.154$, $p = .007$), which shows that able-bodied participants who reported higher psychological PP also tended to have greater behavioral PP. Although technology familiarity was not a significant predictor ($\beta = -0.180$, $SE = 0.132$, $t = 1.357$, $p = .195$), the interaction between technology familiarity and psychological PP was significant ($\beta = 0.314$, $SE = 0.127$, $t = -2.479$, $p = .026$), which suggests that the strength or direction of the relationship between psychological and behavioral PP was different between able-bodied participants using the computer mouse than those using the AT. These findings support Hypothesis 3a.

Hypothesis 3b

Finally, we predicted that technology familiarity would also have a moderating effect on the relationship between neurophysiological MFE and psychological MFE for able-bodied participants (H3b). The multiple linear regression model was significant ($F(3, 15) = 7.26$, $p = .003$) and accounted for 51.0% of the variance in motor function efficiency (adjusted $R^2 = .510$). Participant group significantly predicted neurophysiological MFE ($B = 0.014$, $SE = 0.005$, $t = –3.09$, $p = .008$), showing that able-bodied participants using the computer mouse had significantly greater neurophysiological MFE than those using the AT. We also found that psychological MFE was a significant predictor (B = 0.012, SE = 0.004, t = 3.41, p = .004), and that the interaction between technology familiarity and psychological MFE approached significance (B = –0.008, SE = 0.004, t = –1.97, p = .067). This suggests a possible moderation effect indicating that the strength or direction of the relationship between psychological MFE and neurophysiological MFE may differ between able-bodied participants using the AT and those using the computer mouse.

2.5.3 Post-hoc Analysis

The Figure below shows the results of bias term, which represents the extent to which participant groups exhibited a positive or negative bias in their psychological measures in contrast with the other groups (Figure 11). Independent sample t-tests revealed that stroke participants had significantly greater positive bias in their psychological PP than able-bodied participants using the AT, in relation with their behavioral PP ($t(14.985) = -5.845$, $p < .001$). However, there was no statistical difference between the bias term for PP of able-bodied participants using the AT and those using the computer mouse ($t(17) = -0.551$, $p = .589$). Regarding MFE, stroke participants had significantly greater positive bias in psychological MFE than able-bodied participants using the AT ($t(13.185) = -2.979$, $p = .011$). Moreover, we found that able-bodied participants using the AT had significantly greater bias term of MFE than those using the computer mouse ($t(15.663) = -2.66$, $p = .017$). This may also suggest that able-bodied participants using the computer mouse exhibited greater negative bias compared to those using the AT.

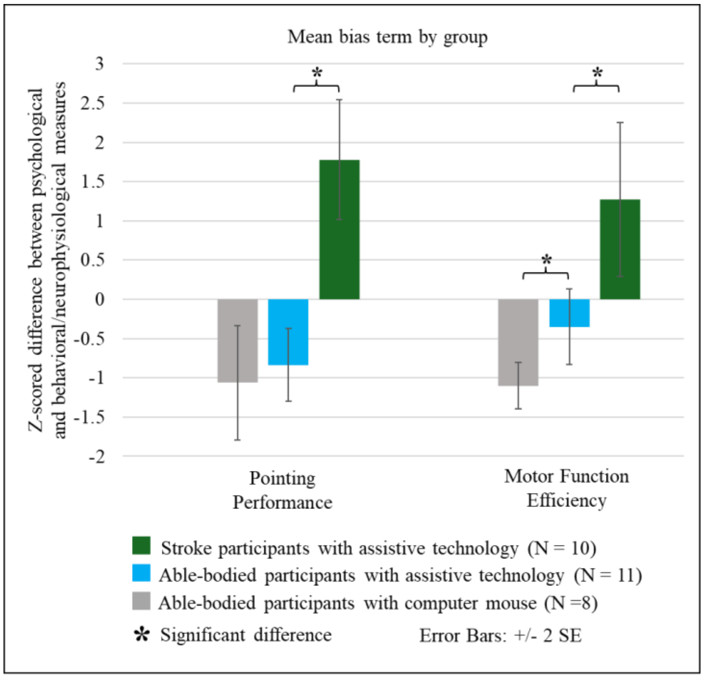

Figure 11: Bar charts showing the difference in mean bias terms by participant group, for PP (left) and MFE (right).

2.5.4 Qualitative Data Results

The following section presents an overview of the usability issues reported during the post-task interviews by participants. We present each usability issue themes by providing examples of quotes that reveal the context or the factors that drive usability issues, including the participants' expected performance of the technologies and their motivation for using them.

Usability Issues with the Assistive Technology

With the AT, some able-bodied participants reported that they were confused with the positioning of their arm, which resulted in a lack of sense of control. Likewise, some stroke participants also mentioned the lack of sense of control with the AT, which can be amplified by spatial neglect, a condition where the brain does not cognitively process one side of the body or environment. The following excerpts by an able-bodied and a stroke participant illustrate the issue of sense of control with the AT.

"The thing is, you have more sense of control when you touch than when it is something you don’t understand, at a distance… it is less stable the motion sensor than a (track)pad where if you go there (hand movement), it goes there (cursor). It is much more reliable, I think." P14 (able-bodied participant)

"I didn't know where I was with the motion sensor... I didn't know whether it would be more centered for picking up a movement. It was about getting the right position." P13 (stroke participant)

Many able-bodied participants reported the lack of precision in movements along the vertical axis. For instance, the targets of the upper or lower area of the circle (see Figure 13) were identified as more difficult to aim at accurately. Similarly, some stroke participants also mentioned that reaching the targets at the top and the bottom of the circle was more challenging, as shown in the next excerpts.

"I was more at ease left-right, top-bottom was a bit awkward, sometimes you don’t know how the sensor will perceive the top and bottom… I was less confident with this." P24 (able-bodied participant)

"Whenever. 10, 11, 12, 1 o'clock if you think of it as a clock... going up for me was more difficult. Possibly because of the amount of arm movement I have... Probably wouldn't have found it difficult at all if I could move my arm normally like an able-bodied person." P01 (stroke participant)

Some able-bodied participants and stroke participants reported experiencing lack of stability with the cursor with the AT.

"About the glitches I realized that in some position on the screen, some movements are accompanied by some glitches, and it is not related to my thumb… Compared to a mouse or an e-pen, it is really hard to follow a path. Or sometimes when you want to move a cursor on a target, you pass by it and then come back." P15 (able-bodied participant)

While no able-bodied participant raised the issue of lack of comfort with the AT, some stroke participants mentioned discomfort or tiredness due to the range of motion required to operate the device. Some stroke participants even compared the task to physical therapy exercises or a workout. They even suggested that the AT would have been beneficial to encourage them to move their upper limb throughout their motor function recovery journey, as shown in the following excerpts.

"Bloody hard work. You needed quite a lot of mobility to actually achieve the range of movement… I did actually think about, you know, this (motion sensor) would be a really good thing for practicing exercises…exercises that you are given, they are so bloody boring. I just think it would be a good way of actively having to do them (exercises with motion sensor), hold yourself to accountable by getting results..." P02 (stroke participant)

"Yeah I think in the early days the motion sensor would have been a good way of encouraging me to move my arm... If I was using it for rehab (motion sensor) to lift my arm up or out or turn my hand over, that kind of rehab, then I think the motion sensor would be good. But if I was returning to work, and I need to click on documents and open things up, I think that a well-fitting or ergonomic mouse would be better." P01 (stroke participant)

" ...because I could feel my muscles a bit and I was thinking this is what I should have done from day one. That would have been good because, I'm thinking now I should do that every day because it's making my brain work. " P08 (stroke participant)

Usability Issues with the Computer Mouse

The majority of able-bodied participants reported that the computer mouse was challenging to control. Specifically, able-bodied participants' restricted dexterity did not allow them to use a standard computer mouse with their fingers. Instead, they had to use their hand palm or knuckles by applying downward pressure on the computer mouse to move it. Other participants mentioned the difficulty of pulling the computer mouse toward themselves, specifically, compared to pushing it away, as shown in the following excerpts.

"It made me realize that these devices are designed to be used with fingers (thumb and little fingers). It's almost impossible to use this mouse efficiently. I use a lot of different muscles than I would use if I would be able to use my fingers. I realize that I can't catch this (the mouse) so I need to manipulate this by exerting some force on it so I was using arm muscles which I would not normally use. " P04 (able-bodied participant)

"...because you pull the mouse in a direction that is more difficult. Since you don't have complete control over the mouse, you really have to pull it back toward your body, and I feel like this movement is a little bit more difficult when you don't have fingers to help you." P07 (able-bodied participant)

Finally, many able-bodied participants reported experiencing a lack of comfort and tiredness, specifically in muscles that they don't normally use for controlling a computer mouse (e.g., arm and shoulder). The following excerpts suggest that able-bodied participants' experiences and expectations with a computer mouse influenced their perception of control and comfort. Indeed, participants reported that, as they could not normally use their fingers, they had to use different muscles to move the computer mouse, thereby increasing their level of tiredness and pointing accuracy.

"I think, given that you don't have dexterity... compared to when I use a mouse with my fingers. It was really in the shoulder that I found was strained the most." P07 (able-bodied participant)

"The fingers, I did not feel much (discomfort). The wrist, maybe in the first task, but for the rest it was really the forearm and the shoulder. I had the impression that I was constantly tensed in a position, because the little control you have is with your hand, so it had to stay still." P09 (able-bodied participant)

The table below shows the proportion of participants by group who reported at least one usability issue, by theme category (Table 6).

Participant group	Proportion of participants reporting at least one usability issue, by theme category, by group	
	Pointing Control	Device Comfort
Stroke participant (Assistive technology)	71.42%	28.57%
Able-bodied participant (Assistive technology)	92.80%	0.00%
Able-bodied participant (Computer mouse)	90.00%	50.00%

Table 6: Qualitative data analysis summary

2.5.5 Triangulating Quantitative and Qualitative Data

Our quantitative data analysis suggests that stroke participants have a positive bias in their psychological measures of PP and MFE, in contrast with able-bodied participants when using the AT. Our qualitative data analysis suggests that, on average, the proportion of stroke participants mentioning usability issues related to pointing control (71.42%) was smaller than those of able-bodied participants (92.80%). Therefore, the qualitative data may support that stroke participants were less sensitive to usability issues than able-bodied participants, which can translate in a positive bias. Moreover, our quantitative data analysis also raises the possibility that able-bodied participants with the AT had a positive bias in their psychological measures of MFE, in contrast to those using the computer mouse. The previous results are also supported by our qualitative data analysis, which shows that none of the able-bodied participants using the AT reported usability issues associated with device comfort, whereas many (50.00%) able-bodied participants using the computer mouse reported usability issues related to this theme category. This suggests that able-bodied participants either had a positive bias toward the AT, or a negative bias toward the computer mouse, when assessing their psychological MFE.

Beyond the previous qualitative data results, our interview data offer additional explanations regarding the asymmetry in the psychological measures, in contrast with behavioral/neurophysiological measures, between able-bodied and stroke participants. First, our post-task interviews revealed that the experience and expectations of able-bodied participants may have shaped their perceptions toward the computer mouse. For instance, many able-bodied participants referred to the computer mouse as being more difficult to control, hold, handle, or manipulate, than usual because of the physical disability simulation. This could suggest that able-bodied participants' expectations of the computer mouse pointing control in normal circumstances (i.e., without a physical disability simulation) may have negatively influenced their psychological PP and MFE. Additionally, our qualitative data suggests that able-bodied participants may have overemphasized usability issues associated to the computer mouse comfort and may have downplayed issues related to the comfort with the AT. Again, this could be explained by able-bodied participants' expectations of comfort with a standard computer mouse in normal circumstances, which may have led them to focus more on the lack of comfort during the experiment. These insights are aligned with past research criticizing the use of disability simulations as able-bodied people tend to focus on what they cannot do instead of raising issues that are relevant to PWD (Bennett and Rosner 2019).

Nevertheless, our qualitative and behavioral data analyses suggest that able-bodied participants experienced and reported usability issues with the AT that were also experienced and reported by and thus relevant for stroke participants. For instance, precision issues with the AT were found with both able-bodied and stroke participants. Specifically, moving the cursor on the vertical axis with the AT was less efficient than on the horizontal axis, which can be observed in our behavioral PP data by target (Figure 13). Indeed, we can see that targets positioned in the upper area (e.g., targets 3, 5, 7, 9, 11, 13) and lower area (e.g., targets 2, 4, 6, 8, 10, 12) of the computer screen generally took more time to be selected. However, the data of stroke participants further suggests that downwards movements along the vertical axis, specifically, took more time than upwards movement, which was not clear from able-bodied participants' data. This suggests that, while able-bodied participants were useful for identifying general usability issues with the AT, stroke participants were essential for uncovering more nuanced aspects of those issues.

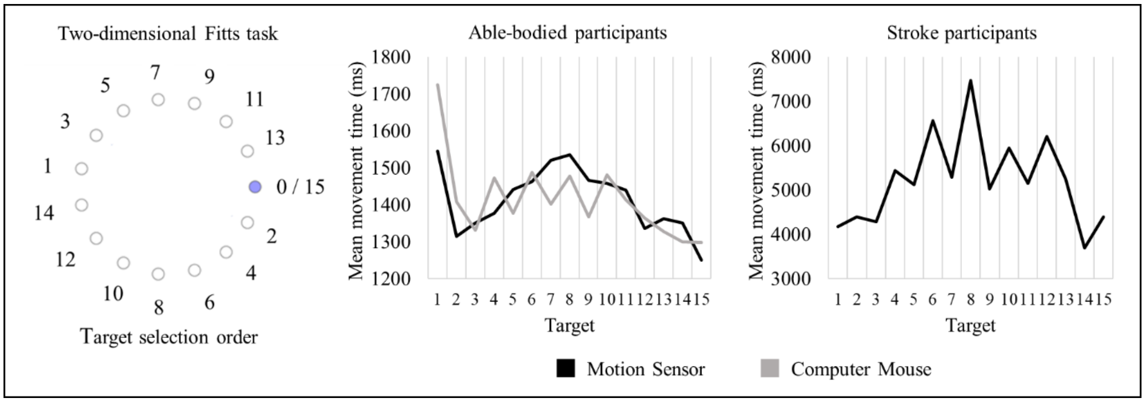

Figure 12: Two-dimensional Fitts task with target selection order and line graphs showing the mean movement time to select each of the 15 targets by technology, and by participant group.

2.6 Discussion

The next section summarizes the results of hypothesis testing, followed by their theoretical and methodological contributions, and their implications for practice. Our quantitative results suggest that stroke participants using the AT had greater psychological measures of PP despite poorer behavioral measures of PP, in contrast to able-bodied participants, as shown by our post-hoc analysis. This result is in line with previous findings by Bajcar and colleagues (2020) regarding the quantification of the positive bias in psychological measures. However, our hypothesis specifically tested whether the disability experience influenced the relationship between behavioral and psychological measures of PP. Our multiple linear regression model failed to show significant results, which does not allow us to support H1. Specifically, we found that both stroke participants and able-bodied participants had a weak and even negative relationship between behavioral and psychological measures of PP. This suggests that participants from both groups who had poor behavioral PP still reported high psychological measures of PP, and that those who exhibited better behavioral PP did not consequently report high psychological measures of PP.

Regarding the second hypothesis, our post-hoc analysis also shows that stroke participants using the AT had greater psychological measures of MFE despite poorer neurophysiological measures of MFE, in contrast with able-bodied participants, which is also in line with past research (Bajcar et al., 2020). Our multiple linear regression further revealed significant group differences in the relationship between psychological and neurophysiological MFE, which supports H2. The previous results further show that able-bodied participants had an expected positive but weak relationship between neurophysiological and psychological measures of MFE, whereas stroke participants had a negative but weak relationship between neurophysiological and psychological measures. This may suggest that, depending on the group, our neurophysiological index of MFE may reflect the outcome of different adaptation strategies to optimize effort during the tasks.

Specifically, for stroke participants with high neurophysiological MFE, the corresponding lower brain connectivity may be linked to enhanced motor learning resulting from greater effort and thus muscle fatigue (i.e., low psychological MFE). Conversely, for stroke participants with low neurophysiological MFE, their corresponding high brain connectivity could be linked to poor motor learning resulting from lower effort exerted and thus muscle fatigue (i.e., high psychological MFE) over the task. Contrastingly, for able-bodied participants with high neurophysiological MFE, the decreased brain connectivity could be associated with the optimization of effort and fatigue, resulting in high psychological MFE (i.e., lower psychological measures of muscle fatigue). For able-bodied participants with low neurophysiological MFE, the increased brain connectivity may be linked to the inability to adapt and optimize their effort and fatigue, leading to low psychological MFE (i.e., higher psychological measures of muscle fatigue) over the tasks.

Hypothesis 3a and 3b further tested whether able-bodied participants using the computer mouse had different relationships between behavioral/neurophysiological and psychological measures of PP (H3a) and MFE (H3b). We found that, although, post-hoc analysis showed no difference in the bias term for psychological PP measures, the directionality of the relationship between behavioral and psychological measures of PP differed between the technologies, which supports H3a. Specifically, only able-bodied participants using the computer mouse had an expected strong positive relationship between their behavioral and psychological measures of PP. The negative but weak relationship between behavioral and psychological measures of PP in able-bodied participants using the AT may suggest that some able-bodied participants, and especially those who had poor behavioral PP, still reported high psychological measures of PP, which indicates a positive bias among the group. It is also possible that able-bodied participants using the computer mouse who had poorer behavioral PP reported excessively lower psychological measures of PP as a result of a negative bias with the familiar technology.

Regarding hypothesis 3b, our post-hoc analysis showed that able-bodied participants using the AT had greater bias term for psychological MFE than those using the computer mouse. The multiple linear regression further revealed that the strength of the positive relationship between neurophysiological and psychological measures of MFE differed between the technologies, which supports H3b. Specifically, the results show that able-bodied participants using the AT had a weaker relationship between neurophysiological and psychological measures of MFE than those using the computer mouse. This may suggest that that some able-bodied participants using the AT, and especially those who had lower neurophysiological MFE, still reported high psychological measures of MFE, which could reflect a positive bias toward the AT.

Our quantitative data analysis findings can be supported by the results of our qualitative data analysis. Specifically, both quantitative and qualitative results suggest that able-bodied participants may have had a positive bias in their psychological measures with the AT, or a negative bias in their psychological measures with the computer mouse. Our qualitative data analysis further highlights that the usability issues reported by able-bodied participants can be influenced by their experiences and expectations regarding the performance and effort required the use a computer mouse normally (i.e., without disability simulation). Moreover, the post-task interviews revealed that stroke patients raised benefits associated with functional recovery when using the AT, which could explain their different expectations of MFE, in contrast with able-bodied participants. Nevertheless, our quantitative and qualitative data offer some evidence suggesting that able-bodied participants can experience and identify some usability issues that are relevant to stroke participants with a physical disability in user testing and digital rehabilitation settings.

2.6.1 Theoretical Contribution

This study makes a theoretical contribution to the fields of IS, HCI, and accessibility research. First, we advance our understanding of the asymmetry in the psychological measures of PWD and able-bodied participants observed in HCI and accessibility research (Bajcar et al., 2020; Hossain, 2017; Ming et al., 2021; Trewin et al., 2015). Specifically, our study offers a more nuanced explanation of the above asymmetry by suggesting that the lack of familiarity with a technology may play a role in the positive bias in psychological measures. We also confirm previous ideas that the asymmetry in psychological measures can be caused by able-bodied participants' negative bias toward a familiar technology (Bajcar et al., 2020). Moreover, we explain the mechanism leading to the positive and negative bias in psychological measures using the theoretical lens of the ECT in IS (Brown et al., 2014), proposing that PWD and able-bodied participants with simulated disabilities may have different expectations of technology performance and effort required to operate it. Therefore, our study advances the ECT by proposing that the disability experience, whether it is situational (e.g., simulated) or permanent, can shape the expectations of participants, and consequently their psychological measures of technologies.

2.6.2 Methodological Contribution

This study also contributes to methods for assessing the asymmetry in psychological measures, in contrast with behavioral/neurophysiological measures, between PWD and able-bodied participants (Bajcar et al., 2020; Hossain, 2017; Ming et al., 2021; Trewin et al., 2015). While previous studies have investigated the above asymmetry by contrasting the mean psychological and behavioral measures between groups (Bajcar et al., 2020), our study further looked at the relationship between behavioral/neurophysiological and psychological measures, and how it differs between groups. In addition, we performed post-hoc analysis to assess the difference in the bias term by subtracting the z-scored mean behavioral/neurophysiological measures to the z-scored mean psychological measures. Taken together, our regression analyses and bias term score comparisons provide complementary insights into intra-group and inter-group bias, respectively. Specifically, the regression approach shows how strongly the psychological measures are related to the behavioral/neurophysiological measures within a group, whereas the bias term approach allows to quantify systematic differences between groups, thereby capturing the inter-group positive bias. We propose that this dual approach is essential to investigate the asymmetry in psychological measures since groups may not only differ in their ability to accurately self-evaluate their performance, but also in the extent to which they overestimate or underestimate their psychological measures compared to other groups.

Secondly, by using a neurophysiological approach to test the asymmetry in psychological measures, our study makes a methodological contribution to the fields of IS, HCI, and rehabilitation science (Balapour & Riedl, 2025; Kirwan et al., 2023; Zaki & Islam, 2021). Most research showing evidence of the positive bias has targeted measures of effectiveness and efficiency in terms of time, disregarding effort efficiency, which can be more challenging to assess without relying on self-reports (Bajcar et al., 2020). In this study, we used a neurophysiological index of MFE based on theta-band interhemispheric connectivity to contrast with our psychological measure of MFE. We show that, for able-bodied participants, neurophysiological MFE was positively associated with psychological MFE, but not for stroke participants. The above findings suggest that our metric of neurophysiological MFE may have had a different interpretation by our participant groups based on their different adaptation strategies aiming at optimizing muscle fatigue. The ecological validity of our findings can be supported by the fact that our controlled laboratory study is generalizable to user testing and digital rehabilitation intervention settings, which typically follow similar procedures, tasks, and measurement tools (Balapour & Riedl, 2025). Nevertheless, we argue that NeuroIS approaches should not replace but complement psychological measures since they also have limitations (Kirwan et al., 2023). For example, neurophysiological measures collected via tools like EEG are likely to have many-to-many relationships with constructs in IS and reference disciplines (Cacioppo et al., 2007; Riedl et al., 2014; Tams et al., 2014).

2.6.3 Practical Implications

Our study also has practical implications for designers and manufacturers of AT and inclusive IT design. We advocate that involving able-bodied participants with simulated disability in the evaluation of AT may offer relevant preliminary insights that can increase the efficiency of user testing of AT, as well as digital rehabilitation interventions aiming to match AT with patients. However, our results show that not only PWD, but also able-bodied participants with simulated disability, may exhibit a positive bias in psychological measures of unfamiliar AT. Furthermore, able-bodied participants with simulated disability may exhibit a negative bias in their evaluation of familiar technologies, which shows promises for design evaluations of inclusive IT. Indeed, while a positive bias may hide areas of improvement in psychological measures, a negative bias may result in more critical evaluations that lead to more effective design recommendations. Nevertheless, we support the idea that preliminary evaluations performed with able-bodied participants with simulated disability should be subsequently complemented with targeted users.

Secondly, our post-task interviews revealed that many stroke participants referred to the AT as a tool for exercising their affected functions due to the high level of muscle fatigue resulting from its use. However, this was not necessarily seen negatively, as some stroke participants reported that the AT would be helpful in rehabilitation therapies and would have been beneficial in earlier days of their recovery to engage their affected arm. This raises the idea that AT like gesture-based interfaces can be used both as a tool to improve IT access and for motor function rehabilitation, simultaneously, for people with temporary disabilities (e.g., post-stroke disabilities) who have the potential to recover by actively exercising their affected functions.

2.6.4 Limitations and Research Avenues

This study has limitations. First, our study suffers from a limited sample of stroke participants with heterogeneous characteristics, which makes it difficult to aggregate and contrast with able-bodied participants. Indeed, the physical disability simulation experienced by our able-bodied participants' group focused on limiting finger and wrist movements, which could not replicate stroke participants' limited arm, shoulder, or neck mobility depending on their diverse condition. Nevertheless, we believe that the stroke participants collected allowed to capture a wide range of physical disabilities, thereby enhancing the generalizability of our results.

Second, it is possible that the cognitive impairments affecting short-term memory of stroke participants, and not by able-bodied participants, may have influenced their perceptions toward the technologies. This stresses the relevance of behavioral/neurophysiological measures as an implicit and real-time measurement, and the importance to collect self-reported measures as soon as possible after an experience with a technology, to mitigate recall bias with cognitively impaired participants. Therefore, it is possible that the reliability of our psychological measures was affected by a recall bias in the stroke participants group, but not our able-bodied participants. It should also be noted that our experimental groups had a large difference in age, which was not controlled for in this study. Since age is known to influence the use and perceptions of technologies like input devices (Smith et al., 1999), future research may explore the effect of age on the asymmetry in psychological measures of IT.

Other response bias induced by our study design may have influenced the reliability of our results, including study fatigue in our stroke participants' group (Ming et al., 2021). Some stroke participants requested to terminate the experiment due to physical and/or cognitive fatigue. This suggests that the other stroke participants who completed the study may have still experienced high levels of fatigue, which could influence their use and evaluation of the technologies.

Finally, participants' familiarity with the technologies was not measured directly, but assumed from participants' self-declaration of whether they had used the technologies before or not. Future research should use pre-task assessment of participants' expectations about the technology performance and/or their own performance at a given task to better understand the underlying mechanism of the positive or negative bias in psychological measures.

2.7 Conclusion

This study highlights the need to consider the positive bias in psychological measures of technologies by PWD, but also able-bodied participants with unfamiliar AT, in user testing and digital rehabilitation intervention settings. Our findings also suggest that able-bodied participants with simulated disability can improve the efficiency and even the effectiveness of user testing with familiar technologies like a computer mouse. More research is needed to better understand how able-bodied participants with simulated disability can be used to test the design of AT and inclusive IT more effectively and efficiently.

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2.9 Appendix A

Selected items from the ISO 9241 - Device Assessment Questionnaire	
Psychological Pointing Performance	Accurate pointing was easy (1) difficult (7)
	Operation speed was too fast (1) too slow (7)
Psychological Motor Function Efficiency	Finger fatigue was none (1) very high (7)
	Wrist fatigue was none (1) very high (7)
	Arm fatigue was none (1) very high (7)
	Shoulder fatigue was none (1) very high (7)
	Neck fatigue was none (1) very high (7)

Table 7: Constructs and items of psychological measures

Chapter 3
Essay 3 - Understanding the Role of Ability Loss Experience in Users' Psychological Measures of IT

Abstract

Participatory research like user testing with people with disabilities (PWD) faces logistic and methodological challenges that slow down or prevent the inclusive design of information technologies (IT). Moreover, the literature suggests that psychological measures by PWD may be positively biased, which can result in less effective design decisions. This study aims to improve both the efficiency and effectiveness of user testing of IT by PWD by investigating the effect of disability experience, whether it is congenital (i.e., since birth), acquired permanent, or acquired situational (i.e., simulated), on the positive bias in psychological measures of IT. Specifically, building on theories in disability studies, rehabilitation, and information systems (IS) research, we test whether able-bodied participants with simulation glasses replicating low vision, or participants with congenital blindness, allow researchers to circumvent the positive bias in psychological measures of participants with acquired blindness and low vision. Our experiment using a NeuroIS approach with 70 participants shows evidence that the experience of ability loss can explain the positive bias in psychological measures of IT. These findings make theoretical and methodological contributions to research on PWD and inclusive design in IS, human-computer interaction, and disability studies.

Keywords: Inclusive design, user test, psychological measures, NeuroIS, expectation-confirmation theory, post-acceptance model, blind and low vision, disability simulation

3.1 Introduction

Over 1.3 billion people worldwide have some form of permanent or temporary disabilities that restrict their access to information technologies (IT) (WHO, 2022). In the last decades, people with disabilities (PWD) have consistently used less IT than able-bodied people (Duplaga, 2017; Scanlan, 2022; Vicente & López, 2010). The digital divide (i.e., a technology-based form of social inequality) between PWD and able-bodied people has been associated with important economic costs due to low online participation (e.g., shopping, banking, politics), unemployment (e.g., invalidity compensation), and healthcare services (Ayabakan et al., 2024; Bastien et al., 2020; Perez et al., 2023; Raja, 2016; Sieck et al., 2021; Weil, 2001). In addition, the number of people with temporary or permanent disabilities is expected to double by 2050 due to the global aging population (WHO, 2024). Meanwhile, recent technological advances and the growth of human- or user-centered research show great promise for the design of inclusive IT (Clarkson & Coleman, 2015; Li et al., 2023; Pisoni et al., 2021).

However, research suggests that inclusive IT design practices in organizations are inefficient and ineffective due to the lack of awareness by managers and developers, and the failure to include PWD in the development process (Mäkipää et al., 2022). Specifically, involving PWD in IT design cycles like user testing faces additional costs, time, and logistic challenges associated with finding, recruiting, and meeting with participants who are underrepresented in the population (Lazar et al., 2017; Sinabell & Ammenwerth, 2024; Turner et al., 2006; Wilson et al., 2022). Consequently, research in accessibility often relies on small sample sizes of PWD complemented with able-bodied participants for comparison, replacement, baseline, or to improve statistical significance (Brulé et al., 2020; Mack et al., 2021).

In addition, the literature raises the challenge of a positive bias in psychological measures of IT by PWD who tend to perceive high levels of satisfaction despite poor performance, in contrast with able-bodied participants (Bajcar et al., 2020; Ming et al., 2021; Pascual et al., 2014; Schmutz et al., 2016; Trewin et al., 2015). This positive bias in psychological measures of IT is significant since it may hide potential areas of improvements in the technology, thereby negatively affecting the effectiveness of user testing.

However, the positive bias in psychological measures by PWD is still unclear (Bajcar et al., 2020; Hossain, 2017). For instance, research in rehabilitation and psychology suggests that people with congenital disabilities (i.e., since birth) may be more self-accepting of their condition and thus more critical toward their psychological measures of quality of life and job satisfaction, compared to people who experienced the loss of an ability later in their life (Bogart, 2014; Campbell, 1995; Catama et al., 2017; Loprest & Maag, 2007; Steverson, 2020; Steverson & Crudden, 2023). Studies in IS research have also found that, in contrast with people with acquired disabilities, those with congenital disabilities had greater psychological measures of functional limitations and stigma consciousness associated with the use of specialized IS (Pethig & Kroenung, 2019), or poorer psychological measures of social connection associated with the use of an app (Gao et al., 2024).

The above evidence suggests that the asymmetry in psychological measures between people with acquired or congenital disabilities may be caused by the positive bias of people with acquired disabilities. This positive bias is not observed in people with congenital disabilities who are more critical toward their perception of quality of life, which may result in psychological measures that reflect their actual quality of life more accurately. This suggests that people with acquired disabilities may not accurately represent those with congenital disabilities in user testing contexts. It could be argued that people with acquired disabilities have experience and expectations with technologies before their ability loss, which may play a role in their psychological measures of quality of life or technology. For instance, people with acquired disabilities may have high expectations with a technology based on experiences before their ability loss. Consequently, even if they experience poor performance with the technology after their ability loss, they may still be satisfied with the technology.

In addition, Human-Computer Interaction (HCI) has reported the benefits of able-bodied participants with simulated disabilities (e.g., glove or splint, simulation glasses, blindfolds, earplugs) to identify accessibility issues in user testing (Cardoso & Clarkson, 2012; Giakoumis et al., 2014; Keates & Looms, 2014; Petrie & Bevan, 2009; Sears & Hanson, 2011). However, it is unclear whether able-bodied participants with acquired simulated (i.e., situational) disabilities can allow researchers to circumvent the positive bias in psychological measures of participants with acquired permanent disabilities (Bajcar et al., 2020). Therefore, to guide more efficient and effective user testing of inclusive IT design, this study addresses the following research questions: ***To what extent do able-bodied participants with acquired simulated disabilities (RQ1) or participants with acquired permanent disabilities (RQ2) exhibit a positive bias in psychological measures of IT, in comparison to able-bodied participants (RQ1) or participants with congenital permanent disabilities (RQ2)?***

We conducted a laboratory experiment with 70 participants, including 15 participants with acquired low vision or blindness, 10 participants with congenital blindness, 26 sighted participants wearing glasses simulating low vision, and 19 without, performing several information search and transaction tasks with an IT (i.e., online banking website). Drawing on adapted technology Post-Acceptance Model (PAM) and Expectation-Confirmation Theory (ECT) (Bhattacherjee, 2001; Brown et al., 2014), we conceptualize the mechanism through which people who experienced an ability loss evaluate IT based on their expectations of IT performance before and after their ability loss experience. Our results show that participants with acquired simulated low vision exhibit a positive bias in their perceived usefulness (PU) and perceived ease of use (PEOU) of IT, in contrast to sighted participants. Moreover, we found that participants with acquired blindness and low vision had a positive bias in their PU, but not in their PEOU of IT, in contrast to participants with congenital blindness. Taken together, our results suggest that the positive bias in psychological measures of IT is observed in both participants with situational and permanent acquired disabilities, but less for those with congenital disabilities.

This research makes two theoretical and two methodological contributions to the field of IS and its reference disciplines like computer science (i.e., HCI and accessibility research) and social science. First, by using an adapted ECT and PAM framework, we offer theoretical explanations for the positive bias in psychological measures of IT of participants with acquired permanent and simulated disabilities due to their expectations before their disability onset. Second, our results contribute to the literature on the role of PEOU in IT post-adoption stages. Thirdly, we offer a methodological contribution regarding the use of able-bodied participants to enhance the efficiency of user testing. Nevertheless, we warn researchers about the positive bias by people with acquired permanent or simulated disabilities in psychological measures, which are used extensively across the fields of IS (Compeau et al., 2012), social science (Peterson, 2001), HCI (Mortazavi et al., 2024), and accessibility research (Mack et al., 2021).

Finally, our work has practical implications for inclusive IT design practices in the industry. Specifically, our findings suggest that able-bodied participants with disability simulation can promote and accelerate inclusive IT design by identifying relevant accessibility issues in preliminary phases of user testing. We further raise the importance of including participants with congenital disabilities in user testing of digital interfaces, as they may provide a more critical psychological measures that are not affected by a positive bias.

The rest of the article is organized as follows. First, we provide research background information on the state and challenges of user testing and psychological measures with PWD. Then, we present theoretical foundations in disability studies, HCI, and IS research to explain and conceptualize how participants perceive IT in user testing. Our theoretical model and hypothesis development follow the theoretical background. Then, we present the methodology, followed by the results and discussion. We conclude with contributions and implications for practice.

3.2 Research Background

Since the 1950s, usability, user, or user experience testing has become a standard in the development of IT (Mortazavi et al., 2024; Ominsky et al., 2002; Waterson, 2011; Wichansky, 2000). Additionally, user testing is central to evaluations of IT artifacts in design science (Hevner et al., 2010; Hevner et al., 2004; Venable et al., 2016) and accessibility research (Mack et al., 2021). A user test allows researchers or organizations to evaluate an IT artifact based on behavioral/neurophysiological and psychological measures resulting from a participant's interaction with an IT.

Psychological data collected in user testing can be quantitative (e.g., psychological measures) or qualitative (e.g., interview). The most relevant data in a user test, from a pragmatic point of view, is the one that allows researchers identifying usability issues to address in subsequent design cycles. For instance, an important research question in HCI over the last decades has been to find the minimum number of participants required to identify at least 80% of the usability issues in a digital interface (Nielsen, 2000). While researchers are not always able to detect usability issues implicitly via methods such as observation, post-task interviews with participants can be highly informative to understand the specific issues experienced (Følstad, 2017). Therefore, qualitative research methods have been extensively used to identify participants' experiences of usability or accessibility issues based on thematic analysis of interview data (Asghar et al., 2018; Følstad, 2017).

Established frameworks to analyze or categorize accessibility issues with IT include the Web Content Accessibility Guidelines (WCAG) (Mäkipää et al., 2022). The WCAG are a checklist of design requirements that designers must follow to ensure that any aspect of a website is perceivable, operational, understandable, and robust. While the compliance with WCAG in organizations is becoming increasingly enforced by policies and laws (Babin & Kopp, 2020), 94.8% of websites in 2025 still do not comply with the checklist of web accessibility guidelines (i.e., WCAG 2.0) published in 2008 (WebAIM, 2025). Moreover, research has shown that user-centered methods like user tests with PWD are necessary and complementary to expert evaluation with a checklist (Martins et al., 2017;

Power et al., 2012; Vollenwyder et al., 2023). This is aligned with the upcoming WCAG 3.0 guidelines (Spellman et al., 2021), which will require organizations to perform user testing of their websites frequently with PWD and assistive technologies (AT) like screen readers. A screen reader is an AT that allows users to navigate through the objects of an app or website, such as headings, paragraphs, or links, by using a range of keyboard shortcuts.

While post-task psychological measures may be less adapted to identify specific usability issues, they can provide a broader view of the strengths and weaknesses of the IT artifact with multidimensional scales such as WebQual (Loiacono et al., 2002). While research in psychology has argued that self-reported measures are more reliable instruments than behavioral measures (e.g., task success, completion time) (Corneille & Gawronski, 2024), they may also suffer from different biases in user testing settings. For example, psychological measures are known to be prone to biases such as social desirability, subjectivity, or memory bias (Brocke et al., 2013; Dimoka et al., 2011; Fadnes et al., 2009).

Other biases may include the positive bias observed in PWD (Bajcar et al., 2020; Ming et al., 2021; Trewin et al., 2015). For instance, one study found that participants with low vision had similar levels of perceived ease of use as sighted participants, despite longer task completion and lower task completion rate in website testing (Pascual et al., 2014). Another study found that, in contrast with sighted participants, participants with visual impairments are less sensitive to usability issues, and their psychological measures of ease of use were positively biased (Trewin et al., 2015). Schmutz et al. (2017) also showed that visually impaired users had lower task completion rate, longer task completion time, and greater task workload than sighted users, despite no difference in psychological measures of usability (Schmutz et al., 2017). The above evidence suggests that despite their poorer performance and higher level of effort, PWDs' psychological measures of IT tend to be positively biased in relation to able-bodied participants.

In user testing, implicit measures include traditional behavioral data (e.g., task success, completion time) and more recent neurophysiological data (Perrig et al., 2024; Zaki & Islam, 2021). The use of neurophysiological measures allows for assessing constructs in real time, which can improve the internal validity of psychological measures (de Guinea et al., 2014; Dimoka et al., 2012; Kirwan et al., 2023). Furthermore, the ongoing advancements in neuroscience allow researchers to accurately assess complex constructs that are more challenging to assess with other traditional implicit measures. For instance, HCI research has typically relied on psychometric scales such as the NASA-TLX to assess cognitive workload (Kosch et al., 2023). In IS and HCI, cognitive workload has been measured with different neurophysiological measures, including heart rate variability (HRV) (Charles & Nixon, 2019; Dirican & Göktürk, 2011; Stangl & Riedl, 2022a). In this study, the goal of using neurophysiological measures is not to validate psychological measures but to contrast them with behavioral/neurophysiological measures among different groups of participants.

To address the challenges of participatory research with PWD, researchers and designers in HCI have simulated a wide range of physical, visual, or hearing disabilities with splints or gloves restricting motion or dexterity, glasses, augmented and virtual reality, blindfolds, earplugs, and even impairment simulator software that alter interface quality or trigger random mouse motion and key errors (Cardoso & Clarkson, 2012; Choo et al., 2019; Giakoumis et al., 2014; Keates & Looms, 2014; Petrie & Bevan, 2009; Pinheiro et al., 2021; Sears & Hanson, 2011). For instance, a study testing the accessibility of a mobile app with four participants with visual impairments and ten developers experiencing an augmented reality-based simulation found that it allowed identifying relevant accessibility issues that are complementary to other methods (e.g., Accessibility checker) (Choo et al., 2019). Another study found that colorblindness simulation can help detecting accessibility problems early in the development process while also increasing the awareness of developers and designers (Pinheiro et al., 2021). Therefore, despite the critics against the use of disability simulation by designers (Bennett & Rosner, 2019; Burgstahler & Doe, 2004; French, 1992; Kiger, 1992; Nario-Redmond et al., 2017; Qiu et al., 2024; Tigwell, 2021), evidence suggests that visual impairment simulations can replicate, at least partially, the behaviors and perceptions of visually impaired participants to gain valuable insights in user testing (Petrie & Bevan, 2009).

The following section presents our theoretical development, starting with the theoretical foundations of the positive bias in psychological measures of IT, followed by our conceptualization of the positive bias using the ECT. We then present our research model and hypotheses.

3.3 Theoretical Development

This section presents three conceptual frameworks that are used for the development of our theoretical model. We first review the disability paradox and its implications on psychological measures by PWD. Then, we use the ECT (Brown et al., 2014; Oliver, 1980) to explain and predict the mechanism by which psychological measures of IT can be positively biased by people with acquired disabilities.

3.3.1 Extension of the Disability Paradox

The positive bias in psychological measures by PWD, in contrast with able-bodied people, was referred to as an extension of the disability paradox in user testing settings (Bajcar et al., 2020). According to disability studies, the disability paradox exists when able-bodied people perceive the quality of life of PWD as worse than PWD's self-perception of their own quality of life (Albrecht & Devlieger, 1999). Over the last decade, studies have reported evidence of the disability paradox in surveys assessing the quality of life of people with a wide range of disabilities or declining abilities (Bajcar et al., 2020; van Loon et al., 2023). Research also suggests that the disability paradox may be more pronounced in people with acquired disabilities who, in contrast with those with congenital disabilities, tend to report greater psychological measures of quality of life, well-being, and social connection (Bogart, 2014; Campbell, 1995; Gao et al., 2024), or poorer psychological measures of functional limitations and stigma consciousness associated with the use of AT (Pethig & Kroenung, 2019). This can be explained by the idea that people with congenital disabilities are more self-accepting of their condition due to lifelong adaptation efforts, which has led to more critical psychological measures of their quality of life, for example (Bogart, 2014; Catama et al., 2017).

The above findings on the disability paradox are closely linked to the concept of crip time in disability studies. Crip time is based on the idea that PWD need more time to accomplish daily activities (e.g., completing an online banking transfer) than the normative structure of time-driven capitalist values like productivity (Kafer, 2013). The additional time PWD require is due to the multiple obstacles they face in their environment, which force them to use adaptation strategies and workarounds.

Consequently, by being constantly exposed to barriers, PWD go through a process of redefining their expectations of productivity in daily tasks. For instance, research has stressed the relevance of task time efficiency as a performance metric for PWD in the workplace (Katzman et al., 2020) or academia (Cosenza, 2014; Rodgers et al., 2023; Soklaridis et al., 2021). According to the literature on crip time, PWD also adapt their expectations of fatigue or pain in future actions based on their experience (Brilmyer, 2022; Kafer, 2013; Samuels, 2017). For example, research in rehabilitation shows that people with chronic disabilities (e.g., chronic pain or fatigue), like stroke survivors, use strategies to minimize fatigue in daily activities by taking more time or optimizing their level of effort (Donnellan & O'Neill, 2014; Sheppard, 2020; W. Zhang & Radhakrishnan, 2018).

Therefore, the concepts of disability paradox and crip time imply that disabilities can shape PWD's expectations of time and effort in daily activities. Moreover, since expectations are based on experience, research suggests that people with congenital and acquired disabilities can have different expectations about themselves and their performance in daily activities, since the latter group goes through a process of redefining their expectations after a loss of ability. The following section presents theories and framework to assess IT performance.

3.3.2 Conceptualizing the Positive Bias with the ECT and PAM

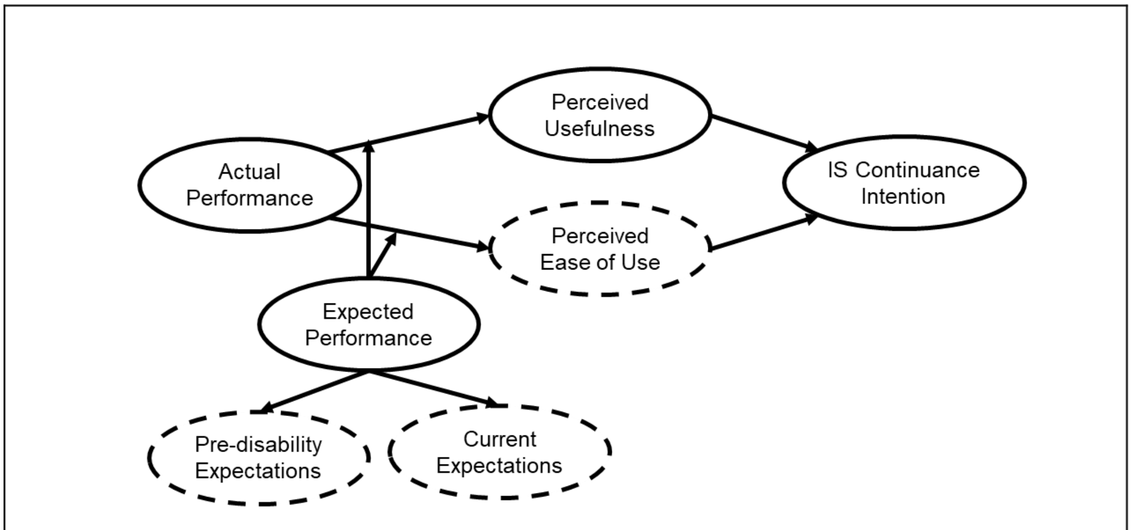
Research in IS has developed models to study post-adoption or continuance intention to use IT. These are relevant to studying the experience of ability loss and how it may influence continued use of IT daily. For example, the post-acceptance model (PAM) suggests that users' confirmation of expectations of perceived usefulness influences satisfaction with IT, and consequently their intention to continue using an IT system

(Bhattacherjee, 2001). The PAM builds on the Technology Acceptance Model by incorporating perceived usefulness as a predictor of continuance intention (Davis, 1989). According to the original Technology Acceptance Model, behavioral intention to use an IT is driven by two primary constructs: perceived usefulness (PU) and perceived ease of use (PEOU) (Davis, 1989). PU and PEOU are respectively defined as the degree to which a person believes that using a particular system would enhance their job performance, and the degree to which a person believes that using a particular system would be free from effort. However, research comparing IT adoption and post-adoption phases suggests that, while PEOU is important in the adoption phase, it becomes a less important predictor of continuance intention in the post-adoption stage (Karahanna et al., 1999).

While some research found that PU, but not PEOU predicts continued use of AT and mobile apps by people with visual or physical impairments (Cho & Lee, 2020; Moon et al., 2022; Nyagah et al., 2017), other research suggests that PEOU can still be important even in the post-adoption stage. For instance, for stroke patients who can experience mental and physical fatigue while interacting with IT, PEOU was shown to be a relevant predictor of continued use (Broderick et al., 2023; Kerr et al., 2018; Klaic & Galea, 2020). Other research also suggests the relevance of PEOU in predicting the continuance intention of older individuals with chronic disease to use mobile health technologies (Tian & Wu, 2022). Therefore, to be more inclusive for people with conditions like post-stroke fatigue or degrading abilities like aging, the PAM should also consider PEOU, how it is affected by the confirmation of expectations, and how it influences continuance intention.

Moreover, building on the ECT, the PAM allows for investigating the mechanism by which users form their psychological measures of IT based on experience and expectations (Bhattacherjee, 2001; Oliver, 1980). Research on the ECT in IS has developed different models explaining how configurations of experience and expectations with IT influence users' satisfaction with its performance (Brown et al., 2014; Taylor & Todd, 1995). These models stipulate that users base their evaluation of IT on assimilating and contrasting their experience with their prior expectations (Brown et al., 2014). Therefore, prior expectations, which are formed before the user interacts with the system, and are based on previous experiences and subjective norms (Taylor & Todd, 1995), play an important role in shaping the evaluation of IT performance.

In the case of people who have experienced ability loss, situationally or permanently, it is conceivable that they have formed initial expectations about how an IT should perform before their disability onset. These expectations may have changed throughout their lives as they adapt to new realities. For instance, these users may have high expectations of how an IT should work before their disability, but lower expectations over time after experiencing accessibility barriers with their disability. When contrasted with their experience, these coexisting pre- and post-disability expectations can lead to a positive bias in users regardless of IT performance. For instance, a low performance with IT can confirm low post-disability (i.e., current) expectations and lead to satisfaction. Conversely, an IT with high performance may confirm the user's pre-disability expectations and still lead to satisfaction. Therefore, satisfaction with IT is maintained by confirming either high or low expectations. The following Figure 14 shows our adapted PAM (Bhattacherjee, 2001) framework, which considers PEOU and the potential role of pre- and post-disability expectations on the confirmation of expected performance.



Note: Dotted circles represent the variables added to the original PAM to make it more inclusive for PWD

Figure 13: Adapted Post-Acceptance Model of IS Continuance by PWD

3.3.3 Social Model of Disability

This study adopts the Social Model of Disability, which views disability as a permanent, temporary, or situational barrier imposed by a social environment that needs to be more inclusive (Oliver, 2013; Oliver et al., 2012; Siebers, 2008). The social model was introduced in disability studies proposing that people are not disabled by their impairments, but instead by the disabling barriers they face in their social, economic, and physical environments (Oliver et al., 2012). According to this model, people with situational or permanent disabilities can face similar accessibility issues with IT. For instance, accessibility issues related to mobile device use can be experienced by visually impaired or sighted people due to visual impairment or sunlight (Tigwell et al., 2018). Likewise, the tactile screen of a mobile, tablet, or smartwatch can cause accessibility issues for people with physical impairment or cold fingers (Yesilada et al., 2010). Thus, both users with situational or permanent disabilities may engage in different behaviors and have different perceptions of IT than other users. In the next section, we develop our research model and hypotheses to test the positive bias in psychological measures of users with acquired or situational disabilities.

3.3.4 Research Model and Hypothesis Development

To address our research question, we developed a research model that investigates the moderating effect of ability loss experience (i.e., situational or permanent) on the relationship between behavioral/neurophysiological and psychological measures of IT (Figure 15). We define ability loss experience as the experience of transitioning from living with a non-affected ability to living with an impaired ability or without it. Therefore, ability loss can be experienced by people who acquire permanent, temporary, or situational disabilities during their lives. Conversely, according to our definition, people with congenital disabilities or able-bodied people have not experienced an ability loss. Based on the ECT and the PAM (Bhattacherjee, 2001; Brown et al., 2014), the literature on crip time (Kafer, 2013), and the Social Model of Disability (Oliver et al., 2012), we predict that participants who experienced ability loss experience (i.e., situational or permanent) will exhibit a positive bias in psychological measures of IT in contrast with those who have not experienced an ability loss. In other words, we expect that the ability loss experience will positively moderate the relationship between behavioral/neurophysiological and psychological measures of IT.

Our psychological measures of IT consisted of the original Technology Acceptance Model's constructs of PU and PEOU (Davis, 1989). These constructs are relevant for psychological measures of IT since they have been used extensively in research, which may allow contrasting our results with the literature and possibly explain discrepancies (Benbasat & Barki, 2007; Venkatesh et al., 2003). Additionally, PU and PEOU conceptually distinguish between time and effort efficiency, which is important according to the literature on crip time in disability studies (Brilmyer, 2022; Kafer, 2013; Samuels, 2017). Indeed, PU can be viewed as the performance of IT to accomplish a task in terms of time efficiency and effectiveness. In contrast, PEOU can be viewed as the effort to use or learn how to use a technology to accomplish a task (Davis, 1989).

The behavioral/neurophysiological measures of IT reflecting PU and PEOU consisted of task performance (TP) and task effort efficiency (TEE), respectively. We define TP as the extent to which participants accomplish a task successfully and in a timely manner, in line with the construct of PU. In HCI studies, TP has traditionally been measured via task effectiveness (e.g., task completion rate) or time efficiency (e.g., task completion time) (Sauer et al., 2020). Research in IS has also suggested that PU is positively associated with behavioral/neurophysiological and psychological measures of TP, including task effectiveness and/or time efficiency (Lim & Benbasat, 2000; Lin, 2013; Parkes, 2013). Therefore, our model suggests a positive relationship between TP and PU.

Building on the ECT (Bhattacherjee, 2001; Brown et al., 2014) and the literature in disability studies (Kafer, 2013), we expect a positive bias in PU for users who have experienced a situational or permanent ability loss. In other words, we expect that the positive relationship between TP and PU will only be held for users who have not experienced an ability loss. For those who have experienced an ability loss, we propose that their high pre-disability and low post-disability expectations regarding IT performance can lead to high PU regardless of high or low TP. Thus, we suggest the following hypothesis:

H1: Experiencing an ability loss (permanent or situational) will positively moderate the relationship between task performance (TP) and perceived usefulness (PU). Specifically, for a given TP, users with acquired blindness and low vision (permanent or situational) are expected to rate the PU of an IT as greater than users who have not experienced ability loss (i.e., sighted or congenitally blind).

Our model also suggests a relationship between TEE and PEOU. Inspired by the construct of PEOU, we define TEE as the extent to which a task is accomplished with the least amount of effort. Neuroimaging studies have shown that a website's PEOU was associated with neural correlates of cognitive resources evaluation or memory load (de Guinea et al., 2014; Dimoka, 2011; Dimoka et al., 2011). PEOU can also be influenced by negative emotional reactions like computer anxiety or frustration, which can reflect users' inability to complete a task easily (de Guinea et al., 2014; Venkatesh, 2000). For instance, Ortiz de Guinea et al. (2014) have shown that the PEOU of IT was negatively associated with a neurophysiological index of memory load, but only when users' frustration level was high (de Guinea et al., 2014). These results suggest that, when the task load is low, users may still exert additional cognitive effort to accomplish the task. Therefore, the literature shows evidence that PEOU is negatively associated with neurophysiological indices of effort, especially in highly demanding tasks (de Guinea et al., 2014). Consequently, our model assumes a positive relationship between TEE and PEOU.

Using the same rationale as in H1, we expect a positive bias in psychological measures of TEE by users who have experienced an ability loss. Indeed, based on the ECT and the literature on disability studies (Bhattacherjee, 2001; Brown et al., 2014; Kafer, 2013), people who have experienced an ability loss can have mixed expectations about the level of effort required to accomplish a computer-based task. Specifically, their pre-disability high expectations and post-disability lowered expectations can lead to confirmation of both high and low TEE. Consequently, users who have experienced an ability loss can perceive high TEE despite exerting a high level of cognitive effort. Therefore, the following hypothesis is proposed.

H2: Experiencing an ability loss (permanent or situational) will positively moderate the relationship between task effort efficiency (TEE) and perceived ease of use (PEOU). Specifically, for a given level of TEE, users with acquired blindness or low vision (permanent or situational) are expected to rate the PEOU of an IT as greater than users who have not experienced ability loss (i.e., sighted or congenitally blind).

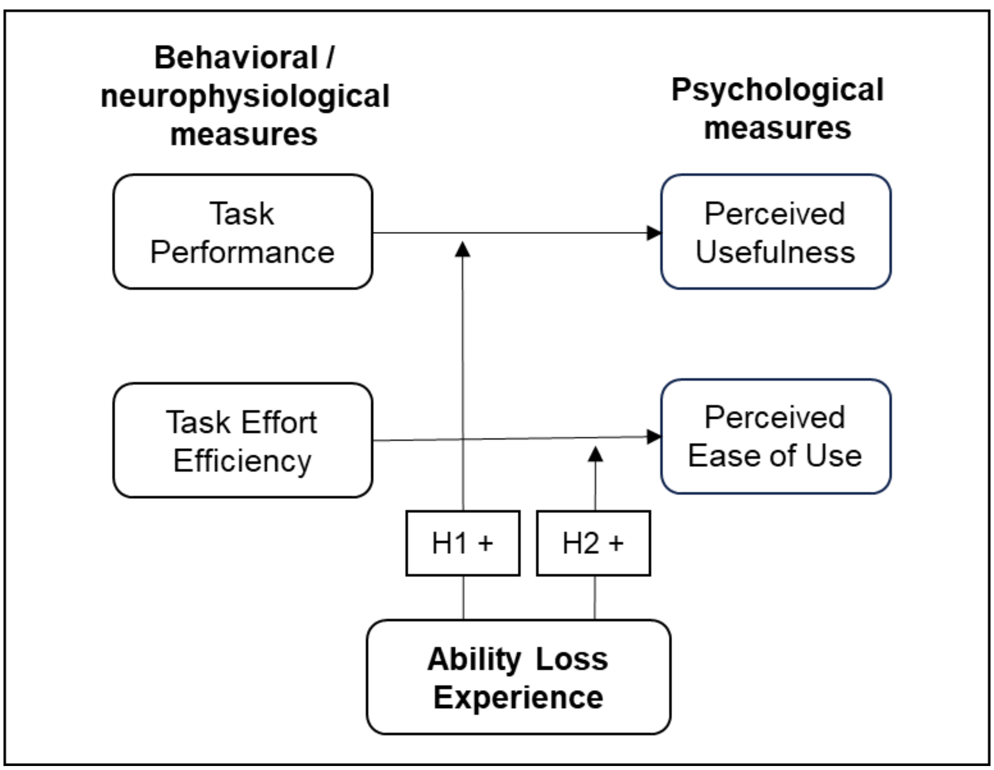


Figure 14: Research model

3.4Method

To test our hypotheses, we conducted a lab experiment involving 25 participants with acquired or congenital blindness and low vision, as well as 55 sighted participants with or without simulated low vision (i.e., glasses replicating low contrast sensitivity and visual acuity). Participants performed a series of six or seven information search and transaction tasks using an IT artifact via a standard desktop computer setup or via a screen reader (JAWS). The experiment was approved by the Ethics Review Board of our institution (Ethics Approval: 2023-5025).

3.4.1 IT Artifact

The IT artifact was a dummy account of a real-life online banking website, which is important for most populations and thus relevant for our study context. For instance, in the U.S., the percentage of people using online banking is expected to increase from 66% in 2023 to 79% in 2029 (Statista Research Department, 2024). For sighted participants and those with simulated low vision, the online banking website was accessed on a standard desktop computer with a standard mouse, keyboard, and graphical user interface zoomed in at 150%. All blind participants used the same standard keyboard and screen reader settings, which were set at a slow speech rate and high verbosity (i.e., level of detail provided by the synthesized speech). We used JAWS and Google Chrome, which are, respectively, the most popular browser and screen reader software, according to a survey with blind users (WebAIM Screen Reader Survey, 2021).

3.4.2 Sample

We recruited 9 participants with acquired low vision, 6 participants with acquired blindness, 10 participants with congenital blindness, 26 sighted participants wearing glasses simulating low vision, and 19 sighted participants without simulation glasses. Our participants with acquired low vision self-reported various symptoms, including difficulty perceiving low contrast, double vision, central vision loss, peripheral vision loss, and most commonly, acuity loss. Our blind participants self-reported their condition depending on whether they were already blind at birth or an early age (i.e., congenital), or if they were sighted for a certain period of time and subsequently lost their visual abilities (i.e., acquired) (Catama et al., 2017). All blind participants self-reported having experience with screen readers on a desktop. We ensured that the experimental groups were balanced regarding familiarity with the bank (i.e., clients and non-clients of the banking institution), age, and gender. The sample size was based on the literature in HCI and accessibility research (Mack et al., 2021; Nielsen & Landauer, 1993; Turner et al., 2006) and was similar or greater to other participatory research in IS (Michopoulou and Buhalis, 2013; Rodriguez-Sánchez and Martinez-Romo, 2017; Tuunanen and Peffers, 2018).

3.4.3 Procedure

We began the experiment by obtaining written consent for sighted participants and verbal consent for participants with blindness and low vision. Then, participants in the simulation group were presented with the simulation glasses and explained that they would have to wear them for the whole experiment to simulate vision impairment. Before starting the tasks, all sighted participants with simulation and participants with acquired low vision performed two web-based Freiburg FrACT tests to assess their visual acuity and contrast sensitivity threshold, respectively (Bach, 1996, 2006). These tests were conducted to ensure our sampling objective of simulating, on average, the visual acuity and contrast sensitivity of participants with acquired low vision. Before the start of the tasks, we presented our blind participants with our standard keyboard and let them familiarize themselves with the different keys and shortcuts.

Then, participants were instructed to complete tasks in a randomized order on an online banking website. For each task, participants were introduced to a scenario that instructed them to find, for example, specific information about insurance packages and coverage, or to complete a transaction like a bank transfer or invoice payment. After each task, we conducted a short semi-structured interview to collect participants' qualitative insights into their accessibility issues experienced. Each task lasted between 2 and 5 minutes. Although we did not use a strict time limit, after 5 minutes, the task would be stopped if participants were not progressing toward the end goal. When participants were still making progress after 5 minutes, we would let them complete the task. Following the last task, we administered a final questionnaire assessing participants' PU and PEOU with the online banking website. All questionnaires were administered aurally and participants responded verbally. We followed the best practices for including PWD in user tests, which include creating comfortable surroundings or proposing breaks if required (Šumak et al., 2023).

3.4.4 Simulating Low Vision

We simulated low vision with the Cambridge simulation glasses (Clarkson et al., 2011; Clarkson & Coleman, 2015), which have been used in several studies to assess the impact of reduced visual acuity and contrast sensitivity in user testing of inclusive IT design (Angeleska et al., 2022), radiographic image inspection (Dos Reis et al., 2020), driving vision standard test (Rae et al., 2016), indoor navigation (Zallio et al., 2021), skiing performance (Stalin & Dalton, 2021), and even Paralympic rifle shooting performance

(Allen et al., 2016). Visual acuity refers to the ability to visually process fine details, such as reading small fonts. Contrast sensitivity has to do with the ability to discriminate an object from its background (Xiong et al. 2020). Visual acuity and contrast sensitivity are common symptoms of people with low vision and are frequently assessed in rehabilitation (Xiong et al., 2020). Studies using the Cambridge simulation glasses typically conduct a vision test due to participants' different initial levels of vision (Goodman-Deane et al., 2014).

Studies using these glasses also typically layer multiple pairs of glasses together to increase the level of impairment (Goodman-Deane et al., 2013, 2014). For instance, a validation study of the Cambridge simulation glasses suggests that for a person with 20/20 vision, one pair reduces visual acuity to 20/24, while two pairs reduce visual acuity to 20/40, three pairs to 20/60, four pairs to 20/110, and six pairs to 20/400, which is considered as severe vision loss or legal blindness (Clarkson et al., 2011; Goodman-Deane et al., 2013). Among our 26 sighted participants assigned to the simulation, 14 had two pairs of the Cambridge simulation glasses and the other 12 had four pairs of glasses, corresponding to mild visual impairment and moderate visual impairment, respectively, according to the World Health Organization (WHO, 2019). We chose two levels of simulation to account for the variability in the severity of our participants with acquired low vision and to reach a similar mean level of visual acuity and contrast sensitivity between participants with simulated low vision and acquired low vision (see Appendix A).

3.4.5 Visual Acuity and Contrast Sensitivity Tests

Our participants' visual acuity and contrast sensitivity were assessed before the experimental tasks using a web-based Freiburg vision test (FrACT10) (Bach, 1996, 2006). The FrACT (Version 10) is a semi-automatic visual test battery widely used by optometrists, ophthalmologists, and in clinical trials (Schmetterer et al., 2023). This computer-based test also allows researchers to rapidly assess participants' visual abilities before computer-based tasks in the same settings. Prior work suggests that our group of participants with simulated low vision had average visual acuity and contrast sensitivity levels that were significantly lower than our sighted participants but not significantly different from those with acquired low vision (Maurice et al., 2023) (see Appendix A). Table 8 below illustrates contrast sensitivity (i.e., logCSweber) and visual acuity (i.e., adjusted logMAR) by participant, and aggregated by group, along with other demographic data.

Hyp.	Experimental Group	Ability Loss Experience	Temporality of ability loss	N	Age (mean ± std)	Gender (Female)	Familiarity (Client)	Visual Acuity*	Contrast Sensitivity*
H1a, H2a	Sighted	No	-	19	46.5 ±15.4	47.37%	57.89%	-	-
	Simulated low vision	Yes	Situational	26	37.5 ±13.3	50.00%	50.00%	0.54 ± 0.20	1.53 ± 0.17
H1b, H2b	Acquired low vision	Yes	Permanent	9	58.0 ± 10.1	44.44%	55.56%	0.53 ± 0.15	1.43 ± 0.42
	Acquired blindness	Yes	Permanent	6	54.5 ± 14.9	83.33%	50.00%	-	-
	Congenital blindness	No	-	10	49.7 ± 15.6	90.00%	50.00%	-	-
Note: * The higher the visual acuity or contrast sensitivity, the better.									

Table 8: Participants' demographics and visual abilities by hypothesis and experimental group

3.4.6 Behavioral and Neurophysiological Measures

Our implicit evaluation of IT is formed by one behavioral and one neurophysiological measure, TP and TEE, collected throughout the tasks.

Task Performance

We assessed TP based on a combined task error rate and completion time metric. Past research in HCI has used single usability metrics by standardizing with Z-score and averaging together measures of task error rate or task completion time (Pearson, 2023; Sauro & Kindlund, 2005). Task error rate refers to the average proportion of tasks that were not successfully completed, while completion time refers to the average time to complete the tasks over the experiment. Our TP metric was computed using the following steps. First, task completion time and error rate were standardized by group and task. Then, we used the inverse of the sum of standardized completion time and error rate as our TP metric, which reflects both task effectiveness and time efficiency.

Cognitive Effort

We measured cognitive effort using participants' physiological responses collected throughout tasks. A wide range of neurophysiological measures have been explored and validated to assess cognitive effort in HCI and IS research, including heart rate (Charles & Nixon, 2019; Dirican & Göktürk, 2011; Stangl & Riedl, 2022a). Measures of heart rate can be collected with medical or even consumer-grade measurement tools like smart wearable devices (Li et al., 2023; Stangl & Riedl, 2022a, 2022b). Specific features of heart rate, such as low frequency between 0.04–0.15 Hz of heart rate variability (HRV), which reflects sympathetic activation (Berntson et al., 1997; Malik, 1996), have been used as a biomarker for increased cognitive effort in HCI contexts (Villani et al., 2020; R. Xiong et al., 2020) and complex reasoning task (Solhjoo et al., 2019). Despite the benefits of electrocardiogram (ECG) signal like low frequency HRV to infer cognitive effort, it is also a well-known index with many-to-many relationships (Cacioppo et al., 2007). In other words, low frequency HRV has been associated with other constructs such as stress (Kim et al., 2018), flow (Tozman et al., 2015), or even emotion regulation (Appelhans &

Luecken, 2006). Therefore, it is important to consider other factors that may influence physiological reactions in controlled experiment settings.

We recorded raw ECG signals at a sampling rate of 500Hz using the software Acqknowledge (Biopac, Goleta, USA). The ECG was recorded using an MP-150 Biopac wireless amplifier (Biopac, Goleta, CA, USA) and two Ag/AgCl sensors positioned on the participants' torsos. To compute cognitive effort, we first standardized the low frequency HRV signal captured during the tasks according to the participants' baseline level captured during a two-minute vanilla baseline performed before the experimental tasks, where participants were instructed to remain still and calm. We then calculated the mean values of standardized low frequency HRV by task for each participant.

Task Effort Efficiency

To assess TEE, we considered both cognitive effort and task error rate by adjusting the participants' mean value of cognitive effort with their mean value of task error rate. A similar approach was used in previous research assessing the interaction between self-reported frustration and memory load (i.e., cognitive demand) on PEOU (de Guinea et al., 2014). The idea behind this approach is that the relationship between cognitive effort and PEOU can be negative when TP is low, but positive when TP is high. Therefore, for each task, we added to the cognitive effort value the product of cognitive effort and the standardized task error rate rescaled from zero to one. Consequently, with high standardized task error rate, the resulting cognitive effort would be positively adjusted. In contrast, it would remain similar with low standardized task error rate. We then computed the inverse of this adjusted metric of cognitive effort as our index of TEE such that higher values represent greater TEE.

3.4.7 Psychological Measures

Our psychological measures of IT were assessed with the PU and PEOU seven-point scale items of the Technology Acceptance Model (Davis, 1989), adapted to online banking services (see Appendix B).

3.4.8 Qualitative Measures

Since this research aims to improve the effectiveness and efficiency of user testing of inclusive IT design, we assessed the number and relevance of accessibility issues mentioned by participants in post-task semi-structured interviews. We used a deductive thematic analysis method (Braun & Clarke, 2006) to code the interview transcripts according to accessibility issues based on the WCAG categories (i.e., perceivable, operable, understandable). The number of unique accessibility issues across the tasks mentioned by participant and experimental group was then calculated. Specifically, we first counted the number of participants, by group, who mentioned each accessibility issue identified in the post-task interviews. We then divided this value by the number of participants in each group to compute the proportion of participants who mentioned each accessibility issue, by group. Then, we aggregated the proportion of participants by category of accessibility issues. The resulting values are the average proportion of participants, by group, to mention each accessibility issue, grouped by WCAG categories. We report the results by contrasting the groups experiencing the tasks with standard desktop computer setup together, and the groups using the screen reader together, since the nature of the tasks and number of tasks differed between the two setups. It should also be noted that only the qualitative data of 12 out of 19 sighted participants was analyzed since the remaining seven participants experienced different slightly different tasks due to changes in the IT artifact content and user interface.

3.4.9 Statistical Analysis

To test each of our hypotheses, we performed a linear mixed model (LMM) using Restricted Maximum Likelihood for our estimation method and Satterthwaite approximation to calculate degrees of freedom. For H1a and H1b, our two LMMs predicting PU included an intercept and fixed effects for ability loss experience, TP, and a two-way interaction between ability loss experience and TP. Our LMMs on PEOU testing H2a and H2b included an intercept and fixed effects of ability loss experience, TEE, as well as a two-way interaction between ability loss experience and TEE.

For each hypothesis, one of the LMMs included sighted participants and participants with simulated low vision to test the effect of situational ability loss experience (H1a and H2a). The other two LMMs (H1b and H2b) included participants with congenital blindness as well as participants with acquired blindness and low vision to test the effect of acquired permanent ability loss experience. All analyses were performed in SPSS (version 30.0.0.0; IBM Corp) with a threshold for statistical significance set at $p \leq .05$. Although we had four different LMMs, we did not apply adjustment for multiple comparisons due to our small number of comparisons and sample size (Nakagawa, 2004), and since we needed both H1a and H1b tests to be significant to support H1 (i.e., conjunction testing: Rubin 2021). Finally, we ran non-parametric tests to make sure that there were no differences in demographic variables (i.e., technology familiarity, gender, and age) between our group comparisons of interest (see Appendix C).

3.5Results

Our descriptive statistics, summarized in Table 9, show the different behavioral/neurophysiological and psychological measures, by hypothesis, and by group. The data show that sighted participants seemed to have higher task error rate, despite having shorter task completion time than those with simulated low vision. This may be explained by the large number of sighted older participants who were unable to complete many tasks. Participants with simulated low vision seemed to have lower TEE than sighted participants. Although PU seemed greater for sighted participants than those with simulated low vision, the latter group had greater PEOU, on average. Regarding blind and low vision, the data show that, on average, participants with congenital blindness had lower task error rate, yet slightly longer task completion time, than those with acquired blindness and low vision. TEE seemed greater for participants with congenital blindness than those with acquired blindness and low vision. Nevertheless, the latter group seemed to have greater PU and PEOU than participants with congenital blindness. The next section presents the results by hypothesis.

Hypothesis	Experimental Group	N	Task Performance				Task Effort Efficiency		Perceived Usefulness		Perceives Ease of Use	
			Task Error Rate (%)		Task Completion Time (sec)							
			Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std
H1a, H2a	Sighted	19	25.61	29.04	153.36	40.05	-297.80	326.76	5.68	0.98	5.34	0.97
	Simulated low vision	26	18.96	16.28	168.20	68.91	-382.04	443.90	5.52	1.11	5.59	1.16
H1b, H2b	Acquired blindness and low vision	15	51.27	24.20	233.80	70.75	-1310.43	1396.36	5.48	1.07	4.91	1.37
	Congenital blindness	10	33.33	35.14	240.70	69.69	-484.47	739.38	4.80	1.38	4.25	1.44

Table 9: Descriptive statistics by experiment and by hypothesis and experimental group

3.5.1 Effects of TP and Ability Loss Experience on PU (H1)

Our first hypothesis predicted a moderating effect of ability loss experience on the relationship between TP and PU, which would manifest in an interaction between ability loss experience and TP (H1a). The results of the LMM testing the effects of ability loss experience, TP, and the interaction between ability loss experience and TP, on PU, with sighted participants and those with simulated low vision, are presented in Table 10. We did not find significant effects of ability loss experience (β = 0.139, SE = 0.302, t(41) = 0.462, p = .646), nor TP (β = −0.068, SE = 0.123, t(41) = −0.556, p = .582) on PU. However, we found a significant interaction between ability loss experience and TP (β = 0.436, SE = 0.187, t(41) = 2.326, p = .025), which suggests that the effect of TP on PU depends on the ability loss experience. Specifically, this result means that sighted participants, but not participants with simulated low vision, exhibited a significant positive relationship between TP and PU. Our results show that, even with low TP, participants with simulated low vision seemed to report high PU (Figure 16). This finding supports the hypothesis that the relationship between TP and PU is positively moderated by the experience of ability loss in participants with simulated low vision, in contrast with sighted participants (H1a).

Fixed Effect	Estimate	Std Error	df	t-value	p-value
(Intercept)	5.519	0.196	41	28.172	0.000
Ability loss experience	0.139	0.302	41	0.462	0.646
Task performance	-0.068	0.123	41	-0.556	0.582
Ability loss experience × Task performance	0.436	0.187	41	2.326	0.025*
Note: * p < 0.05					

Table 10: Results of linear mixed model predicting PU - sighted vs. simulated low vision (H1a)

Our second LMM testing the effect of our variables on PU, including participants with congenital blindness and those with acquired blindness and low vision (H1b), are shown in Table 11. Ability loss experience did not have a significant effect (β = −0.645, SE = 0.415, t(21) = −1.555, p = .135), nor TP (β = 0.063, SE = 0.158, t(21) = 0.402, p = .692) on PU. However, the interaction between ability loss experience and TP was significant (β = 0.477, SE = 0.226, t(21) = 2.110, p = .047), suggesting that the effect of TP on PU depends on ability loss experience. Results show that participants with congenital blindness, but not those with acquired blindness and low vision, had a significant positive relationship between TP and PU. Indeed, participants who experienced ability loss seem to perceive high PU even with low TP. This supports the hypothesis that the relationship between TP and PU is positively moderated by the experience of ability loss in participants with acquired blindness and low vision, compared with participants with congenital blindness (H1b).

Fixed Effect	Estimate	Std Error	df	t-value	p-value
(Intercept)	5.478	0.262	21	20.875	0.000
Ability loss experience	-0.645	0.415	21	-1.555	0.135
Task performance	0.063	0.158	21	0.402	0.692
Ability loss experience × Task performance	0.477	0.226	21	2.110	0.047*
Note: * p < 0.05					

Table 11: Results of linear mixed model predicting PU – congenital vs. acquired blindness and low vision (H1b)

3.5.2 Effects of TEE and Ability Loss Experience on PEOU (H2)

The second hypothesis predicted a moderating effect of ability loss experience on the relationship between TEE and PEOU, which was indicated by an interaction between ability loss experience and TEE. We present the results of our third LMM testing the effect of our variables on PEOU for sighted participants and those with simulated low vision (H2a) in Table 12. The model showed that ability loss experience had no significant effect ($\beta = 0.275$, $SE = 0.471$, $t(34) = 0.583$, $p = .564$), nor did TEE ($\beta = -4.50e\text{-}04$, $SE = 0.001$, $t(34) = -0.866$, $p = .393$) on PEOU. Results revealed a marginally significant interaction between ability loss experience and TEE ($\beta = 0.002$, $SE = 0.001$, $t(36) = 2.021$, $p = .051$), showing that the relationship between TEE and PEOU is moderated by the experience of ability loss by participants with simulated low vision. More precisely, only sighted participants, not participants with simulated low vision, had a significant positive relationship between TEE and PEOU. Again, results show that the lack of a positive relationship between TEE and PEOU for participants with simulated low vision may be explained by the positive moderating effect of ability loss experience (Figure 16), which marginally supports H2a.

Fixed Effect	Estimate	Std Error	df	t-value	p-value
(Intercept)	5.465	0.300	34	18.205	0.000
Ability loss experience	0.275	0.471	34	0.583	0.564
Task effort efficiency	-4.50E-04	0.001	34	-0.866	0.393
Ability loss experience × Task effort efficiency	0.002	0.001	34	2.021	0.051
Note: * p < 0.05					

Table 12: Results of linear mixed model predicting PEOU – sighted vs. simulated low vision (H2a)

Our last LMM tested the effect of our variables on PEOU with participants with congenital blindness and those with acquired blindness and low vision (H2b) as shown in Table 13. Ability loss experience had no significant effect ($\beta = -.540$, $SE = 0.882$, $t(17) = -0.613$, $p = .548$), nor did TEE ($\beta = -2.39\text{e-}05$, $SE = 3.33\text{e-}04$, $t(17) = -0.072$, $p = .944$), nor their interaction ($\beta = 1.54\text{e-}04$, $SE = 0.001$, $t(17) = 0.191$, $p = .851$) on PEOU. Therefore, results do not show evidence that the relationship between TEE and PEOU differs between participants with congenital blindness vs. participants with acquired blindness and low vision, which does not allow us to support H2b.

Fixed Effect	Estimate	Std Error	df	t-value	p-value
(Intercept)	4.899	0.623	17	7.870	0.000
Ability loss experience	-0.540	0.882	17	-0.613	0.548
Task effort efficiency	-2.39E-05	3.33E-04	17	-0.072	0.944
Ability loss experience × Task effort efficiency	1.54E-04	0.001	17	0.191	0.851
Note: * p < 0.05					

Table 13: Results of linear mixed model predicting PEOU – congenital vs. acquired blindness and low vision (H2b)

The following figure shows scatter plots illustrating the relationship between TP and PU, or TEE and PEOU, for each hypothesis (Figure 16). The positive bias in psychological measures can be indicated by its weak relationship with behavioral/neurophysiological measures.

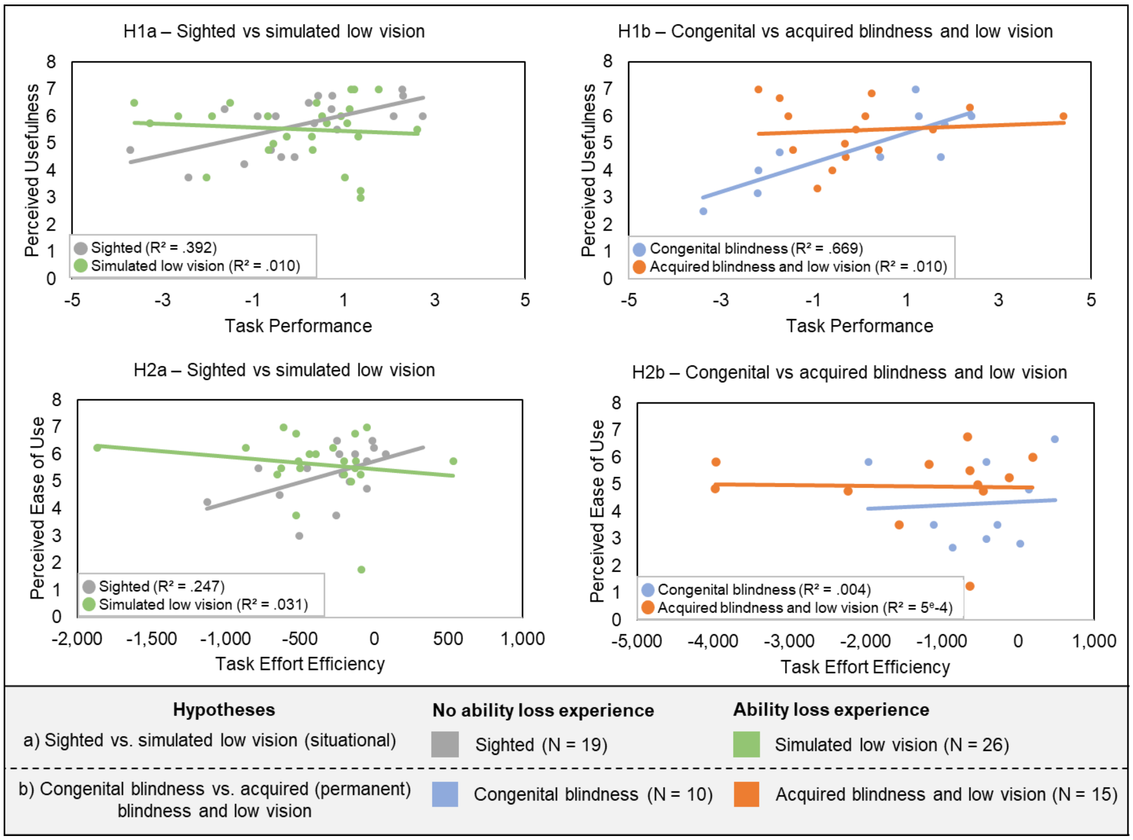


Figure 15:Scatter plots illustrating the relationship between our variables for each hypothesis

3.5.3 Qualitative Results

Another objective of this study was to assess the qualitative measures of the participants based on accessibility issues mentioned during post-task interviews. We split the analysis of accessibility issues mentioned to contrast participants who used a screen reader with those who used a standard desktop computer setup (Table 14).

WCAG categories	Standard PC access			Screen reader	
	Sighted (N = 12)	Simulated low vision (N = 26)	Acquired low vision (N = 9)	Acquired blindness (N = 6)	Congenital blindness (N = 10)
Perceivable	1.52%	14.69%	17.17%	38.89%	30.00%
Operable	20.83%	15.11%	24.60%	35.42%	30.00%
Understandable	41.67%	15.38%	11.11%	16.67%	50.00%
Total	13.46%	14.94%	20.94%	30.21%	36.25%

Table 14: Proportion of participants, by group, to mention each accessibility issue (averaged by WCAG category)

The results show that, with the standard desktop computer setup, the average proportion of sighted participants who mentioned each of the accessibility issues varied by WCAG categories, with relatively low average proportions for perceivable issues (1.52%) and relatively high average proportions for understandable issues (41.67%). For both participants with acquired and simulated low vision, who used the same standard desktop computer setup, the average proportion of participants who mentioned each accessibility issue was more consistent among the WCAG categories. Most importantly, the average proportion of participants mentioning accessibility issues of perceivable nature, which sighted participants barely mentioned, were similar between the simulated low vision (14.69%) and the acquired low vision (17.17%) groups. Overall, participants with acquired low vision mentioned more different or more frequent accessibility issues, followed by participants with simulated low vision and sighted participants.

With the screen reader, the average proportion of participants with acquired blindness who mentioned each of the accessibility issues varied by WCAG categories and differed from participants with congenital blindness. The latter group had a relatively high proportion of participants who mentioned accessibility issues of understandable nature (50.00%) compared to perceivable and operable nature (both 30.00%). For participants with acquired blindness, a relatively low proportion of them mentioned accessibility issues related to the understandable WCAG category (16.67%), in contrast to the perceivable (38.89%) and operable (35.42%) categories. Overall, the results show that participants with congenital blindness tend to mention more different or more frequent accessibility issues than those with acquired blindness.

The above results could be explained by the fact that our congenitally blind group included participants with more expertise, as shown by their generally better performance. Consequently, these participants may have been better at identifying accessibility issues from experiences. It is also possible that, as congenitally blind participants were more successful in completing the tasks, they could overcome challenges related to navigating the interface and using its functions with keyboard shortcuts to access and input information. Therefore, congenitally blind participants may have experienced more issues that impede with their understanding of this information, in contrast to participants with acquired blindness who may have faced more accessibility issues related to the perception of the information and functions to access it. This idea is coherent with our finding that sighted participants primarily identified and mentioned accessibility issues of understandable nature, in contrast with the groups with acquired and simulated low vision. Therefore, both the congenital and acquired blindness groups mention relevant and complementary accessibility issues. The nature of the accessibility issues mentioned seems to depend on the participants' level of expertise with the screen readers, which may have been higher among the congenitally blind participants in our sample.

3.6 Discussion

This study investigates how the experience of ability loss influences the psychological measures of IT in user testing context. We addressed this research question with a lab experiment involving participants with acquired blindness and low vision, congenital blindness, and sighted participants with and without simulated low vision. We found that sighted participants with simulated low vision exhibited a positive bias in the PU and PEOU of IT, in contrast with sighted participants (H1a and H2a). Moreover, our results showed that participants with acquired blindness or low vision exhibited a positive bias in their PU of IT, but not PEOU, compared to participants with congenital blindness (H1b). Therefore, our results suggest that participants with acquired ability loss (i.e., situational or permanent), exhibit a positive bias in their evaluation of PU. However, our results show that participants with acquired low vision and blindness, and those with congenital blindness, exhibited a positive bias in PEOU (H2b).

3.6.1 Theoretical Contributions

This study makes two theoretical contributions to the field of IS, HCI, and disability studies. First, we tested assumptions from the disability paradox and the concept of crip time (Brilmyer, 2022; Kafer, 2013; Samuels, 2017) through the theoretical lens of the ECT and PAM (Bhattacherjee, 2001; Brown et al., 2014). Specifically, previous research in HCI has referred to the positive bias in psychological measures of IT by PWD in user testing as an extension of the disability paradox where PWD have high satisfaction with IT despite its poor performance (Bajcar et al., 2020). However, current literature does not allow us to understand how and why the previous positive bias occurs. In this study, we propose that people who have experienced an ability loss factor their pre- and post-disability expectations in their evaluation of IT performance, leading to confirmation of high or low expectations, and thus satisfaction with high or low IT performance. Our study shows positive bias in psychological measures of IT by participants with situational simulated disability and participants with acquired blindness and low vision. Therefore, our work contributes to the call for more interdisciplinary research involving insights and theories from fields of disability and rehabilitation, for example, to better understand the development, implementation, and use of IT by PWD for everyday tasks (Zhou et al., 2024).

Our study also contributes to the PAM (Bhattacherjee, 2001). As predicted by past literature (Karahanna et al., 1999), our results suggest that PEOU is a less important predicting factor of continuance intention than PU in the post-adoption stage. However, we show that participants' PEOU may vary based on their disability experience. Therefore, PEOU may be less important for people with permanent disabilities, but more important for people with temporary disabilities or declining abilities (Broderick et al., 2023; Kerr et al., 2018; Klaic & Galea, 2020; Tian & Wu, 2022). While the role of PEOU in the post-adoption stage is unclear, it may be more inclusive for PWD to consider its influence on their intention to continue using IT.

3.6.2 Methodological Contributions

Our study also offers two methodological contributions to the fields of IS, HCI, and accessibility research (Compeau et al., 2012; Mack et al., 2021; Ming et al., 2021; Mortazavi et al., 2024; Peterson, 2001; Trewin et al., 2015). First, we contribute to research using able-bodied participants to address challenges associated with sampling the targeted population. Our study shows that able-bodied participants with simulated disabilities can improve the efficiency of user tests by identifying relevant accessibility issues more proactively.

Second, our work contributes by stressing that the positive bias in psychological measures can negatively impact their validity and thus the effectiveness of psychological measures. By doing so, we contribute to research studying the relationship between explicit and implicit (i.e., neurophysiological) measures in IS (de Guinea et al., 2014). To ensure the effectiveness of IT evaluation by PWD, we suggest that contrasting psychological measures with behavioral/neurophysiological measures can be a good practice to identify participants who may exhibit a positive bias in psychological measures. While recent discussions in psychology suggest that self-reported measures may surpass implicit performance metrics like task error and completion time (Corneille & Gawronski, 2024), we argue that NeuroIS methods allow for increasing the internal validity of psychological measures in experiments (Kirwan et al., 2023). Consequently, this study contributes to IS research involving PWD (Jia et al., 2022; Trauth, 2017; Vassilakopoulou & Hustad, 2023), and specifically those with congenital or acquired low vision and blindness (Gao et al., 2024; Michopoulou & Buhalis, 2013; Pethig & Kroenung, 2019; Rodriguez-Sánchez & Martinez-Romo, 2017; Tuunanen & Peffers, 2018). Our results support and complement past research suggesting that people with acquired blindness and low vision may have a positive bias in psychological measures, which may explain the generally lower psychological measures by people with congenital blindness and low vision (Bogart, 2014; Catama et al., 2017).

3.6.3 Practical Implications

Our research also provides insights to help organizations implement more efficient and effective inclusive IT design practices. Our qualitative results showed that sighted participants with simulated low vision mentioned similar accessibility issues than participants with low vision. The data also show that participants with congenital blindness mentioned more accessibility issues than those with acquired blindness, despite their better performance on average. This could be explained by the potentially higher level of expertise of our participants with congenital blindness with screen readers, which made them more effective at identifying and mentioning accessibility issues throughout the tasks. It is also possible that, compared to participants with acquired blindness, participants with congenital blindness are more critical in their qualitative evaluation of IT, which is not affected by the positive bias. In either case, our results suggest that researchers and designers should include participants with congenital blindness and/or with high levels of expertise with screen readers to enhance the effectiveness of qualitative evaluation of IT via a screen reader in user testing.

3.6.4 Limitations and Future Research

This study suffers from small sample sizes, specifically of our participants with acquired blindness and low vision, a common limitation in accessibility research (Šumak et al., 2023). Ironically, the essence of our research is to address the inevitable issue of relying on low sample sizes of PWD who are more challenging to find and recruit, in contrast with the able-bodied population, for participatory research like user testing. Nevertheless, our experiment with a real-life online banking website using mixed methods and a NeuroIS approach provided rich and complementary evidence that allows us to support our claims. The following section presents the study's limitations and future research avenues.

First, participants with acquired low vision had many different visual impairment symptoms that were not replicated by our simulation glasses. Nevertheless, our preexperiment vision tests showed that the simulation glasses could replicate, on average, the visual acuity and contrast sensitivity of our participants with acquired low vision.

Second, although we tried to replicate similar age means between our sighted participants and participants with simulated low vision, the latter group was generally younger. Moreover, participants with congenital blindness were slightly younger than those with acquired blindness, which could also have influenced our comparisons since age is known to influence technology perceptions (Elias et al., 2012; Niehaves & Plattfaut, 2014; Sonderegger et al., 2016; Venkatesh et al., 2003). Future research should investigate the effect of age or declining abilities on psychological measures of IT.

Third, we imposed a screen reader (JAWS) with default settings to all participants with blindness, most of whom would have preferred using their own screen reader settings and keyboard. In future studies, researchers could investigate how the experience and expectations of different AT and settings can influence satisfaction with IT by PWD.

Fourth, our findings are based on visual disabilities, which affect the visual sensory information presented in the physical structure of an IS (e.g., mouse, keyboard, monitor, microphone, speaker) (Burton-Jones & Grange, 2013). While physical or hearing impairments can also affect the access to the physical structure of an IS, it is unclear whether they affect the use of the surface (e.g., user interface, accessibility features, functionalities) and deep structures (e.g., representation of information) of an IS similarly to visual impairments. For instance, visual impairments may impede the understanding of the information presented more than physical impairments. As for people with cognitive impairments, while access to the physical structure of an IS may not be affected, their use of functionalities and their understanding of information in the surface and deep structures may be impacted. Future research should investigate whether the findings apply to other impairments.

Finally, by using the Social Model of Disability (Oliver, 2013; Oliver et al., 2012; Siebers, 2008), our study investigated the temporariness of a disability in terms of time experiencing a disability (permanent vs. situational) and time since disability onset (acquired vs. congenital). However, we did not investigate the projected time living with a disability. For instance, people with temporary disabilities have the potential to recover some or most of their abilities over the year following their disability onset. During rehabilitation, people with temporary disabilities can benefit from AT to improve their use of IT and their recovery simultaneously. Future research evaluating AT or inclusive IT design for people with temporary disabilities could investigate the effect of users' ability recovery strategies on their psychological measures of AT or IT.

3.7 Conclusion

This article presents an experiment involving 70 participants with acquired low vision and blindness, congenital blindness, and sighted participants with and without simulated low vision performing tasks on an online banking website. Drawing on theories in disability studies and IS, we investigate the effect of ability loss experience on psychological measures of IT in user testing context. Our results show that participants who have experienced an ability loss (i.e., acquired low vision or blindness and simulated low vision) exhibit a positive bias in psychological measures of IT, contrasting with sighted participants or participants with congenital blindness. These results have theoretical and methodological implications for research in IS and HCI studying or conducting inclusive

IT design evaluation. With the recent initiatives and special issues on diversity, equity, and inclusion at the MISQ (Aanestad et al., 2021; Burton-Jones and Sarker, 2021), we hope our results can foster more inclusive IS research and design practices.

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3.9 Appendix A

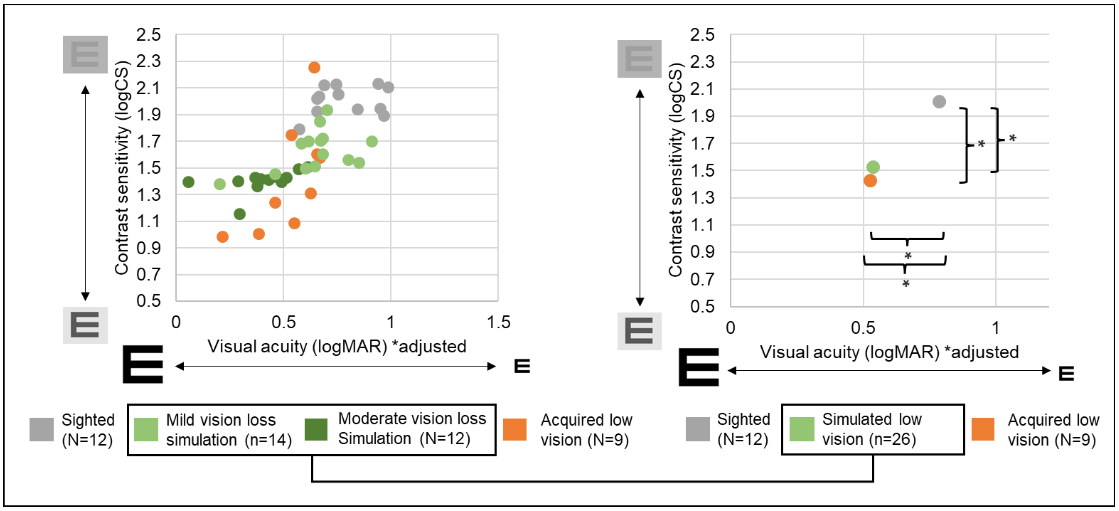

Figure 16: Simulating contrast sensitivity and visual acuity of participants with low vision

3.10 Appendix B

Perceived Usefulness (Davis 1989) * adapted for online banking services
• PU1: (Organization X) online services are useful to carry out my banking activities. • PU2: (Organization X) online services enable me to conduct my banking activities more quickly. • PU3: Using (Organization X) online services increases my productivity in my banking activities. • PU4: (Organization X) online services improve my performance in my banking activities.
Perceived Ease of Use (Davis 1989) * adapted for online banking services
• PEOU1: My interaction with (Organization X) online services is clear and understandable. • PEOU2: I expect to become skillful in using (Organization X) online services. • PEOU3: I find (Organization X) online services easy to use. • PEOU4: Learning to use (Organization X) online services is easy for me.

Table 15: Constructs and items of psychological measures of IT

3.11 Appendix C

Non-parametric test (Mann–Whitney U Test)				
Experimental Group comparison			Demographics	Two-sided p-value*
Acquired blindness and low vision	vs.	.Congenital blindness	Familiarity (Client)	0.244
			Gender (Female)	0.871
			Age	0.248
Simulated low vision	vs.	Sighted	Familiarity (Client)	0.594
			Gender (Female)	0.862
			Age	0.051

Table 16: Non-parametric tests

Conclusion

This thesis aimed to advance theories and methods to study IT use by PWD in IS research. First, the thesis presents the disability digital divide as a twofold research problem that requires inclusive IT design practices and digital rehabilitation. Then, we present insights from a scoping literature review on how the field of IS has contributed to research addressing the disability digital divide. Building on the gaps highlighted in the literature and in industry, we developed three overarching research questions.

Our first research question explored to what extent we can develop IS theories that are inclusive for people of all abilities (RQ1). Essay 1 presents a refined conceptualization of individual IT performance in theories of IT use that is more inclusive for people with post-stroke disabilities. This essay further discusses how our refined conceptualization of individual IT performance, as well as our developed theoretical propositions, can be applied to able-bodied IT users. Specifically, we propose that IS theories can be more inclusive by distinguishing between and by considering both time and effort efficiency when assessing individual IT performance. Indeed, because time and effort efficiency can vary independently, splitting the construct of efficiency may offer more nuanced results for both PWD and able-bodied users. Therefore, we suggest that it is possible and that it can be beneficial to develop and adapt IS theories that are inclusive for people of all abilities.

The second research question investigated the influence of technology familiarity (Essay 2) / ability loss experience (Essay 3) on the positive bias in psychological measures of IT (RQ2). Essay 2 advances our understanding of the asymmetry in psychological measures, in contrast with behavioral/neurophysiological measures, between PWD and able-bodied participants in the HCI literature (Bajcar et al., 2020). Specifically, this essay suggests that the familiarity with the technology can contribute to the positive bias in psychological measures. Our experiment with 15 stroke participants with physical disability and 21 able-bodied participants with a physical disability simulation showed that both groups had a positive bias in the psychological measures of AT.

The results of Essay 2 also show that the neurophysiological measure of motor function efficiency (MFE) used may reflect different adaptation strategies, leading to different psychological MFE between stroke patients and able-bodied participants. For instance, for able-bodied participants, higher neurophysiological MFE may reflect the use of successful adaptation strategies aiming at optimizing muscle fatigue, which consequently resulted in higher psychological MFE. However, stroke patients had a negative but non-significant relationship between neurophysiological and psychological MFE. It is possible that, for stroke participants, higher neurophysiological MFE reflected signs of enhanced motor learning consequence of their perseverance in completing the tasks despite muscle fatigue, which led to low psychological MFE.

The third essay of the thesis also advances our understanding of the positive bias in psychological measures and further explores the validity of able-bodied participants with simulated disability in user testing of inclusive IT design. The results of our experiment with 70 participants show that those with acquired permanent and simulated low vision and blindness exhibited a positive bias in their psychological measures (i.e., PU and PEOU), but not congenitally blind and sighted participants. This finding indicates that the positive bias in psychological measures may be attributed to the experience of ability loss, be it permanent or situational (simulated). We conclude that both the technology familiarity and ability loss experience can play a role in the positive bias in psychological measures. Specifically, Essay 2 shows that testing an unfamiliar technology without experience may itself induce a positive bias, whereas Essay 3 suggests that people who have acquired a disability, in contrast to those who are born with it (i.e., congenital), tend to exhibit a positive bias in their psychological measures.

Our third research question explored how the disability experience can influence the usability/accessibility issues identified in user testing context (RQ3). The qualitative data presented in the second and third essays offer a nuanced explanation regarding the asymmetry in psychological measures. For instance, in Essay 2, our qualitative data suggest that able-bodied participants with simulated physical disability may have overemphasized usability issues associated with the familiar technology as well as downplayed issues related to the unfamiliar AT, in contrast with stroke participants. This could be explained by the disability simulation, which negatively impacted the use of the familiar technology (i.e., computer mouse). Moreover, our post-task interviews revealed that stroke participants have perceived the unfamiliar AT as a tool for exercising, and that it would have been beneficial to their functional recovery during earlier stages of their rehabilitation.

In Essay 3, our qualitative data further show that sighted participants with simulated visual disability mentioned similar accessibility issues than our participants with acquired permanent low vision. Moreover, we found that participants with congenital blindness tend to identify accessibility issues of different natures than those with acquired blindness. Therefore, we conclude that the disability experience, whether it is acquired or congenital, and permanent, temporary, or situational (i.e., simulated) can influence the nature of usability or accessibility issues uncovered in qualitative evaluation of PWD and able-bodied users.

Overall, this thesis addresses different calls for Human-Centric Healthcare research (Bardhan et al., 2025), and diversity, equity, and inclusion initiatives in the field of IS (Aanestad et al., 2021; Burton-Jones & Sarker, 2021). More broadly, our work contributes to IS research on social and workplace inclusion of PWD (Tanyel et al., 2025; Tarafdar et al., 2023). The following sections present our theoretical and methodological contributions, followed by the practical implications of the thesis, as well as a research agenda.

Theoretical Contributions

This thesis contributes to the development of inclusive theories in IS research. Our scoping review shows that IS research have borrowed from theories in other fields and combined them with IS theories. This suggests that IS theories are not originally inclusive for PWD, and that future IS theory development should be performed with people of all abilities in mind to promote the inclusion of PWD in future IS research. We present two examples of adapting IS theories to make them more inclusive for PWD by refining (1) the construct of efficiency in theories of IT use like the TEU, and (2) the construct of expectations in the ECT.

First, we refine the conceptualization of IT performance in theories of IT use (Ringeval et al., 2025). Specifically, in Essay 1, we used construct's splitting as a theory elaboration approach to improve the validity and scope of the construct efficiency by distinguishing between time and effort efficiency (Fisher & Aguinis, 2017). We further contextualize our adapted conceptualization of IT performance in post-stroke digital rehabilitation settings by using and extended TEU framework (Burton-Jones & Grange, 2013). This Essay offers testable propositions that predict the relationships between adaptation or learning actions and IT use performance and digital rehabilitation outcomes. Furthermore, we suggest that our more granular conceptualization of individual IT performance can be relevant for able-bodied users. For example, we propose that the idea of distinguishing between time and effort efficiency can be applied in contexts such as learning a new input device (e.g., ergonomic keyboard or mouse), learning to touch type, or delegating tasks to a generative artificial intelligence, where users of all abilities can face trade-offs between time and effort resources, and even between physical and cognitive effort. Indeed, people may not interact with IT using traditional mice and keyboards. User interfaces of the future (e.g., gesture-based interface, brain-computer interface) may change the way users of all abilities physically and cognitively interact with IT.

This thesis also suggests that the disability experience, whether it is congenital or acquired permanent, temporary, and situational (Figure 3), can shape users' expectations and perceptions of IT. For instance, Essay 1 suggests that people with temporary disabilities may perceive IT differently than those with permanent disabilities due to different expectations of future experiences. Specifically, while people with temporary disabilities have different expectations of IT with their future abilities as they recover, whereas people with permanent disabilities have lower hopes to recover their abilities. Moreover, people with permanent disabilities may expect IT to maximize effort efficiency, which can be detrimental to people with temporary disabilities for whom the recovery depends on exercising their affected function by exerting effort. Therefore, Essay 1 challenges the idea of combining participants with temporary disabilities with those with permanent disabilities since the latter group may be prone to biases that may not affect the former group.

In Essay 2 and 3, we found that people with acquired disabilities, permanently, temporarily, or situationally (simulated) may perceive IT differently than those with congenital disabilities or sighted people due to their expectations based of experiences with abilities. In Essay 2, our results show that the absence of experience and thus expectations with an unfamiliar technology can induce a positive bias in the satisfaction with IT even if it performs poorly, when contrasted with a familiar technology. In Essay 3, we propose that participants who experienced ability loss have expectations of IT performance before and after their ability loss. In summary, the idea that the disability experience can influence expectations and perceptions of IT has implications beyond for inclusive design beyond user testing. It raises questions regarding emotions, coping, adaptation, and other aspects of IT and AT use that requires users to build engagement with the technology. Therefore, moving forward, researchers should consider and collect data about disability experience beyond body functions, and also consider the temporal trajectory of disability and recovery (e.g., disability onset and duration). This thesis further proposes that the disability experience can be studied through the lens of the ECT (Bhattacherjee, 2001; Brown et al., 2014). Indeed, although we have not measured the previous expectations directly, our results suggest that participants' expectations with a familiar or unfamiliar technology, or with abilities pre- or post-disability experience, may influence their psychological measures of IT.

Methodological Contributions

The results of this thesis put in perspective the validity of psychological measures by PWD, as well as the validity of able-bodied participants with simulated disabilities, which is relevant for a wide range of fields, including social sciences (Peterson, 2001), HCI research (Mortazavi et al., 2024), accessibility research (Mack et al., 2021; Ming et al., 2021; Trewin et al., 2015), or IS research (Compeau et al., 2012).

First, the results presented in this thesis contribute to the literature on the asymmetry in psychological measures between PWD and able-bodied participants (Bajcar et al., 2020). While past research has highlighted the positive bias in psychological measures by PWD, our results add precision regarding the factors that may lead to the above asymmetry. In Essay 2, our results suggest that the asymmetry may also be influenced by a negative bias exhibited by able-bodied participants with simulated disability toward a familiar technology. Moreover, we found that able-bodied participants with simulated disability may also exhibit a positive bias in their psychological measures of an unfamiliar AT with which they have no experience and expectations. In Essay 3, our results further suggest that the positive bias is not exhibited by participants with congenital disabilities, but only in those with acquired permanent or situational (i.e., simulated) disabilities. Taken together, our findings shed light on the role of experience and expectations with familiar technology or with healthy abilities (i.e., before disability onset) in participants' psychological measures of IT. These findings have implications for the sampling of user testing in the development and evaluation of new AT with which participants may have little to no prior expectations.

In addition, this thesis contributes to methods for studying the asymmetry in psychological measures, in contrast with behavioral/neurophysiological measures, between PWD and able-bodied participants (Bajcar et al., 2020; Hossain, 2017; Ming et al., 2021; Trewin et al., 2015). Specifically, we propose that the positive bias in psychological measures can manifest in two different ways. Psychological measures can be systematically increased across a group (i.e., inter-group positive bias), or only by a certain cluster of participants who tend to overestimate their psychological measures despite exhibiting poorer behavioral performance (i.e., intra-group positive bias) (Figure 17). We further propose two different data analysis approaches, regression analyses and bias term score comparisons, to capture these complementary types of positive bias. Specifically, while the regression approach highlights how strongly the psychological measures are related to the behavioral/neurophysiological measures within a group (i.e., intra-group positive bias), the bias term approach quantifies systematic differences between groups, thereby capturing the inter-group positive bias.

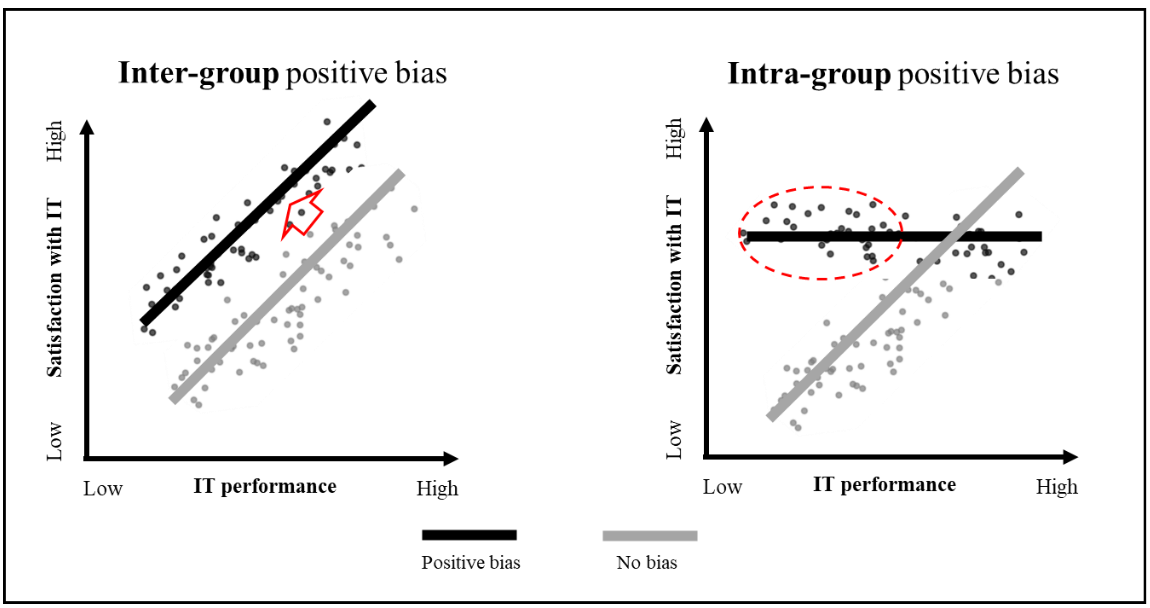

Figure 17: Illustration of inter- and intra-group positive bias

Secondly, this thesis investigated the potential of able-bodied participants with simulated disability to improve the efficiency of user testing. Our experiments show that able-bodied participants with simulated disability allow researchers to uncover relevant usability and accessibility issues, which is consistent with past literature in HCI and accessibility (Chen et al., 2009; Kwan et al., 2014; Palani and Giudice, 2017; Meena et al., 2018; Menges et al., 2019; Manresa-Yee et al., 2019). However, our results suggest that able-bodied participants with simulated disability may not allow researchers to circumvent the positive bias in psychological measures by PWD since they also exhibit a positive bias. Consequently, this thesis argues that behavioral/neurophysiological measures may be necessary to complement psychological measures like scales and surveys. Nevertheless, more research is needed to develop valid and reliable neurophysiological correlates of IS constructs. The experiments presented in Essays 2 and 3 used and advance NeuroIS methods for assessing cognitive effort via ECG-based HRV, and EEG-based MFE, in participants with physical or visual disabilities.

The above findings suggest a nuanced perspective on the benefits and limitations of able-bodied participants with simulated disability who can improve the efficiency of user testing of AT and inclusive IT design by identifying relevant usability and accessibility issues via qualitative evaluation (e.g., post-task interview). Meanwhile, the positive bias in psychological measures of able-bodied participants with simulated disability may affect the effectiveness of user testing. Finally, our findings have high ecological validity since the context of our experiments were highly similar to digital rehabilitation intervention (i.e., computer access assessment) (Essay 2) and user testing (Essay 3), in terms of procedures, tasks, and measurement tools (Balapour & Riedl, 2025).

Practical Implications

The practical implications of this thesis stem from its methodological contributions. First, the banking organization that offered their IT artifact for evaluation has integrated methodological guidelines derived from this thesis (e.g., use of low vision simulation) into their inclusive IT design. Therefore, our methodological contributions had direct implications for an organization that adapted their design practices according to our methodology. Specifically, our findings offer insights into the number of participants to collect, the use disability simulation, and the order in which different groups of participants should be collected in user testing of inclusive IT design. For example, we found that collecting able-bodied participants with simulated disabilities before PWD not only allows researchers to pretest a study protocol, but also to identify and address preliminary issues. Consequently, researchers can optimize their time with limited samples of PWD to validate the previous preliminary issues and to identify new ones in later testing phases. We also hope that this thesis guides future research and practice on user testing with PWD, which will be increasingly important with the upcoming WCAG 3.0 (Spellman et al., 2021), and eventually required by laws like the Accessible Canada Act of 2040 (Tsalis et al., 2020; UN, 2024).

Secondly, our interviews with several health professionals, stroke patients, and caregivers, of which some were volunteering in stroke charities, contributed to raising awareness of solutions to improve IT use. For example, at the end of the interviews, different resources were shared with our interviewees, including the website My Computer My Way from AbilityNet.uk, which assist users in identifying and using accessibility features in different operating systems of computers, tablets, or mobile devices. Most interviewees were surprised to realize they had not been made aware of these solutions. Indeed, raising awareness of solutions to improve IT use is an easy first step to address the disability digital divide. There are a growing number of powerful accessibility features integrated in our IT device's operating system, although most users ignore them (Franz et al., 2019; Wu et al., 2021). Being aware about IT access solutions like accessibility features can be relevant for future potential situational, temporary, or permanent disabilities, but also to help our loved ones, employees, patients and others who may at some point require assistance. Therefore, the practice of digital rehabilitation investigated in this thesis is a social phenomenon that involves people of all abilities who will inevitably experience forms of ability loss.

Moreover, increasing awareness of solutions for IT access can scale up the benefits of digital rehabilitation globally. For instance, PWD in low-income countries who do not have access to AT, but who can afford a mainstream IT device, rely on accessibility features to improve their use of IT. Increasing awareness of accessibility features available in our own device should be a first and necessary step that may require interdisciplinary effort involving AT developers, organizations, health professionals, and even policy-makers, which is aligned with the global health and rehabilitation initiatives (e.g., rehabilitation initiative 2030).

Research Agenda

This thesis advances a relatively unexplored topic in IS research, as shown by our scoping literature review in the introduction. Addressing the disability digital divide will be of critical importance in the coming years with new laws and policies on accessibility. Moreover, with the exponential development of technologies like generative artificial intelligence, the next decade is crucial to make sure that we are not further exacerbating the disability digital divide. This section presents a research agenda, illustrated in Figure 18, which can be split into theory and methodological advancements, as well as impact on practice.

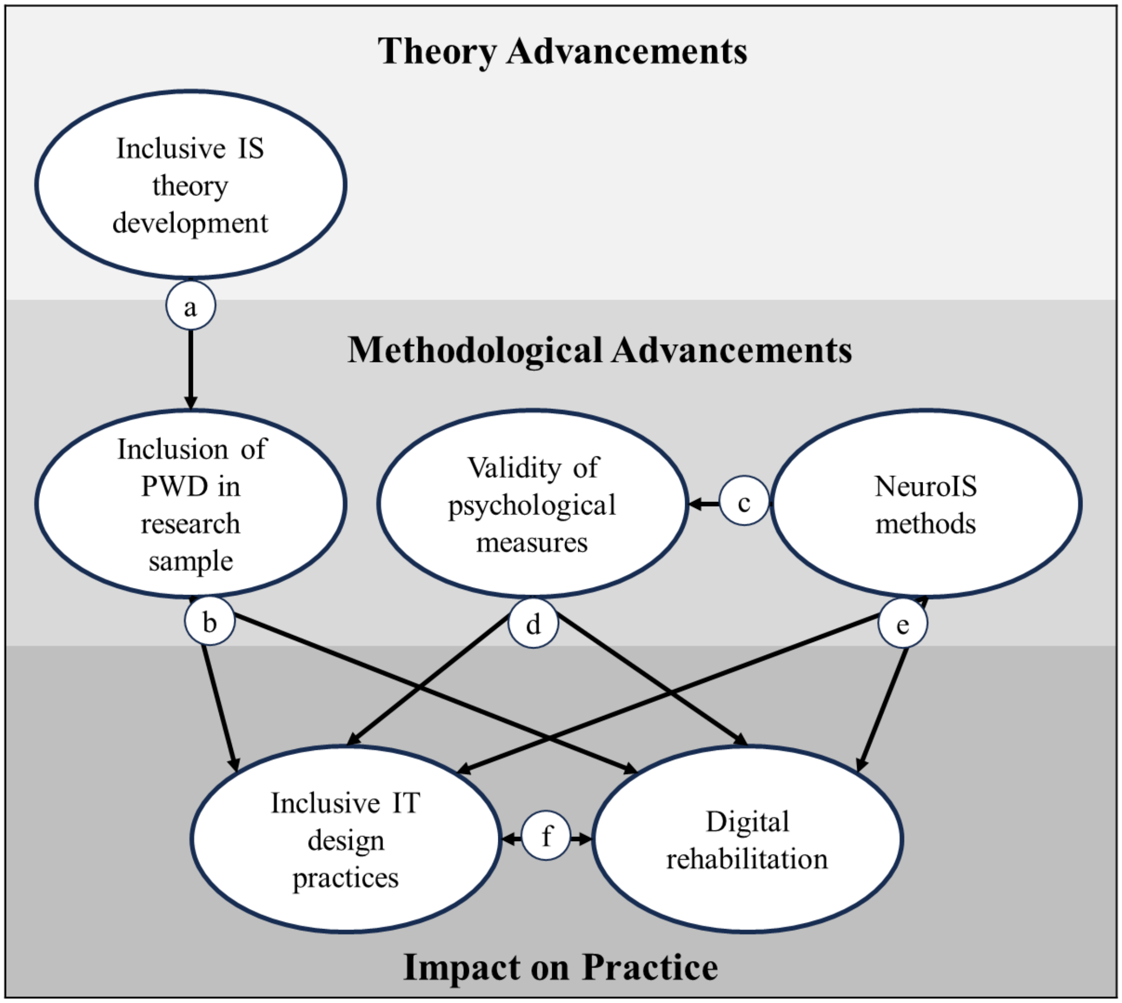

Figure 18: Framework of future areas for research and their relationship

Theory Advancements

This thesis introduces the idea of refining an IS theory (e.g., conceptualization of efficiency in theories of IT use) to make it more inclusive for PWD. We also propose that our refined conceptualization of efficiency is relevant for any users for whom the functional abilities will degrade due to aging. Indeed, there is a fine line between people with disabilities and aging people with degrading abilities, which resulted in a recent call for an integrated approach in gerontology research (Barton et al., 2025).

Our proposed conceptualization may also be relevant for any users learning new technologies (e.g., ergonomic keyboard, generative artificial intelligence, BCI) to improve their use of IT. Indeed, technological advances can reduce both the time and effort required to perform a wide range of IT-based activities like typing or searching for information online. While increasing time efficiency can be beneficial for users' productivity, increasing effort efficiency can come at the cost of losing abilities that needs to be maintained (i.e., deskilling). Therefore, future research may explore how preventive digital rehabilitation may address, more proactively, the future dangers related to users' degrading abilities or automation of our IT-based tasks.

We also argue that making IS theories more inclusive can encourage the inclusion of people of all abilities in samples of research participants (Figure 18, a). Consequently, the resulting research outcomes consider and may be applied to the reality of PWD who represent a growing proportion of the global population, thereby contributing to inclusive IT design and digital rehabilitation practices (Figure 18, b).

Nevertheless, adapting IS theories to make them more inclusive can come at the cost of methodological limitations. For example, construct splitting to improve the scope and generalizability of a theory may increase the complexity of a research model or the sample size required to test it (Fisher & Aguinis, 2017). Moreover, researchers should be careful with multicollinearity between overlapping constructs that need to be conceptually distinct. Therefore, although a construct splitting approach may increase the generalizability of IS theories and allow for more nuanced interpretation of findings

(Fisher & Aguinis, 2017), future research should investigate the benefits and limitations of IS theory development that is inclusive for people of all abilities.

Methodological Advancements

This thesis has shown that behavioral/neurophysiological measures in experiments can also be used to identify participants who overestimate or underestimate their psychological measures, thereby improving the internal validity of psychological measures collected via surveys (Kirwan et al., 2023). Consequently, researchers may decide to ignore or adjust the positively or negatively biased psychological measures during the analysis. NeuroIS measures may also be used as part of a metric to adjust psychological measures. However, neurophysiological measures have limitations, including their many-to-many relationships with a wide range and growing number of constructs (Cacioppo et al., 2007). Therefore, research in neuroscience and applied fields still have a long way to fully understand and interpret neurophysiological signals.

In addition, future research may use NeuroIS methods to study the cognitive or emotional mechanisms by which participants rate psychological measures. Such a study could provide insights on the underlying neural mechanisms and strategies to mitigate bias in scale response, which can be relevant across research disciplines (Figure 18, c). For instance, research in Neuroscience found neural correlates of psychological of thoughts related to planning or self-referential processing of autobiographical self (Araujo et al., 2015; Knyazev, 2013; Portnova et al., 2019; Zanesco et al., 2021). When research participants respond to psychological measures like Likert scales, they go through introspection (i.e., self-referential processing), emotional processing, or decision making to rate the items (Brosch & Sander, 2013; Finlayson-Short et al., 2020). Research has also shown that depression can negatively bias self-referential positive information (Collins & Winer, 2024). Therefore, future studies should investigate neural correlates of positive or negative bias in psychological measures based on brain activity assessed during scale response. Methodological advances in the previous area of research can also benefit organizations employing psychological measures from user testing participants or patients in digital rehabilitation interventions (Figure 18, d).

With the rise of low-cost commercially available wearables like smart watches or consumer-grade mobile EEG systems (Ariza & Pearce, 2022; Enríquez et al., 2024), and the democratization of applied neuroscience methods (Dimoka et al., 2012; Entezarian et al., 2025), NeuroIS methods can have a large-scale impact for organizations conducting user testing or digital rehabilitation interventions (Figure 18, e). NeuroIS measurement tools overlap with AT in terms of neurophysiological signal input used. For instance, three of the AT (e.g., BCI, eye tracker, video camera) presented in Figure 1 shown in the thesis introduction can be used as neurophysiological measurement tools to assess brain activity, eye gaze, or automatic facial expressions analysis. Therefore, future research evaluating AT based on neurophysiological signal input also have the opportunity to inform on participants' cognitive or emotional states during their interaction. Moreover, it is likely that innovations in NeuroIS and its reference fields contribute to the development of new AT, which increasingly use neurophysiological signals as input. The development of new AT in research can be beneficial to digital rehabilitation practices, although these innovations need to be communicated, commercialized and accessible by PWD.

Impact on Practice

Advancing theories and methods in IS may help to produce better cumulative research. Yet, fundamentally, our field must have an impact in organizations, education, and society. The above methodological advancements would ensure the design of inclusive IT by organizations. With new laws and policies on accessibility, future research should further study and guide organizations and governments in the integration of accessibility into their different practices (e.g., employment, customer service, or user experience design). For instance, the Accessible Canada Act will force organizations from government, public, and private sectors to have websites and apps that comply to WCAG 2.1 AA by 2040. Until then, provinces apply different legislations. In Québec, the *Act to secure handicapped persons in the exercise of their rights* forces organizations from the public sector to comply to the *standard sur l'accessibilité des sites Web (SGQRI 008 3.0)*, inspired by the WCAG 2.1 and WCAG 2.2, since April 2024. In the United States, the Americans with Disabilities and Section 508 forces compliance to WCAG 2.1 AA for state and local government websites and apps since April 2024 and is set to enforce compliance for public entities serving populations of 50,000 or more by April 2026, and under 50,000 by April 2027. Although complying to WCAG is not yet mandatory for private organizations, there has been a growing number of lawsuits filed against large organizations for website accessibility issues in the United States (Babin & Kopp, 2020).

The identification of usability and accessibility issues can be performed by using a combination of methods, including automatic checkers, expert evaluation (e.g., WCAG checklist), or observation and post-task interviews. Future research should highlight the contribution of each method in terms of type or frequency of accessibility issues identified to drive more efficient inclusive IT design practices. For instance, while web accessibility issues related to low color contrast are straightforward to assess with automatic checker, issues related to poor understanding may be more subjective and require other methods like user testing. Therefore, from a practical perspective, it is more effective to identify certain issues with automatic tools and to focus on other types of issues with user testing performed in later stages. Organizations need guidance from future research to effectively and efficiently integrate accessibility testing in their iterative design cycles of IT (Egan et al., 2022).

This thesis also advances digital rehabilitation practices aiming to improve people's or patients' use of IT. The provision of IT access solutions (e.g., AT) in digital rehabilitation is an important challenge that requires an interdisciplinary research effort in collaboration with the government, the industry, and society. Future research should investigate ways to detect users IT access needs in real time and automatically provide adjustments like AT, as well as solutions to increase awareness and access to AT through funding or rental and trial services, for example. Such research would contribute to close the gap between people's current or future IT access needs and the IT access solutions that are already available, including accessibility features in their own devices or AT that are not used by health professionals or their patients. To conclude, by ensuring that PWD have the appropriate IT access solutions, and that IT are inclusive and compatible with those solutions, we can hope to bridge the disability digital divide.

Our work revealed various similarities between user testing of AT and inclusive IT and digital rehabilitation interventions for patient-AT matching. The following table summarizes some similarities between the two practices. First, both practices have automatic tools to assess and adjust the accessibility of websites (e.g., accessibility checker plug-ins or tools like Microsoft Accessibility Insights) (Abascal et al., 2019) or the pointing and typing performance of patients (Koester et al., 2013). Then, in user testing or digital rehabilitation interventions, researchers or health professionals have traditionally observed users or patients in scenarios (Martins et al., 2017; Power et al., 2012; Simpson et al., 2010). Both practices have also developed standardized tools to assess pointing or typing speed and accuracy (Koester et al., 2003; Soukoreff & MacKenzie, 2004).

Participant or patient behavior observation is an important method in user testing or digital rehabilitation interventions to identify usability or accessibility issues (Abou-Zahra, 2008; Manresa-Yee et al., 2014; Simpson et al., 2010). However, evaluation by observation may require a certain level of knowledge to understand the nature of usability or accessibility issues experienced by users or patients (Følstad, 2017; Kearney-Volpe & Hurst, 2021; Mankoff et al., 2005). Other traditional measures like task completion time and task success or accuracy provide a relevant and even direct index of constructs like task time efficiency or effectiveness (Koester & Arthanat, 2018; MacKenzie & Isokoski, 2008). Since other constructs like cognitive workload or effort are more challenging to measure implicitly, HCI research has typically relied on psychometric scales such as the NASA-TLX (Kosch et al., 2023). Using neurophysiological tools as a method for implicit and real-time assessment of constructs that would be difficult to assess otherwise (e.g., cognitive or emotional states) has been explored in user testing and digital rehabilitation contexts (Ortega & Mezura-Godoy, 2022; Pasqualotto et al., 2015; Zaki & Islam, 2021).

Finally, both user testing and digital rehabilitation interventions employ quantitative and qualitative measures, including scales or questionnaires of satisfaction and usability

(Arthanat et al., 2007; Brooke, 1996; Demers et al., 1996; Douglas et al., 1999; Loiacono et al., 2002), as well as interviews to assess satisfaction (Koester, 2004) or to identify usability and accessibility issues (Abou-Zahra, 2008; Følstad, 2017; Koester, 2004). Although research in psychology argues that psychological measures are more reliable instruments than behavioral measures like task success or completion time (Corneille & Gawronski, 2024), they are prone to recall, social desirability, or subjectivity biases (Brocke et al., 2013; Dimoka et al., 2011; Fadnes et al., 2009). In addition, this thesis supports previous literature suggesting a positive and even negative bias in psychological measures of IT by PWD (Bajcar et al., 2020; Ming et al., 2021; Trewin et al., 2015).

Considering the similarities between user testing assessing the performance of inclusive IT and AT, and digital rehabilitation interventions assessing patients' performance with IT or AT, this thesis argues that these two practices can learn from each other (Figure 18, f). While rehabilitation professionals are experts in humans' abilities and functions, user experience or accessibility professionals have expertise for identifying usability or accessibility issues and IT-based solutions. In the future, universities should develop interdisciplinary education programs that integrate the best practices of both disciplines to improve the training and skills of future professionals and potentially create new specialist roles. We argue that rehabilitation professionals can benefit from knowledge and skills to conduct user testing with technologies, and that experience or accessibility professionals can benefit from knowledge and skills to evaluate and design technologies for PWD.

In conclusion, the research agenda presented above may guide researchers in addressing the disability digital divide from different perspectives and invites collaboration between different disciplines. Moreover, the expected contributions of the proposed research avenues can extend beyond research with PWD, and beyond research in IS. It is hoped that, in the future, researchers from all disciplines succeed at demonstrating the value of narrowing the disability digital divide to include PWD in our society and workplace.

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