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From translation process and product to reception: Investigating cognitive effort of the translator and the reader

Od procesu i produktu tłumaczenia do recepcji przekładu: Badanie wysiłku poznawczego tłumaczy i czytelników

Rozprawa doktorska napisana
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To my Parents
Moim Rodzicom

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List of Research Articles

The present PhD thesis comprises **five thematically related *Research Articles*:**

Article 1:

Tomczak, **Ewa** and Bogusława Whyatt. 2022. "Directionality and lexical selection in professional translators: Evidence from verbal fluency and translation tasks", *Translation and Interpreting* 14, 2: 120-136. DOI: 10.12807/ti.114202.2022.a08.
Publication date: 29 July 2022. Publisher: *Western Sydney University*. See Appendix K.

Article 2:

Whyatt, Bogusława, Olga Witczak and **Ewa Tomczak**. 2021. "Information behaviour in bidirectional translators: Focus on online resources", *The Interpreter and Translator Trainer* 15, 2: 154-171. DOI: 10.1080/1750399x.2020.1856023.
Publication date: 14 January 2021. Publisher: *Taylor & Francis*. See Appendix L.

Article 3:

Whyatt, Bogusława, Olga Witczak, **Ewa Tomczak-Łukaszewska** and Olha Lehka-Paul. 2023. "The proof of the translation process is in the reading of the target text: An eye-tracking reception study", *Ampersand* 11, 100149. DOI: 10.1016/j.amper.2023.100149.
Publication date: 20 September 2023. Publisher: *Elsevier.* See Appendix M.

Article 4:

Whyatt, Bogusława, **Ewa Tomczak-Łukaszewska**, Olga Witczak and Olha Lehka-Paul. 2025. "Readers have to work harder to understand a badly translated text: An eye-tracking study into the effects of translation errors", *Perspectives* 33, 5: 1085-1105.
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Online first: 13 November 2024.
Publication date: 1 October 2025. Publisher: *Taylor & Francis*. See Appendix N.

Article 5:

Tomczak-Łukaszewska, Ewa. 2025. "Spotlight on the Reader: Methodological challenges in combining translation process, product, and translation reception", *Poznan Studies in Contemporary Linguistics* 61, 4: 623-652. DOI: 10.1515/psicl-2025-0074 .
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(1) **Article 1** (authors: Tomczak and Whyatt 2022) – the journal *Translation and Interpreting* provides immediate open access to its articles.

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(3) **Article 3** (authors: Whyatt, Witczak, Tomczak, and Lehka-Paul 2023) – open access publication (the fee waived by the publisher).

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(5) **Article 5** (author: Tomczak-Łukaszewska 2025) – the journal *Poznan Studies in Contemporary Linguistics (PSiCL)* provides immediate open access to its articles.

List of abbreviations

TS – Translation Studies

CTIS – Cognitive Translation and Interpreting Studies

TPR – Translation Process Research

TIS – Translation and Interpreting Studies

CTS – Corpus Translation Studies

IS – Interpreting Studies

RS – Reading Studies

AVT – Audiovisual Translation

TQ – translation quality

TQA – Translation Quality Assessment

ST – the source text in translation (the original text)

TT – the target text in translation (the end product)

SL – source language

TL – target language

L1 – native language (mother tongue)

L2 – second language (non-native language, foreign language)

LLD – language of low diffusion

L1 translation – L2→L1 translation, direct translation

L2 translation – L1→L2 translation, inverse translation

HT – human translation

MT – machine translation

TUs – translation universals

IB – information behaviour

OR – online resources

VF – verbal fluency

HQ – high quality

LQ – low quality

Introduction

As a complex cognitive task, whole-text translation is directed toward producing a target text that functions effectively for its intended audience (Chesterman 1998; Shreve 2009). The cognitive processes by which translators transform a source text (ST) into a target text (TT) – the longstanding focus of *Translation Process Research* (TPR) – have been rendered empirically accessible through keylogging and eye-tracking, methodologies that help to investigate information processing at both micro (e.g. lexical access) and macro (e.g. whole-text production) levels (e.g. Alves et al. 2009; Jakobsen 2003, 2014; Krings 2001; O'Brien 2011).

Central to this empirical investigation is the construct of *cognitive effort*, understood as the amount of mental resources invested in a task (Piolat et al. 2004). Within Translation Studies (TS), cognitive effort is fundamental to translation process-oriented research (Gile and Lei 2020; Lacruz 2017) and has now been studied mainly through keylogging and eye-tracking metrics that are taken to indicate how the translator's cognitive effort changes across the orientation, drafting, and revision phases (Jakobsen 2011), and how it is modulated by translation direction (Buchweitz and Alves 2006; Ferreira et al. 2016; Pavlović and Jensen 2009), text type (Hvelplund and Dragsted 2018; Wang and Daghigh 2024), information-seeking behaviour (Hvelplund 2017b; Kuznik and Olalla-Soler 2018), and translation strategies (Sjørup 2013; Tirkkonen-Condit 2005), to name the most studied factors. In parallel, product-oriented research has extensively examined the features and quality of the TT, utilising methods from corpus-based comparisons to error analyses (Baker 1993; Hansen-Schirra et al. 2007; Koby et al. 2014; Waddington 2001b).

While the two research traditions have undeniably yielded profound insights into the translator's cognitive effort during the translation process and into the quality of the TT, the

reception of the translated text by the target reader has often remained theoretically assumed rather than empirically linked and tested (Kruger and Kruger 2017; Walker 2021a). Despite methodological advancements, research in Translation Studies has largely treated the three domains – process, product, and reception – in isolation (Kruger and Kruger 2017). Consequently, a critical empirical gap persists in understanding whether, and how, the translator's cognitive effort and the resultant quality of the TT together shape the reading experience of the TT's end-user (i.e. the reader). Investigating whether, and how, the process of reading and reception of translated texts can be modulated by the translator's effort and translation quality remains an empirically unexplored frontier. This underscores the need for an integrated approach that closes the loop between translation production and reception.

The present thesis directly addresses this gap. It proposes a novel, integrated investigation that bridges the domains of translation process, product, and reception. It posits that a comprehensive understanding of translation requires an integrated approach, one that moves beyond studying these domains in isolation to empirically examine the links between them. It is a first-of-its-kind approach empirically connecting the translator's cognitive effort, the quality of the translated text, and the reader's experience within a unified empirical framework. By integrating data from the two complementary experimental studies conducted within two large-scale projects (*EDiT project*, *Read Me project*), this thesis addresses an overarching research question: Is the cognitive effort invested in the translation process, and the resultant quality of the translated text, reflected in the cognitive effort exerted by the reader during translation reception? Ultimately, it thus aims to test whether the act of reading a translation (i.e. the end product of the translation process) can serve as a means of evaluating its translation quality and the effectiveness of the translation process itself.

At the heart of the present PhD project, therefore, lies a vivid interest in two human agents paramount to the translation endeavour: the translator and the reader of the translated text. Mirroring the integrated framework it advocates, the primary objective of this thesis is twofold. First, it aims to investigate and compare the cognitive effort of professional bidirectional translators (Polish L1, English L2) during the translation process of two different text types in both translation directions (L2→L1, L1→L2) to shed light on how it shapes the resulting translation quality of the final text. This effort is examined through two key empirically accessible processes involved in translation: translators'

lexical selection processes and their use of online resources. They both – lexical selection effort and information searching effort – substantially contribute to the overall cognitive effort of translating a text, and are thus investigated empirically. Second, this thesis aims to explore whether, and how, the cognitive effort exerted into the translation process and the translation quality of the translated texts affect the process of reading (reading experience) and reception of those same texts (i.e. post-reading comprehension of the texts), and whether, and how, the cognitive effort invested into reading a human translated text is further modulated by the reader's own individual linguistic background. In other words, it seeks to examine whether the cognitive effort made by the translator and the quality of the translation are visible in the eye-movement behaviour of the reader.

To trace cognitive effort and investigate the link between translation process, product, and reception, this thesis rests on two experimental studies that are connected by their shared understanding of cognitive effort and by their use of a shared corpus of texts. The target texts produced in *translation process-and-product study* (i.e. the end products from the *EDiT project*) are utilised as experimental texts in a reading comprehension task in the *translation reception study* (conducted within the *Read Me project*). Translations in two directions were produced in the translation process study. Only texts translated into the readers' native language (L1) were selected for reading in the translation reception study.

To bring together the process, product, and reception, this thesis employs the well-established *keylogging* and *eye-tracking* methodologies. To this end, the eye-tracking method is used to trace the cognitive effort of both translators and readers, while keylogging (accompanied by screen recording) is employed in the translation process experiment to capture process-oriented effort data. Translator's increased cognitive effort is inferred from a translator's keystrokes and other keylogging metrics such as longer and more frequent pauses, and longer search time to resolve uncertainty, all taken as indicators of more effortful processing needed to resolve translation problems and make decisions (Alves 2015; Jakobsen 2011). Similarly, a translator's eye movements reflected in longer average fixation duration are taken to reflect more taxing processing of the investigated part of text. More effortful target text production is reflected in longer overall task duration. Analogously, during reception, the readers' cognitive effort is quantified through eye-movement metrics, which provide a powerful suite of metrics to capture the mental processes underlying reading for comprehension. More fixations on sentences and over the whole text, longer dwell time and re-reading dwell time, higher number of runs (passes) are

taken as proxies which provide a granular view of higher cognitive effort invested by readers to process and comprehend the text. The methodological integration of translation process, product, and reception data allows for tracing how the translator's choices and the resulting target text's quality affect the reading experience and reception of a translated text.

The specific research objectives of this thesis stem from the overarching aim of integrating the translation process, product, and reception, and are reflected in the five constituent research articles. First, this thesis seeks to provide a detailed account of lexical selection and information behaviour (the use of OR) as part of the translator's cognitive effort (*Articles 1 and 2*). Second, it aims to investigate the relationship between the translator's cognitive effort, the resulting translation quality and the reader's cognitive effort (*Articles 3 and 4*). Finally, it explores the role of the reader-related language background in the interplay of the translator's cognitive effort, translation quality and reader's cognitive effort (*Article 5*). The objectives of the thesis are also organically related by the use of the texts: translated in the experiment reported in *Articles 1 and 2* (conducted within the *EDiT project* testing *the effects of directionality in the translation process and product*) and employed in the reception study described in *Articles 3, 4 and 5* (conducted within an extensive, multi-layered *Read Me project* on *reading and reception of mediated (translated) texts*).

The structure of this PhD thesis mirrors the research trajectory it documents: the steps undertaken to explore the interplay between the translation process, the resulting product, and how this product is experienced and received by the readers. This interplay is investigated step-by-step, with the research trajectory reported across five research articles contained in this thesis. The undertaken research quest documented in this thesis begins at investigating translation process and product, and ends at reader experience and translation reception enriched by translator and reader profiles. More specifically, the thesis progresses systematically from the investigation of the translation process in professional bidirectional translators (in two translation directions) and the resultant translation quality, to the evaluation of the effect of the translator's effort and translation quality on readers' experience (here, reading behaviour) and reception of the translation (here, text comprehension). The participants in this empirical quest are professional bidirectional translators with Polish as L1 and English as L2, and the readers who are Polish (L1) users of English (L2, highly proficient).

The journey begins with ***Article 1*** ("Directionality and lexical selection in professional translators: Evidence from verbal fluency and translation tasks"), which forms the baseline by focusing on the process of lexical selection in professional bidirectional translation. The article establishes the cognitive profile of professional bidirectional translators by investigating their lexical selection process and language dominance across the two translation directions (L2→L1 and L1→L2 translation). Its key contribution to this thesis is threefold: first, it offers insights into how cognitive effort of translators invested in lexical selection is managed across the two different translation directions and how it is related to the translators' asymmetries in language dominance; second, it taps into the correspondence between the lexical selection effort and the quality of the final product in both translation directions; third, it reveals how reliance on online resources (OR) differs between the L2→L1 and L1→L2 translation processes, but remains crucial in aiding the translator's decisions.

Building directly on the findings from *Article 1* pointing to directionality-dependent differences in translators' *lexical selection effort* (and efficiency) and *information searching effort*, ***Article 2*** ("Information behaviour in bidirectional translators: Focus on online resources") zooms in on how professional bidirectional translators use OR. The use of OR is the key information-seeking behaviour (IB) reported to be cognitively taxing, and thus likely to increase the cognitive effort involved in translation tasks. This article investigates (1) whether (and how) the use of OR affects the translation process in terms of cognitive demands imposed on bidirectional translators, (2) how the direction of translation and the type of the source text affect the way translators use OR, and – lastly – (3) whether the time spent in OR correlates with the quality of the translated texts.

The foundation laid by *Articles 1 and 2* sets the stage for the thesis's turn towards reader experience and translation reception introduced by ***Article 3*** ("The proof of the translation process is in the reading of the target text: An eye-tracking reception study"), and is continued in the following two articles (*Articles 4 and 5*) that primarily investigate the reading process of translated texts. *Article 3* acts as a methodological bridge and introduces an innovative approach of combining the translation process and product with the reception process of that product. By integrating keylogging data collected from the professional bidirectional translators who had translated the texts (the process data recorded in the previous translation process-and-product study in the *EDiT project)* with eye-tracking data collected from readers of those translated texts (collected in the *Read Me*

project), the authors investigate whether the translator's cognitive effort exerted into translation, and translation quality, affect the reading process of the produced translation. In that way, in their exploratory study, the authors of *Article 3* construct a bridge from the translation process to the reading experience and translation reception. The authors explore a context where the target recipient of the translated text (i.e. the reader) is physically present and engaged in the process of reading and comprehending the translated text.

Article 4 ("Readers have to work harder to understand a badly translated text: An eye-tracking study into the effects of translation errors") further extends this approach with a more robust design and sample size to test the impact of translation quality on readers' cognitive effort. Its specific focus lies in investigating the impact of translation errors (possibly related to translator's insufficient diligence and low effort) on the reading experience, and on verifying the hypothesis that a low-quality translation product (with errors and other disfluencies) forces its readers to work harder in terms of cognitive effort to build a mental model of the text and to understand its content.

Finally, ***Article 5*** ("Spotlight on the reader: Methodological challenges in combining translation process, product, and translation reception") delves deeper into the interplay of translator's effort and translation quality, and it introduces another dimension to this interplay and its analytical framework: reader-specific factors. It aims to explore how readers' cognitive effort during reading is further modulated by individual reader characteristics. By doing so, it introduces another angle to translation reception by investigating whether, and how, reader-specific factors such as L2 proficiency and the number of years of L2 use (the source language for the translation) interact with the translator's cognitive effort and translation quality.

Bridging the gap between the translation process, product, and reception, however, is a journey full of methodological challenges. These stem partly from the inherently complex and latent nature of the investigated constructs: translator's cognitive effort, translation quality, and reader's cognitive effort. A further difficulty lies in measuring these constructs indirectly in a way that simultaneously allows for reasonable ecological validity (i.e. as high as feasible within the constraints of laboratory-based translation and reading studies) and controls for confounding factors. Several key methodological challenges in integrating translation process, product, and reception, and combining experimental data across the three domains are detailed in *Articles 3 and 5*.

The first part of this PhD thesis presents the theoretical background for the experimental studies, presenting the key concepts, definitions, and models that inform the addressed research objectives. *Part 1* frames the research process within the three domains: translation process, product, and reception – thereby outlining a research trajectory mirrored in the five thematically related *Research Articles* comprising this PhD thesis: from tracking and analysing the translator's effort and translation quality (*Articles 1 and 2*) to tracking and evaluating the reader's effort involved in the processing of the translated text (*Articles 3, 4 and 5*). This part also provides a focused overview of cognitive effort, its (indirect) indicators and selected factors affecting it. The models, definitions, concepts, indicators, and factors are framed and examined for its specific relevance to the aims of this PhD thesis. **The second part** of this thesis details its core methodologies and provides an overview of the five constituent *research articles*. For each article, the summary presents the theoretical background, key research objectives, key findings (and their interpretation), limitations of the study, and main conclusions. **The third part** evaluates the key findings from both studies against the overarching research objectives. It also overviews methodological considerations, limitations, and proposes directions for future research.

Part 1: Translation process, product, and reception: Key concepts

1.1. Translation process: Focus on translator's cognitive effort

Behind a translated word lies a moment of decision, and behind a translator's decision, lies an amount of *cognitive effort*. This section introduces and contextualises the cognitive effort inherent in the translation process. It defines this effort and outlines the key indicators used to quantify it and selected factors found to modulate it, with direct relevance to the study reported in *Articles 1 and 2* contained in this thesis. To establish a framework for this analysis, the following subsection opens with a review of the selected translation process models and definitions of translator's cognitive effort that have informed the choice of its proxies (i.e. indirect indicators) for this project.

1.1.1. Translation process and translator's cognitive effort

The translation process has been analysed through numerous theoretical lenses, including the seminal Seleskovitch's (1968) Interpretive Theory of Translation (ITT), Bell's (1991) information processing model, Gutt's ([1991] 2000) cognitive-pragmatic model of translation built upon Relevance Theory of Sperber and Wilson (1995), Alves'(1995) model, Kiraly's (1995) psycholinguistic model of translation processes, Gile's (1995, 2009) Effort Model, Tirkkonen-Condit's (2005) monitor model of translation, Levy's ([1967]2000) translation as a decision-making type of behaviour model or translation as a form of problem-solving, to name but a selection (for a comprehensive overview of the translation process models see Alves and Hurtado Albir 2010). Even if not explicitly

acknowledged, central to many such models is the construct of *cognitive effort*, a concept of broad relevance across disciplines from cognitive and educational psychology to human-computer interaction, often discussed using related terms such as *cognitive load* (Sweller et al. 1998), *mental effort*, *processing effort*, or *cognitive costs*. These terms (sometimes used interchangeably) share the core assumption that cognitive attention and processing resources are limited in their capacity.

Within Translation and Interpreting Studies (T&I), cognitive effort has been theorised through several models. A prominent example is Gile's Effort Model (1995), originally conceived for simultaneous interpreting. It posits that performance depends on managing competing efforts (Listening/Analysis Effort, Memory Effort, and Production Effort) under severe time constraints. While frequently applied to explain the cognitive demands in simultaneous interpreting (e.g. Gumul 2018, 2019), the model has also proven useful in TPR. Reconceptualised for translation, its core components to explain translation are the Reading and Analysis Effort (for source-text comprehension) and the Writing Effort (for target-text production). Although Gile (1995, 2009, 1999) highlights that translation is considerably less time-constrained than interpreting, the model's clear conceptual distinction offers a valuable theoretical scaffold for experimental TS studies that operationalise and investigate translators' and translation trainees' cognitive effort using methodologies such as keylogging and eye-tracking (Hvelplund 2016; Pietryga 2024).

A primary application of this framework is examining the assumed relationship between translator's management of cognitive effort and the quality of the end product. As Gile and Lei (2020: 265) note, this relationship is complex: when cognitive demands exceed available cognitive resources, translation quality deteriorates. This premise allows for the derivation of testable hypotheses. For instance, a target text (TT) produced with insufficient cognitive effort is thus likely to contain errors. On the other hand, greater invested cognitive effort (e.g. through thorough information searching or self-revision) can be assumed to improve translation quality. Consistent with the efforts postulated by Gile's model, TPR investigates how translators coordinate reading and writing efforts across a translation task (e.g. Alves and Vale 2011; Balling et al. 2014; Dragsted 2010; Dragsted and Hansen 2008; Hvelplund 2011, 2017a), and how these efforts are modulated by factors such as *translation direction* (e.g. Buchweitz and Alves 2006; Ferreira et al. 2016; Pavlović and Jensen 2009; Whyatt 2018a, 2019) and *ST complexity* (e.g. Balling et al. 2014;

Hvelplund and Dragsted 2018; Jensen 2009; Liu et al. 2025; Sharmin, Špakov, Räihä, and Jakobsen 2008; Sjørup 2013).

Other frameworks adopted within TPR include Sweller et al.'s (1998) Cognitive Load Theory (borrowed from educational psychology) and Seeber's (2011) Cognitive Load Model (developed for interpreting). Noteworthy, within T&I, the terms cognitive load and cognitive effort have often been used interchangeably without a clear distinction or definitions. A recent conceptual advance (see Ehrensberger-Dow et al. 2020: 221-222), however, disentangles them: *cognitive load* is defined as the objective demands imposed by a task's intrinsic complexity (e.g. inherent in the task and stimuli), while *cognitive effort* is an individual's (subjective and often strategic) response to such demands. Grounded in Cognitive Load Theory (Sweller et al. 1998), this distinction posits that while *cognitive load* is an external, potentially uniform and constant demand across individuals, *cognitive effort* is internal, non-uniform and variable. To illustrate, a given task may present an identical cognitive load across all translators, but their cognitive effort exerted will be inherently idiosyncratic, and – importantly – subject to individual strategic management and skills. This distinction highlights that translators are not merely passive to cognitive demands, but can actively and strategically manage their varying cognitive effort to optimise their performance, for instance, through additional deliberate information searching behaviour or targeted preparation.

This PhD thesis adopts a broad-scope definition of *cognitive effort* where it is understood as the amount of mental resources invested to produce a translation (Hvelplund 2011; Vieira 2014), a definition resonating with Kruger's (2016: 27) notion of "the amount of cognitive resources required to complete a processing task" and by Piolat et al.'s (2004: 22) "the amount of resources required by a given task." Specifically, the translation-process-and-product study reported in *Articles 1 and 2* follows Hunziker Heeb's (2020: 48) definition, which conceptualises the translator's cognitive effort as "[t]he total effort that the translator expends during the translation task," with the target text as its product (as explained in *Article 5*). Under this conceptualisation, cognitive effort is framed as a single, overarching entity which subsumes different measurable manifestations including observable behavioural correlates such as keystrokes, time-on-task, pauses, and eye movements (Jakobsen 2014) which serve as valid and complementary proxies for the same, unified underlying construct of cognitive effort. This integrative definition has already

proven empirically productive in CTIS in the contexts where the effects of directionality were investigated (e.g. Pietryga 2024).

To investigate the construct of cognitive effort empirically, TPR has consistently employed keylogging and eye-tracking methodologies. Over recent decades, these methods have been central to elucidating how translators allocate cognitive resources across different tasks, translation phases, and translation directions. Given that the validity of the empirical work relies on the clear and precise operationalisation of cognitive effort through its measurable proxies, the following subsection addresses this crucial methodological step.

1.1.2. Indicators of translator's cognitive effort

Cognitive effort lends itself to measurement that is indirect (Vieira 2016: 43). In Translation Studies (TS), its indirect indicators are captured primarily with retrospective interviews, keystroke logging, screen-recording techniques, and eye-tracking, all used to provide insight into a translator's mental processes allocated during translation. Following Gile and Lei (2020: 269-273), subjective feelings and perceptions of effort are captured via *retrospective rating scales* and other verbal protocols and online description of thoughts (e.g. *Think Aloud Protocols*, i.e. TAPs, cf. Muñoz Martín 2015). More objective behavioural indicators of cognitive effort in translation are primarily derived from keylogging (often coupled with screen-recordings) and eye-tracking. Being a central methodology in *Articles 1 and 2* of this thesis, keylogging provides quantifiable data such as *pauses* (Hunziker Heeb 2020; Immonen 2006; Immonen and Mäkisalo 2010; Kruger 2016; Kumpulainen 2015; Lacruz and Shreve 2014; Muñoz and Apfelthaler 2022; O'Brien 2006), where longer pauses are taken to reflect increased cognitive effort, *mouse and keypress events* (Ferreira et al. 2021), and the *eye-key span* (Dragsted 2010; Dragsted and Hansen 2008; Pietryga 2025; Schaeffer and Carl 2017; Timarová et al. 2011), where a longer time lag between the first fixation on a source-text word and the onset of typing its translation are assumed to indicate heightened cognitive effort, as evident when translating more difficult expressions. Other established metrics readily used to gauge cognitive effort in TPR include *reaction times per word* in self-paced reading paradigms (Macizo and Bajo 2004, 2006; Ruiz et al. 2008) and *reading times per sentence clause* (Shreve et al. 1993), where longer times indicate higher effort.

To complement the keylogging data or/and triangulate measurement of translator's cognitive effort, TPR scholars readily reach for eye-tracking. *Articles 1 and 2* of this PhD thesis follow this methodological practice by treating translators' *eye-movement behaviour* as a complementary source of indirect evidence of their cognitive effort invested in translation. The underlying principle for using eye-tracking metrics to quantify cognitive effort in the translation process builds on the eye-mind hypothesis (Just and Carpenter 1980), which posits a link between visual attention (the location of eye fixation point) and what the mind is processing (cognitive processes). Consequently, tracking where and how long translators look – at the ST, TT, or external resources – provides insight into attention allocation and invested cognitive effort (see Płużyczka 2018, 2019). On the whole, higher values of eye-tracking measures are taken as proxies for the increased cognitive effort needed to process what the eyes fixate on.

Eye-tracking metrics are commonly categorised according to cognitive processing stage: those assumed to reflect **early-stage processing** (word recognition and lexical access) and **late-stage processing** (meaning integration and comprehension monitoring). Following the insights from the reading research, early-stage processing effort is operationalised through measures such as *first fixation duration*, *first-pass gaze duration* or *first-pass reading* (first-run dwell time) (e.g. Schaeffer et al. 2016). Late-stage processing effort is indexed by metrics such as *re-reading dwell time* (total fixation duration excluding first-pass reading) and *regression count* (number of visits to a previously viewed area of interest – AOI, e.g. a word, a sentence). Furthermore, aggregate measures are used to gauge overall processing effort. These include: *dwell time* (total fixation duration, total gaze time) – the sum duration of all fixations within an AOI (e.g. Balling et al. 2014; Jakobsen and Jensen 2008), *fixation count* – the total number of times the eyes fixated on a given AOI (e.g. Ferreira et al. 2016; Jakobsen and Jensen 2008), and *average fixation duration* calculated as dwell time divided by fixation count (Ferreira et al. 2016; Pavlović and Jensen 2009; Schaeffer et al. 2017; Whyatt et a. 2018a).

Eye-tracking metrics have been extensively applied in TPR. Specifically, *dwell time*, *fixation count*, *average fixation duration*, and *re-reading dwell time* have been crucial for investigating how cognitive effort of professional translators and/or translation trainees is affected by such factors as translation direction (e.g. Ferreira et al. 2016, 2021; Pavlović and Jensen 2009; Pietryga 2024; Whyatt 2018a, 2019) or reliance on online resources during translation tasks (e.g. Hvelplund 2017b, 2019). The key empirical findings on the

influence of both factors on the translator's cognitive effort as indexed by eye-tracking measures are synthesised in *Articles 1 and 2* and in the following section (*1.1.3*) of this thesis.

1.1.3. Selected factors affecting translator's cognitive effort

Article 1 and *Article 2* of this thesis investigate cognitive effort in professional bidirectional translators, focusing on how it is modulated by *directionality*, *source-text type*, and *the use of online resources.* Accordingly, this subsection elaborates exclusively on the selected factors central to the research framework of this thesis.

Directionality – defined as "whether translators work into their first or 'native' language (L1) or out of their L1 and produce translations in their 'first foreign' language (L2)" (Whyatt 2019: 79) – has long been central. Historically, the L1→L2 translation direction (i.e. L2 translation) was often neglected, mostly due to the influential "Golden Rule of Translation" (Newmark 1981, 1988), which promoted translation into the native language and stigmatised L2 translation as yielding unnatural, non-nativelike outputs. Contemporary TPR, now systematically explores differing demands between the two translation directions, often corroborating the "L2 cognitive disadvantage," i.e. greater processing demands in L2 than L1 (Muñoz et al. 2019). Evidence for *directionality effects* comes from retrospective protocols (Buchweitz and Alves 2006; Ferreira et al. 2016, 2021), behavioural (Pietryga 2024; Whyatt 2018a, 2019), physiological (Pavlović and Jensen 2009), and neuroimaging studies (Christoffels et al. 2013; for a review see Muñoz et al. 2019).

Studies using the same core methodologies as used in the present PhD project – *keylogging* or *eye-tracking* (and/or triangulating both) – to investigate cognitive processing in translation, increasingly show greater cognitive demands for L1→L2 translation. Buchweitz and Alves (2006), with Portuguese (L1) – English (L2) translation trainee, found that L2 translation hindered the *lexical selection process* and required more effort evidenced by longer *total task time* and *drafting time*. Ferreira et al. (2016), with professional Spanish-English translators, reported significantly higher *total task time* and *average fixation duration* for L2 translation. Pavlović and Jensen (2009), with professional Danish-English translators and trainees, corroborated the "L2 cognitive disadvantage"

through longer *total task time* and *larger pupil dilation*; yet, not with translators' other eye-tracking measures (*gaze time*, *average fixation duration*). Results, however, are mixed. Ferreira et al. (2021) studying professional Spanish-English and English-Spanish translators, and Hunziker Heeb (2020) with bidirectional and unidirectional German-English translators, found only few significant differences in most key eye-tracking and keylogging measures. In the Polish-English context, with professional bidirectional translators (L1: Polish, L2: English), Whyatt (2019) found no directionality effects on *total task time*, while Whyatt (2018a) observed *longer average fixation duration* only in the L2→L1 orientation phase. Conversely, Pietryga (2024), with Polish-English translation trainees, found significantly higher cognitive effort across multiple metrics for L1→L2 translation, including *total gaze time*, *average fixation duration*, *total task time*, *and the number of pauses longer than 5 seconds*. This inconclusive evidence across language pairs and expertise levels supports further examination of directionality as an independent variable in this thesis (see *Articles 1 and 2*).

Other factors affecting translator's cognitive effort stem from the source text (ST) itself. Of immediate relevance to this thesis are the ***type of source text*** (ST type) and its ***complexity***. Texts can be classified functionally, e.g. into informative, expressive, operative, and audio-medial (Reiss 1976), and the features of ST types impact cognitive demand. Sharmin et al. (2008) found that complex texts (high structural complexity, low lexical frequency) attracted significantly more *fixations* and *ST-TT shifts* than simple texts, but not longer *fixation durations*. Furthermore, word translation entropy (Schaeffer et al. 2016) – where a source word has multiple target translation equivalents – increases processing effort. Concrete and abstract words with one-to-many equivalence take longer to translate (Kroll and Tokowicz 2001) and induce longer *first fixation durations* during reading for translation (Schaeffer and Carl 2017; Schaeffer et al. 2016). Translating metaphorical content also demands more cognitive effort, reflected in longer *fixation durations* (Sjørup 2013) and more *re-reading* (Liu et al. 2025). Thus, lexically and structurally complex ST features impose greater processing demands on translators (see also Alves and Gonçalves 2013 for the effects of types of segmentations; O'Brien 2007 – for different input types from various sources; and for other effects of text type – Hvelplund and Dragsted 2018; Wang and Daghigh 2024).

The third set of factors relevant to the present thesis is translator-specific: their information behaviour and expertise. ***Information seeking*** during translation is assumed to

be guided by *the uncertainty principle* (seeking information to resolve knowledge gaps; Dervin 1998) and *the principle of least effort* (optimising search cost-benefit; Zipf 1949). Cognitive uncertainty increases when translators encounter problems in the ST, prompting consultations in online resources (OR) to bridge the knowledge gaps. *Directionality* affects this information behaviour, though findings are inconsistent. Some report greater use of OR in L2 translation (e.g. Pavlović 2007), others in L1 translation (e.g. Ferreira et al. 2016). *Article 2* in this thesis addresses this divide with a study conducted to determine whether, and how, professional bidirectional translators' use of OR is influenced by translation direction (L1 vs. L2), translation phase (Jakobsen 2002), and source-text type.

Since the present thesis aims to explore cognitive effort of professional bidirectional translators (expert translators), a final key factor relevant to this thesis is ***translation expertise***, understood as "a unique combination of experience, knowledge and skills" (Whyatt 2018b: 65), developed through sustained deliberate practice (Massey 2017; Shreve et al. 2018). In conceptual terms, expertise has enjoyed "almost as many definitions (…) as the number of researchers studying the subject" (Muñoz Martín 2014). In methodological terms, translation expertise is often linked to measurable components of professional experience (Tiselius and Hild 2017: 430) such as years of practice, volume of translation activity, or a number of pages translated per month. It is noteworthy that even though experience and professional status do not always equate to expertise (Dragsted 2010; Siren and Hakkarainen 2002) and expertise cannot be reduced to the number of years in the profession (Diamond and Shreve 2017), these quantifiable proxies remain relatively frequent operationalisations of translation expertise in TS research. There is compelling evidence that expertise levels modulate cognitive resource allocation during translation (see Massey 2017; Muñoz Martín 2009, 2014; Shreve 2006; Shreve et al. 2018; Tiselius and Hild 2017). Eye-tracking and keylogging studies demonstrate that, compared to less experienced translators, experts exhibit strategic and efficient processing patterns (i.e. fewer but longer fixations, shorter pauses), and more efficient coordination of reading and writing evidenced by shorter fixations and fewer regressions (Hvelplund 2011, 2016). Findings on *directionality* further underscore this efficiency. Unlike novices, who show significantly increased cognitive effort during L2 translation (evidenced by more fixations and regressions), expert translators exhibit lower cognitive effort in both directions, evidenced by shorter fixations and fewer regressions (see Pavlović and Jensen 2009). In

summary, greater expertise and experience in translation are associated with optimised cognitive effort management, reflected in more strategic eye-movement behaviour.

1.2. Translation product: Focus on translation quality

Translation quality is another multifaceted construct in TS that seems to resist a single frame and assessment. As a prolific research avenue (Han 2020: 257), *Translation Quality Assessment* (TQA) is a critical concern for translator education, the translation industry, and TPR itself, generating diverse methods and metrics. Recent decades show a clear evolution from often subjective (thus, at times, inconsistently applied) TQA practices and methods toward more standardised, systematic approaches, driven by the goal of bridging the gap between academic TQA research and its application in professional settings. This progression is documented in comprehensive overviews by Han (2020) and House (2014, 2015), and in the collection edited by Moorkens et al. (2018).

In this PhD thesis, *translation quality* assumes a dual role. First, it is the product of an investigated translation process (*Articles 1 and 2*). Second, in the subsequent reading experiment, its effects on the whole-text reading process and comprehension are examined (*Articles 3,4 and 5*). The following three subsections, therefore, situate *translation quality* specifically within the context of the experimental translation process-and-product and translation reception studies of this thesis.

1.2.1. Translation quality: Definitions and assessment methods

As an elusive, enigmatic, and essentially contested construct, *translation quality* (TQ) appears to resists a single definition due to the relativity of the construct of 'quality' itself (i.e. its cultural-dependent nature) and diverse perspectives on what constitutes 'translation' (Colina 2011: 43). This definitional challenge is fundamental, as different conceptualisations of TQ shape expectations for both translation product and process (Fields et al. 2014). As Koby et al. (2014: 413) note, its assessment seems circular: "[t]o determine whether someone has attained translation quality, one must be able to measure it. To measure translation quality, one must be able to define it. And to define translation quality, one must be able to define both translation and quality."

These theoretical dilemmas stand in opposition to the professional imperative to assess the quality of translated texts which is formalised in standards such as ISO 17100:2015 used in professional translation contexts. For most practitioners, a high-quality translation is typically a target text (TT) that is functionally "fit-for-purpose" (O'Brien 2012: 56), successfully balancing adequacy/accuracy (faithful content transfer) and fluency/acceptability (linguistic well-formedness in the TL) within its specific sociocultural context (Daems et al. 2013; Koby et al. 2014; Toury 1995; Whyatt 2019).

Two competing perspectives, broad and narrow, work toward defining *translation quality* (Fields et al. 2014; Koby et al. 2014; Melby et al. 2014). The narrow view posits that high quality entails the complete transfer of the ST's meaning, connotation, and style into a fluent, culturally-appropriate TT that reads as if originally written in the TL. Conversely, the broad view defines quality functionally, as fulfilling explicitly negotiated specifications (e.g. for localisation, transcreation, gisting), where the TT meets the accuracy and fluency required for its specific purpose and audience (Melby et al. 2014). This distinction fuels practical and ethical debates, with proponents of the narrow view prioritising absolute quality standards (even if conflicting with a client's directives) and the broad view emphasising adherence to the negotiated brief, even if its specifications define a lower or minimal quality threshold (Koby et al. 2014). This distinction underscores translation as a norm-governed activity (Toury 1995), where quality evaluation hinges on whether a text aligns with ST norms (prioritising adequacy) or target-culture norms (prioritising acceptability), and expectations of clients, translators, or TT's end-users (Koby et al. 2014). It is the broad view that fuels functionalist approaches to translation quality evaluation, most prominently skopos theory, alongside other equivalence-based and reader-response approaches (for an overview see Colina 2011; Nord 1997; Reiss and Vermeer 1984).

The methodological evolution of TQA reflects efforts to objectify an inherently subjective evaluation, often tacitly operating under a hypothetical "golden standard" (Whyatt 2019: 84; for an overview see Martínez 2014). Han (2020: 259-265) traces seven key methods in this evolution. Early *intuitive assessment*, based on a rater's previous experience, provided a global impression of translation quality, with no explicit criteria or metrics, and was often criticised for high subjectivity and thus low reliability. *Error analysis* introduced more objective, systematic assessment through predefined error typologies and error severity weighting (e.g. classifying errors as minor, major, critical) as

seen in frameworks and standards such as *the Localisation Industry Standards Association (LISA) Quality Assessment model*, *the Multidimensional Quality Metrics (MQM)* or *the Society of Automotive Engineers (SAE J2450) Translation Quality Metric* (Lommel et al. 2014; Waddington 2001a). However, as detailed by Han (2020), error analysis has also attracted some criticism: it is labour-intense (and thus impractical for large-scale use), retains subjectivity in error classification (undermining its claim to objectivity; the illusory nature of its "objectivity"), and has a reductionist, micro-textual focus.

The subsequent methods emerged as methodological responses to these flaws. *Corpus-based evaluation* offered an empirical, data-driven alternative by using reference corpora as benchmarks for lexical and syntactic choices, though it demands technical expertise and resources required to build and maintain corpora (Baker 1993; Laviosa 2002). Addressing the narrow, reductionist focus of error analysis and its questionable efficiency, *rubric scoring* (or *scale-based scoring*) uses predefined rating scales with well-crafted descriptors to assess broader textual (and functional) adequacy. While capturing broader textual qualities, it inherently involves rater subjectivity. *Mixed-methods scoring* integrates scores from both error analysis and rubric scoring for a more comprehensive evaluation of translation quality. Inspired by psychometrics, *item-based assessment* (e.g. *Calibration of Dichotomous Items – CDI*, *Preselected Item Evaluation – PIE*) seeks high statistical reliability but sacrifices construct validity – it is criticised for evaluating isolated segments rather than a holistic text and for underrepresenting the multifaceted nature of translation quality. A relatively recent approach within TQA, *comparative judgement* (or *pairwise comparison*), leverages the innate human capacity to make relative (e.g. comparing one translation of the ST against another) rather than absolute judgements (e.g. judging the quality of the TT in isolation), by having experts' compare the quality (higher vs. lower) of translation pairs, and then statistically modelling the results from their successive pairwise comparisons. It aims to complement, rather than supplant, earlier methods. For a developmental, comprehensive review of how the aforementioned TQA methods have evolved see Han (2020).

To overcome single-method limitations, contemporary TPR increasingly advocates triangulating multiple, complementary indicators of TQ, mirroring the commitment to triangulation and data-source integration already signalled in CTIS (e.g. Rojo López and Ramos Caro 2022).

1.2.2. Indicators of translation quality

There is no universal 'best' indicator of translation quality. The choice of metric is dictated by the TQA method used, as each operationalises the construct of "quality" differently, yielding distinct quantitative or qualitative indices. These range from simple counts and ordinal scale values to statistically complex values (see Han 2020). The TQA methods relevant to this PhD thesis prioritise direct analysis of the TT through expert human evaluation, error identification and weighted classification.

Of immediate relevance to this thesis is *error analysis*, a primary approach in TQA, which provides deficit-focused metrics to evaluate errors at micro-textual level. The core indicators of TQ typically include *error frequency* (*raw count*), *error severity* (weighted classifications as *minor, major, or critical,* with assigned penalty points), and a *final score* (derived by deducting penalty points from a maximum).

In contrast, *rubric scoring (scale-based scoring)* evaluates macro-textual and functional adequacy and employs more holistic, criterion-based scores. TQ is assessed against predefined descriptive scales (e.g. a 5-point scale) across distinct quality criteria such as *accuracy, fluency*, and *functional adequacy*. This yields both separate criterion ratings and a composite score (often a sum or average of the criterion scores).

To balance a granular and holistic (functional) view, *mixed-methods scoring* integrates both approaches, yielding a composite score (i.e. an indicator), which is a combination of scores calculated based on granular error data from error analysis and the rubric-scoring data (typically through a weighted formula, to provide a balanced single metric) – for an review see Han (2020).

A persistent challenge across TQA methods that centre on direct analysis of the TT through expert human evaluation is balancing objectivity with validity and reliability, and practicality. For instance, a highly reliable metric (e.g. error counts) may not validly represent overall TQ if it underrepresents the construct.

Moving beyond the product, it can be hypothesised that TQ can also be inferred through indirect indicators that reflect the cognitive effort of the reception process. A pivotal yet underexplored dimension here is *translation reception*, where the reader's experience could serve as a proxy for TQ. The underlying principle is that texts with translation errors, incoherence, or unnatural wording typically require a higher cognitive effort to process and comprehend (Kruger 2013). Eye-tracking methodology provides

sensitive, real-time (online) measures of this processing effort. Increased values of early-stage processing measures (such as first fixation duration) are taken to index lexical access difficulty, while higher values of late-stage processing (e.g. re-reading dwell time) are assumed to reflect problems with higher-order meaning integration and comprehension monitoring (Clifton et al. 2016; Inhoff et al. 2019; Rayner 1998). Empirical studies demonstrate that readers exert significantly more cognitive effort processing erroneous or foreignised translations, directly linking textual features to a quantifiable reading experience (Kruger 2013; Stafura and Perfetti 2017). Integrating reception data into the frameworks of TQA thus promises a more holistic, evidence-based approach to TQA, moving beyond the product alone to encompass its cognitive effects on the target reader.

The integrative approach to TQA directly informs the approach of the present thesis, which to assess TQ employs a fine-grained, expert error analysis (informed by models such as MQM). This is supplemented by proofreading time records and, innovatively, by investigating translation reception through eye-tracking. By targeting both micro-textual accuracy and macro-textual functional adequacy, this thesis aims to examine whether reader experience eye-movement data (i.e. translation reception metrics) can provide valid, evidence-based, complementary measures of TQ, to supplement traditional TQA methods. This goal aligns with the overarching research objectives of this PhD project and its research trajectory across translation process, product, and reception reported in this thesis.

1.2.3. Selected factors affecting translation quality

As already established, the quality of the translated text is not an absolute attribute. It is dependent upon a text's specific purpose and its target audience (Koby et al. 2014): translation considered high quality in one context (e.g. a technical manual for in-house use) might be evaluated as deficient, low-quality in another (e.g. a high-end brochure marketing a luxury product).

A factor that is taken to be critical for translation quality is individual translation expertise (see also *section 1.2.3* in this thesis). This "unique combination of experience, knowledge and skills" (Whyatt 2018b: 65), especially high language proficiency and specialised knowledge reduce cognitive uncertainty and thus allow for more efficient problem-solving. One of the hallmarks of translation expertise is effective management of

cognitive effort in a translation task. Experts in contrast to novices have a deeper understanding of the task, the complexity of the translation process and the need for self-monitoring to filter out errors. For instance, Dragsted and Carl (2013) found that they invest more time and effort to end revision to ensure the final product meets the required standard.

Another essential factor for ensuring high-translation quality is the requirement to involve revisers and proofreaders as stipulated by the translation industry standards such as ISO 17100:2015. With a process-oriented framework and standardised quality management protocols, it details the requirements for a high-quality translation service (including high-quality translation and a satisfied customer). Amongst these are the requirements for professional expertise and for revision by a second qualified linguist.

From a very practical point of view, what then seems worthwhile is an empirical verification of whether, and how, the translator's cognitive effort invested to produce a high-quality TT translates into the reader's benefit (i.e. their lower cognitive effort) while reading that TT.

1.3. Translation reception: Focus on reader's cognitive effort

This part of present PhD thesis examines ***translation reception*** by focusing on the ***cognitive effort*** required from the reader to process a translated text. It first outlines the theoretical framework, connecting translation reception to established models of the reading process. Next, it defines reader's cognitive effort and then discusses the eye-tracking metrics used as its proxies (i.e. indirect indicators). Finally, it briefly examines a selection of key factors, ranging from textual features to reader-specific characteristics – frequently reported to affect the amount of cognitive effort needed to read and comprehend a text. Building on theoretical foundation from *sections 1.1.* and *1.2.*, this section aims to ground an empirical evaluation of the reading experience and translation reception presented in *Articles 3*, *4 and 5.*

1.3.1. Translation reception, reading experience, and reader's cognitive effort

To empirically investigate how translated texts are processed and received, this PhD thesis adopts a cognitively-oriented view of *translation reception* as advanced by Walker (2021a, 2021b). At its core, this construct integrates Gambier's (2018: 56) broad definition of *reception* as how a translated product is "processed, consumed, absorbed, accepted, appreciated, interpreted, understood and remembered by the viewers" (developed particularly for audiovisual translation, AVT) with Krings' (2005) methodological distinction between *online* and *offline* research methods (developed mostly for TPR). Building on both, Walker (2021a) refines the definition for the reception of translated texts by proposing a key conceptual distinction: ***reception*** refers to the post-hoc act of responding to a translated text after reading (e.g. interpretation, evaluative response) captured via offline methods such as questionnaires, retrospection, or interviews, while ***reader experience*** denotes the moment-to-moment, real-time process of engaging with a text while reading, gauged indirectly through online tools such as eye-tracking.

While this thesis recognises the distinction proposed by Walker (2021a), in the constituent *Articles 3, 4 and 5* it also employs "translation reception" as a broader umbrella term for the research area that seeks to explore and understand how translations are processed and consumed. It is also used to denote the act of 'consuming a translation' (including reading and reader's reactions to it) as opposed to 'producing a translation.' In this thesis, *reader experience* is operationalised through the indirect indicators of the core construct '*reader's cognitive effort'* (also referred to as *reception effort*) understood as "the reader's behavioural response to the task demands" (see *Article 4:* Whyatt et al. 2025: 1086). In the context of *translation reception research*, it denotes the amount of mental resources allocated during the processing inherent in reading a translated text (cf. Piolat et al. 2004: 22). Reader's cognitive effort is the primary dependent variable across *Articles 3, 4, and 5*. It serves as an indicator of processing fluency and, by extension, an indirect evaluation of translation quality, where increased effort can signal disfluency and can indicate low translation quality (see Doherty and O'Brien 2014; Doherty et al. 2010). In this way, the reading experience in this thesis is viewed as a dynamic, active reading behaviour into which cognitive resources are invested, forming a vital component of the multifaceted process of translation reception.

Investigating reader's cognitive effort requires a framework for understanding the *reading process* itself. As a complex cognitive activity, reading has been modelled through various theoretical lenses (for a comprehensive review, see Acartürk 2025; Alvermann et al. 2013; Rayner and Reichle 2010), primarily to account for the differences between fluent (skilled, efficient) and disfluent (poor, deficient) reading. **Bottom-up models** emphasise linear, text-driven decoding from smaller units, assigning a minor role to the reader. These include seminal *Information-Processing* model (Gough 1972), *Dual-Route Cascaded (DRC) model* (Coltheart et al. 2001), and *Theory of Automatic Information Processing* (LaBerge and Samuels 1974), to name the most prominent (for an overview see Alvermann et al. 2013). **Top-down models** foreground the reader's active role, using expectations and context to predict meaning, framing disfluency in reading as inefficient hypothesis-forming (*Psycholinguistic Guessing Game* model by Goodman 1967) or as a process of "reduction of uncertainty" (*Smith's model* 1971). For *translation reception research*, **interactive models** are particularly relevant as they account for the simultaneous interaction of bottom-up (text-driven) and top-down (reader-driven) processes (e.g. Kintsch, 1998; Stanovich, 1980). For instance, a very early, prominent model of reading – Rumelhart's *Interactive Model of Reading* (1977) – posits parallel interaction of multiple knowledge sources. Stanovich's (1980) *Interactive-Compensatory Model* asserts that deficits in one processing component (e.g. word decoding) increase reliance on another (e.g. contextual knowledge) to compensate. This is crucial for understanding how readers cope with potential disfluencies in translated texts. Adams' *Cognitive Model of Reading* (1990) highlights phonemic awareness and automatic word recognition (i.e. automated letter-sound correspondence) as freeing cognitive resources for comprehension, whereas poor reading stems from effortful decoding that overwhelms working memory. Kintsch's (1988, 1998) *Construction-Integration (CI) model*, on the other hand, describes how readers build a coherent "situation model" of a text. It attempts to explain "how top-down processes guide comprehension and how bottom-up processes constrain it" (Kintsch 2005: 125). In other words, how reading comprehension processes can be disrupted by textual inconsistencies or errors (Stafura and Perfetti 2017).

Contemporary reading research aligns with interactive frameworks that treat eye movements as a window into cognitive processing (Just and Carpenter 1980; Rayner 1998) and into how it becomes facilitated or hindered. The core assumption is that fluctuations in cognitive effort are reflected in observable, measurable changes in eye-movement

behaviour (Clifton et al. 2016; Rayner 1998). While interactive models of reading provide a valuable framework for *what* is likely processed during comprehension, the effective operationalisation of cognitive effort through eye-tracking requires a more granular understanding of *how* the reading process guides eye movements. This function is fulfilled by computational *models of eye-movement control in reading* (for comprehensive reviews see Rayner 2009; Rayner and Reichle 2010: 793-794). Prominent models such as *E-Z Reader model* (Rayner 1998; Reichle et al. 2003) and *SWIFT* (Engbert et al. 2005) "attempt to explain the actual performance of human readers" by detailing the "determinants of when the eyes move from one word to the next, and the nature of attention allocation" (Rayner and Reichle 2010: 793). They achieve this by simulating the moment-by-moment decisions governing *when* (saccade timing) and *where* (saccade targeting) to move the eyes, thereby formally integrating the dynamic interaction between visual input, lexical processing, attention, and oculomotor control (see Rayner 2009).

By acknowledging the simultaneous contributions of text and reader, interactive models of reading such as Kintsch's model (1988, 1998) and models of eye-movement control in reading such as Rayner's (1998) *E-Z Reader model* provide a supportive framework for the eye-tracking translation reception experiments reported in this thesis. By highlighting that efficient reading depends on the seamless interaction between the perception of textual features and the reader's knowledge and expectations, they support the view that reading a translation is an active, cognitive process where effort fluctuates based on textual features and available cognitive resources. Disfluent reading, marked by increased cognitive effort, occurs when this interaction is disrupted. As Walker (2021a) contends, increased cognitive effort during reading might be a sign of disfluency and potentially of lower text quality. Thus, quantifying this moment-to-moment cognitive effort becomes central to the empirical investigation of how translated texts are processed and received, and more specifically, to verifying whether, and how, translator's choices and translation errors may disrupt the reading experience. The next section, therefore, details the specific eye-movement indicators used to operationalise the reader's cognitive effort for empirical investigation.

1.3.2. Indicators of reader's cognitive effort

In reception studies, reader's cognitive effort is a latent construct that can be inferred through observable behavioural and physiological proxies. The *experimental translation reception studies* in this thesis (*Articles 3, 4 and 5*), operationalise this effort primarily through eye-tracking metrics, based on the premise that visual attention aligns with cognitive processing (Just and Carpenter 1980). Eye-tracking methodology offers a rich suite of well-established metrics that serve as validated (though indirect) indicators of information processing during reading. As noted in *section 1.1.2*, these measures are categorised as early, late, and global measures, reflecting different stages and depths of information processing in reading (Clifton et al. 2016; Inhoff et al. 2019; Rayner 1998, 2009), and as such are examined in *Articles 3, 4 and 5* of this thesis.

In reading research, ***global processing measures*** are assumed to reflect the total (overall) cognitive effort exerted over an area of interest (AOI), such as a word, sentence, or text. *Dwell time* (or total fixation duration) is the sum of all fixation durations within an AOI and often serves as a primary, holistic indicator of the processing effort (Clifton et al. 2016; Walker 2019). To enable comparison across text segments of different lengths, this is often calculated as *character-adjusted dwell time* (total dwell time divided by the number of characters), a method used effectively in *translation reception research* (Kruger 2013; O'Brien, 2010; Walker 2019). *Fixation count* (the total number of fixations within an AOI), similarly adjusted, provides a complementary global measure.

Early-stage processing measures, such as *first fixation duration* and *gaze duration* (the sum of all fixations during the first pass), are linked to initial lexical access and word recognition. They are highly sensitive to local lexical properties (e.g. word frequency, predictability). Longer early-stage measures typically indicate immediate difficulty in lexical processing, such as encountering low-frequency or unpredictable words (Staub 2015). While informative, these were less central to the whole-text reception research reported in *Articles 3, 4 and 5*, which prioritise global and late-stage processing metrics.

Late-stage processing measures are assumed to index higher-order comprehension-monitoring and meaning-integration processes, increasing with the difficulty to understand the underlying meaning. These include (but are not limited to) *re-reading dwell time* (dwell time after the first reading pass), *regressions* (moving the eyes back to previously viewed text), *the number of runs (or passes)* an AOI is entered and exited, *second-pass* and *third-*

pass dwell time (also known as second-run and third-run dwell time). As explained by the 're-viewing for re-processing' hypothesis (Inhoff et al. 2019; Rayner 1998), they signal attempts to re-analyse, re-process the words to resolve comprehension problems. Increased late-stage effort typically indicates problems with integrating information into a coherent mental model of the text, often triggered by syntactic ambiguity, semantic inconsistency, or logical errors (Hessel and Schroeder 2022; Inhoff et al. 2019).

In *Articles 3, 4 and 5* forming this thesis, character-adjusted dwell time is used as a key global processing measure, mainly alongside the number of runs and re-reading dwell time to capture meaning-integration effort. Employing character-adjustment dwell time enables length-independent comparison of reader's effort across different text segments (Kruger 2013; O'Brien 2010; Walker 2019), and, most importantly, it allows for comparisons with character-adjusted translator's effort. In contrast, measures such as number of runs or re-reading dwell time are left unadjusted, based on the premise that re-processing is not systematic but triggered by comprehension challenges (Inhoff et al. 2019).

In sum, this selection of indicators – guided by the research questions – allows for a nuanced analysis of where and how reading a translation becomes effortful. Longer character-adjusted dwell time and increased re-reading are interpreted as evidence of disrupted fluency and higher cognitive effort, potentially arising from translator's choices or errors (Walker 2021a). These indicators are grounded in reading research showing that the processing effort fluctuates relative to various 'bottom-up' and 'top-down' factors, a selection of which is discussed in the following section.

1.3.3. Selected factors affecting reader's cognitive effort

The cognitive effort that a reader invests in processing a translated text is not modulated by a single factor but rather arises from a more complex interaction of factors related to the translation process, product, and the reader.

Factors related to translation product comprise **text-specific features** often reported to affect the processing effort in reading. Grounded in decades of reading research, eye-movement proxies (see *section 1.3.2*) indicate that processing effort increases for text segments containing words of low frequency, of greater length, of lower predictability (or

higher surprisal), syntactic or semantic ambiguity, unpredictable text structure, and other inconsistencies (see Cop et al. 2015; Frazier and Rayner 1982; Norkina et al. 2025; Rayner and Duffy 1986; Staub 2015; Wilcox et al. 2023). Readability metrics (e.g. sentence length, lexical diversity) help to provide an estimate of text complexity, though they should be interpreted with caution (see *Article 4*). In the context of translation reception, processing difficulties are also assumed to arise from translation errors, unnatural wording or phrasing, or lack of cultural adaptation, making eye-tracking metrics highly relevant for assessing the reading experience and reception of translated texts. Informed by *Corpus-based Translation Studies* (CTS), we know that translations may contain explicitations, simplifications, and normalisations (Baker 1993; Laviosa 2002) – known features of translated language (see *Article 4*). These, in turn, may modulate the reader's reception effort. Less diverse lexis, simpler syntax, and more explicit meaning may facilitate cognitive processing, whereas unnatural wording and errors may hinder it (Toury 2004; Xiao and Hu 2015). Further, SL features unintentionally transferred to the TT and unadapted to the reader's expectations (e.g. unnatural or unpredictable linguistic idiosyncrasies in the TL) may surprise the reader as odd or inconsistent, which may increase processing difficulty (e.g. Rayner et al. 2004).

In TPR, *translation quality* has often been operationalised through the presence or absence of errors. Lexical inaccuracies, grammatical mistakes, problems with logic, lack of cultural adaptation, and other inconsistencies tend to violate reader expectations, by creating "surprisal" and disrupting coherence-building. As a result, they might lead to increased cognitive effort, particularly meaning-integration effort captured by late-stage processing measures (e.g. re-reading dwell time). *Article 4* in this thesis tests this assumption empirically by analysing the effects of translation errors on cognitive processing indexed by late-stage processing measures and more global eye-tracking metrics. Reading a translation containing errors (hence, of low translation quality, LQ) is assumed to elicit higher cognitive effort than a high-quality (HQ) translation. While machine translation (MT) research has robustly employed eye-tracking to quantify the impact of errors on text readability (Colman et al. 2022; Doherty et al. 2010; Kasperavičienė et al. 2020; Stymne et al. 2012), the effects of errors inherent to human translation (HT) remain acutely under-researched (Kruger and Kruger 2017). Therefore, this PhD thesis addresses this gap and investigates whether, and how, low-quality translation (primarily due to HT errors) affects reader experience and reception of a

translated text (see *Articles 3 and 5*), and how specific HT errors modulate reader experience and TT's reception (see *Article 4*)

Since the quality of the translation product emerges from the translation process, the cognitive effort invested by the translator during production might be related, perhaps not straightforwardly, to reader's cognitive effort, especially if the translated text was not revised by proofreaders. This underscores that the translator's expertise and diligence (reflected in time spent translating, including the time on end revision) is likely to affect translation reception and reading experience via the end product's quality (TT). In view of lack of earlier studies testing that link, the very hypothesis about the relationship between the translator's cognitive effort and reader's cognitive effort is tested in *Articles 3 and 5* in the present PhD thesis.

Finally, the cognitive effort involved in reading translated texts is filtered through the **reader's individual profile**. Reader-related relatively stable factors frequently reported to modulate cognitive effort exerted in reading include readers' executive control functions, working memory, and inference-making skills (Hessel and Schroeder 2022), as well as prior knowledge of the text topic, reading skills, vocabulary size, and general reading habits, to name but a handful. These top-down factors affect how much cognitive reserve a reader has at their disposal to handle errors, inconsistencies, or ambiguities posed by the text. Given their power to influence cognitive processing, it would be ideal for these individual differences to be addressed – whether by being controlled for at the study design level, or at least accounted for and described (see *Articles 3, 4 and 5*). However, full control if often not feasible in practice. Simultaneously, the reader's moment-to-moment cognitive effort is additionally modulated by more transient factors including psychological and emotional states (e.g. their motivation to read, attitude, expectations, the level of anxiety, or fear of experiments), more attentional factors (e.g. their level of boredom) and physiological conditions (e.g. their current level of caffeine intake, fatigue).

While reading studies typically foreground native **language background** (e.g. L1 proficiency), in translation reception research yet another factor is noteworthy: the reader's proficiency in the *source language* (SL, L2). Bilingual processing research that provides evidence for the non-selective bidirectional activation of languages, points that the L1 and L2 systems are interconnected and are activated in parallel. Such evidence is consistent with conceptual frameworks such as *Bilingual Interactive Activation Plus (BIA+) Model* (Dijkstra and van Heuven 2002) that posits that lexical representation of the non-target

language can indeed be activated in a non-selective way (L2 is activated when reading in L1, and vice versa), with selection determined by task and context. Within the BIA+ framework, language proficiency is modelled as a variable that modulates the baseline activation levels of words in each language, with higher proficiency leading to stronger and faster activation of that language's lexicon. Drawing on cross-language (CI) activation models, this thesis hypothesises that high proficiency in the source language can act as a compensatory resource when reading a flawed L1 translation, enabling more efficient inference of meaning and reducing cognitive effort. This hypothesis is tested empirically in *Article 5.* This factor (i.e. proficiency in the source language, frequently English as a global source language) is very common (i.e. many users of English as a lingua franca) and often overlooked when defining the target reader profile in reception studies.

In summary, the cognitive effort a reader invests in processing a translated text is not shaped by the text alone. It emerges from a complex interaction between text-related (bottom-up, including linguistic features) and reader-related (top-down) factors (e.g. Stanovich 1980). Poor translation quality, especially errors disrupting coherence and understanding, are likely to increase the reader's cognitive effort. The translator's production effort and translation expertise influence this dynamic primarily through their impact on the translation product's quality. Finally, the reader's own linguistic background, particularly the proficiency in the ST language, may serve as a top-down resource that can optimise the effort required to process a low-quality translation.

Part 2: From translation process and product to reception: Methodologies and key findings

The second part of this PhD thesis contains a summary of the rationale behind the conducted studies and main methodologies used in this project, followed by a detailed step-by-step description of the five thematically related *Research Articles* comprising the present thesis. Each description features a brief theoretical background, key research objectives, key findings and their interpretation, limitations of the study, and main conclusions.

2.1. Bridging the translation process, product, and reception: Rationale and research objectives

Although with every single study we contribute to a better understanding of the intricate cognitive processes involved in composing a translation, we have very little understanding of how the cognitive effort invested in translation and the resulting target text's quality impact the ultimate recipient of the text: the reader. While individual studies elucidate specific aspects of translation production, few connect translation process and production data with translation reception data. This creates a substantial gap to bridge (Kruger and Kruger 2017; Walker 2021a). Bridging this gap calls for a research design that treats the text as the constant link between these domains: where the product of the translation process becomes the stimulus (i.e. the experimental text) for investigating reading comprehension. This integrative approach, although methodologically complex as discussed in *Articles 3 and 5* of the current thesis, moves beyond isolated perspectives. It synthesises insights from translation process- and product-oriented studies to address

critical questions: Does greater translator's effort yield a more readable product? Did the translator's effort pay off? Does a translated text deemed high-quality by expert proofreaders facilitate an efficient reading experience and text comprehension (translation reception) for the end-user? Integration of the three domains enables us to test whether a translation that is correct and accurate in professional terms is also optimal for its intended audience. In essence, the integrative approach shows the potential to test the real-world effectiveness of the translator's work (i.e. both the process and the product).

The experiments in this thesis were conducted in Poland with groups of native speakers of Polish (L1) highly proficient in English (L2). Polish, as a language of low diffusion, creates a professional context where translators often work bidirectionally into their native (L1) and non-native language (L2). At the same time, the Polish readership most frequently encounters published translations in their native language (L2→L1) where English is the most common source language. Studying the reception of L1 translations, therefore, mirrors a predominant real-world scenario in the target culture. This choice has high ecological validity and may have its practical implications: exploring how a Polish reader interacts with a poorly translated text in Polish is directly relevant to the local translation industry and the Polish readers.

By integrating data from the two complementary experimental studies, it was possible to address an overarching research question of whether reading of a translated text can serve as a way of evaluating its translation quality and the effectiveness of the underlying translation process. To answer this question, the thesis first investigates (within the *EDiT project*) whether, and how, *directionality* modulates the cognitive effort of professional bidirectional translators during the lexical selection process and information searching (the use of OR), and how this effort shapes *translation quality* of the end product. The target texts produced in this *translation process-and-product study* then become the experimental materials for the subsequent *translation reception study* (within the *Read Me project*), allowing for a unique examination of whether, and how, translation production influences reception. The second study analyses how different translation quality of the target text (TT) and the translator's effort invested in that TT affect the reader's reading experience and text comprehension. Not only does this integrated design allow us to explore the reception of the TTs by analysing the reading process (reader's experience) and post-reading text comprehension (translation reception), but also it creates an empirical link that allows us to trace the consequences of translation decisions from their genesis in the

translator's mind to their impact on the reader's reading experience and reception (comprehension).

The integration of translation process, product, and reception research offers a powerful framework for understanding how the translator's decisions eventually affect the target reader. *Keylogging* and *eye-tracking* methodologies are pivotal to this empirical quest as they provide quantifiable, behavioural correlates of cognitive effort, thereby creating a research trajectory from the translator's production challenges and cognitive effort needed to overcome them, to the reader's experience and reception of the translated text. This approach essentially seeks to trace "the cognitive echo" of the translation process within the reading of its final product.

2.2. Methods in the translation process-and-product study and translation reception study

2.2.1. Methodological challenges and considerations

Combining translation process, product, and reception, and, more specifically, integrating experimental data across the three scopes, presents several key methodological challenges. A number of them are described in *Articles 3 and 5* and in the section in the present PhD thesis solely devoted to the limitations of the conducted studies along with methodological challenges and future research directions (Part 3. *Section 3.4*).

Methodological challenges across the studies primarily stem from the inherent difficulty in defining and measuring the underlying constructs (*cognitive effort* and *translation quality*, in particular) and controlling various extraneous factors and potential confounding variables (for eye-tracking method-related challenges, see also Alves et al. 2009; O'Brien 2009). In brief, a key issue for both translator process and reader reception studies is the selection of the framework, model, and definitions, followed by the selection of proxies for cognitive effort.

A challenge lies in gauging the *translator's cognitive effort* – it is understood as the total mental resources expended during the task (Hunziker Heeb 2020). This requires using valid and reliable proxies, such as total task time (or pause length or number of pauses recorded) tracked via keylogging, and often adjusting them (e.g. per character) to allow for

valid comparisons across text segments of varying length, a necessity already mirrored in reception studies (e.g. O'Brien 2010). Similarly, eye-tracking researchers in reception studies need to use precise definitions and precise operationalisations. They should accurately index the reader's cognitive effort using eye-tracking data, requiring careful distinction between early-stage processing measures (initial lexical access indexed by e.g. initial fixation duration) and late-stage metrics (e.g. re-reading dwell time and refixations), which reflect complex semantic integration and re-analysis often triggered by processing difficulties (Inhoff et al. 2019; Rayner 2009). Moreover, the *translator's expertise*, frequently linked to their years of professional experience (Massey 2017; Tiselius and Hild 2017), also affects the allocation of cognitive resources and the quality of their final product (TT), and should be accounted for.

Furthermore, *the choice of experimental stimuli* is critical because cognitive effort is highly sensitive to the lexico-semantic and syntactic complexity of the text: denser, grammatically intricate structures can increase effort independently of translational errors (Frazier and Rayner 1982; Singh et al. 2016). Challenges that can be encountered early are inherently indeed related to *experimental materials* used in the translation process and reception tasks. Given that cognitive effort is tied to the specific features of the text, in a study examining how much cognitive effort translators exert into text translation and then readers into reading that translation, the choice of a source text (ST) to translate will partly affect the outcome of the translation process (the TT), and the TT (with its specific translation features) used as an experimental text in a reading experiment will affect readers' processing effort. Furthermore, when the same material (e.g. a text) is utilised for both tasks – as an end product in the translation task and as a text to read in the reading task – deciding how to re-scale and match the translator's effort and the reader's effort seems a priority. Where participants are tasked with reading the whole text rather than isolated words or sentences, also *text length* emerges as one of the factors to consider and control for, since as a modulator of cognitive effort, it may unnecessarily hinder the comparative analysis of the cognitive processes underlying the reading of such texts. *Task effects* also serve as a substantial source of data variability (see Ho and Tsai 2025); for example, a reading-for-translation task is significantly more cognitively taxing for readers than a reading-for-comprehension task (Schaeffer et al. 2017; Shreve et al. 1993).

Finally, individual differences in the ***reader's profile***, including their *linguistic background*, especially their knowledge of the source language (L2 proficiency, years of

L2 use, age of L2 acquisition), tend to modulate the reader's cognitive effort. For instance, through cross-language activation (Berghoff and Bylund 2024; Spivey and Marian 1999), which is an effect that must be carefully accounted for.

Reconciling high experimental control to isolate these factors with ecological validity of the findings still remains a challenge to overcome.

2.2.2. Method in the translation process-and-product study

The translation process-and-product study reported in *Articles 1 and 2* is part of a large-scale *EDiT project* (*"Effects of Directionality in the Translation process and product"*) launched to explore the effects of directionality on the translation process and its end product – the target text (see also Whyatt 2018a, 2019). The *EDiT project* addressed many research questions, part of them concerning translator's cognitive effort and translation quality.

The translation process-and-product investigation reported in this thesis employed a within-participants experimental design and combined TPR methodology with translation product (quality) assessment. The overall objective was to investigate how directionality affects the translation process and its outcome. The results presented in this thesis on lexical selection effort (*Article 1*) and information searching effort (*Article 2*) are based on the analyses of the datasets collected from the same group of professional bidirectional translators with Polish as their L1 and English as their L2.

Thirty **professional bidirectional translators** participated in the study. The pre-selection criteria included: the working language pair: Polish (L1) and English (L2), a minimum of 3 years of professional experience in translation, and a regular output of at least 50 translated pages a month. The participants were dominant in Polish but highly proficient in English. Data trimming (excluding incomplete or poor-quality sets) resulted in 26 data sets suitable for analysis of translation process and product. Data from 25 participants were analysed for Verbal Fluency (VF) tasks (used for participant profiling).

The materials comprised four comparable source texts (STs, approximately 162 words each). The texts represented two distinct text types: a product description (descriptive) and a film review (expressive). Two texts were translated into L1 (Polish) and two comparable texts were translated into L2 (English). The texts were balanced in terms of

readability scores (Gunning Fog 14.1 for English, 14.2 for Polish). The materials also included VF tasks to gauge language dominance. Participants performed three letter fluency tasks and three category fluency tasks in both their L1 and L2.

The translation process data were collected in individual sessions using a combination of software and hardware. Each individual experimental sessions lasted up to 120 minutes. The participants received a translation brief and were remunerated for their work. Translation performance was recorded using three tools: the keylogging program Translog II, the eye-tracker EyeLink 1000 Plus, and the screen-recording program Morae. VF performance was registered using Translog II. **The experimental setup** featured the Translog II window (ST at the top, TT at the bottom) on the left-hand side of the screen, and an Internet browser on the right-hand side (Google Chrome running in private mode), allowing translators easy access to OR without switching windows. **The experimental procedure** was counterbalanced to minimise task order effects. Participants performed three letter fluency tasks and three category fluency tasks in both their L1 and L2. They were asked to type as many meaningful words as possible within a 1-minute time frame in response to a specific cue. They first performed the VF tasks in their L1, followed by (reading the STs in L1 and) translating two texts into L2. After a short break, they performed the VF tasks in their L2, followed by (reading the ST in L2 and) translating comparable texts into L1.

The resulting quality of the translated texts (TTs) was assessed by two experienced **proofreaders** who were native speakers of the target language for each translation direction, and one additional external evaluator (experienced professional bidirectional translator). Proofreaders used the 'track changes' function in Microsoft Word and their corrections were later classified into categories which are frequently used in error-based translation assessment, e.g., grammar, vocabulary, style, etc. All corrections to vocabulary (lexical) were classified as minor if they did not affect understanding the meaning (1 penalty point) or major if they hindered understanding the meaning (5 penalty points), whose total sum informed about *translation quality* of the end product. Translation quality was also operationalised by measuring the time needed by proofreaders to correct the translated texts to make them publishable (i.e. to revise the translated texts to a publishable standard).

The study investigated translator's *cognitive effort* involved in the *lexical selection process* (*Article 1*) and in *information searching*: the use of OR (*Articles 1 and 2*). In the

first investigation (*Article 1*), the following independent variables were analysed: translation direction (two levels: L1→L2, L2→L1), text type (two levels: product description, film review), and cue type (for VF tasks: letter-, category-cued). *Lexical selection effort* was indexed by proofreader corrections, online lexical changes, and lexical selection automaticity (using pause thresholds: automatic < 5 s, effortful > 5 s). The second investigation (*Article 2*) examined translation direction and text type as independent variables, but also added translation phase (orientation, drafting, revision), and specific AOIs (ST, TT, OR). *Information searching effort* quantified by time spent in OR, the number of searches, and the range and kind of the consulted OR, and fixation durations within specific AOIs. This searching effort was analysed across translation phases. Finally, *translation quality* was operationalised through both process-oriented (the time required for proofreading) and product-oriented metrics (sum of error penalty points for lexical errors). The descriptions and operationalisations of all the examined variables are provided within the respective research articles comprising this thesis.

Statistical analyses employed linear mixed-effects models as the primary method, with *translation direction* and *text type* as fixed factors and the translators and proofreaders as random factors, used for analysing lexical corrections (*Article 1*) and the use of various OR (*Article 2*). They were also supplemented by repeated-measures ANOVAs (two-way and three-way) for specific comparisons. Post-hoc tests used Bonferroni correction for multiple comparisons. Additional tests included Spearman's correlation and the Wilcoxon matched-pairs signed-rank test for non-parametric data, as detailed per article.

2.2.3. Method in the translation reception study

The studies described across the three *Articles 3, 4 and 5* share the same experimental methodology focusing on translation reception, utilising identical design, materials, apparatus, and experimental procedures. The experimental protocol was approved by the *Ethics Committee for Research Involving Human Participants* at Adam Mickiewicz University, Poznań. The research is part of *the Read Me project* (*"Reading and Reception of Mediated/translated Text"*).

The study employed a between-participants **experimental design** to investigate the relationship between *translator's cognitive effort* (in the subsequent *Articles* in this thesis

also referred to as 'translator's effort', 'production effort'), *translation quality*, and *reader's cognitive effort* involved in the process of reading the target text (in the subsequent *Articles* in this thesis also referred to as 'reader's effort', 'processing effort', 'reception effort'). The overarching objective of the reception experiment was to empirically test the impact of translator's cognitive effort and translation quality on the reception of the translated text. Informed by Gambier (2018) and Walker (2021a), *translation reception* is conceptualised as comprising both the online reading experience (the real-time reading process/behaviour) and post-reading outcome (response) in terms of text comprehension. Translation reception is operationalised here using eye movement metrics and (text) comprehension task scores. Participants were randomly assigned to read either a high-quality (HQ) or a low-quality (LQ) translation of the same source text (ST).

Participants were native speakers of Polish (L1) highly proficient users of English (L2) as a foreign language. A total of 67 university students of English, not enrolled in translation training programmes, were recruited. All participants had normal or corrected-to-normal vision and were reimbursed for their time (approximately one-hour session).

Not all datasets were suitable for statistical analyses either due to their poor quality or incomplete data in the investigated variables (uncorrectable eye drifts, missing responses in questionnaires and tests). The sample size analysed to answer research questions presented within the current PhD thesis thus varied: 20 datasets (i.e. 20 readers; *Mean age* = 20.8, *SD* = .83) analysed in the exploratory study reported in *Article 3*, 64 datasets (*Mean age* = 20.52, *SD* = 1.37) analysed to address research questions of *Article 4*, and 63 datasets (*Mean age* = 20.52, *SD* = 1.38) to answer a set of research questions investigated in *Article 5*. All participants were randomly assigned to an LQ or HQ condition.

A battery of participant profiling instruments was used to assess readers' language background, proficiency and reading habits. Their high English (L2) proficiency, corresponding to C1/C2 CEFR levels, was confirmed by *LexTALE Test* scores (mean ranging from 80.64% to 81.2% across the three reports). Detailed self-reported data, including also their L2 proficiency, but also years of L2 use (mean ~14 years), age of L1/L2 acquisition, and other language dominance data (that helped to picture the profiles of participants), were collected via the *Language History Questionnaire (LHQ 3.0)*. Furthermore, a self-composed *Reading Habits Survey* indicated the group was relatively homogeneous in this respect – the majority (across the three reports between 73% and 81% of participants) self-identified as avid readers, with a preference for digital over print

formats (across the three reports between 58.8% and 72% of participants). All participant profiling information was obtained from the set of digitalised questionnaires and surveys administered after the reading task.

The **materials** comprised one baseline text originally written in Polish and two texts translated into Polish (the participants' L1) from English (the participants' L2), all texts reported in *Articles 3, 4, and 5* belonged to the same text type: a product description. The two translations were selected for the reading experiment from a corpus of translations recorded in *the EDiT project* (we had 26 translations of the product – ceiling fan), and they differed in translation quality. All translations were produced by 26 professional bidirectional translators, whose translation process-and-product data (cognitive effort, lexical choices, error types, evaluated translation quality, reliance on online resources) were investigated, analysed, and are reported in *Articles 1* and *2*. *A high-quality (HQ) translation* of a product description text into Polish (out of 26 translations) was functionally error-free – it required only 2 minor proofreader corrections to become publishable. It turned out to be produced by an experienced translator (with 25 years of experience, high L2 proficiency – LexTALE score = 91.25%). This TT was later categorised as a high-quality (HQ) translation. *A low-quality (LQ) translation* of a product description text into Polish (out of 26) required 17 corrections, including 10 vocabulary errors (minor), 2 grammatical errors and 1 major logic error (opposite meaning) affecting meaning integration processes, 3 typos, and 2 punctuation mistakes. It turned out to be produced by a less experienced translator, with 3 years of experience, lower L2 proficiency (LexTALE score = 71.25%), who allocated considerably less end revision time. This translation was later labelled a low-quality (LQ) translation.

These two translated texts, being the final products (TTs) of the translation process in *the EDiT project* (whose participants' cognitive effort is analysed in *Articles 1 and 2*), served as the two experimental texts (of an HQ and LQ translation quality) in the translation reception study (reported in *Articles 3, 4 and 5*). All participants first read a Polish baseline text (a descriptive text of a similar type originally written in Polish: product description of a mop cleaning set) to familiarise themselves with the experimental procedure and to control for the participants' baseline reading rate (words per minute). All participants read the selected HQ and LQ TTs in the exact form as originally produced by the translators before they were corrected by the proofreaders (i.e. without corrections). Both TTs and the ST had an identical eight-sentence structure. Readability metrics for the

Polish translations were calculated using *jasnopis.pl*, and for the ST in English – the Gunning Fog Index was used. The HQ translation was assessed as being potentially more difficult to read (higher FOG index = 19.11) compared to the LQ translation (FOG index = 13.86). Translation quality was determined by the proofreading process (two expert proofreaders and one professional translator who evaluated TTs' accuracy). Specific sentences with errors and inconsistencies (Sentences 4, 7, and 8) were later targeted for detailed analysis in *Article 4*.

Data collection was performed in an experimental research facility of AMU Faculty of English: *EYE-LANG – Eye-tracking Laboratory for Research in Language*. The experiment was programmed using Experiment Builder (SR Research) and data were collected using an EyeLink 1000 Plus eye-tracker. Following written informed consent form, participants were tested for eye dominance (for monocular tracking), familiarised with the experimental setup, and completed a 9-point calibration procedure. They were instructed to read silently for comprehension (reading comprehension task) to ensure attentive processing (Kaakinen et al. 2003; Kaakinen and Hyöna 2005). The experimental text was presented on a single screen (24-inch, 1920 x 1080 resolution) in monospaced Arial 25 pt. font with 2.5 line spacing (10 lines in total per screen). Participants used a forehead and chin rest to minimise head movement. Tracking was monocular (dominant eye). The task was self-paced. The entire reading experiment included three other texts which are not analysed here. The analysed HQ or LQ translations of the ceiling fan were displayed as the first experimental text for both groups, after the baseline text. After reading each text, participants pressed the key (right ENTER key or spacebar) to advance to four true/false text comprehension statements and one purchase-intention question (i.e. asking about the reader's willingness to buy the described product). The entire reading session, involving five texts, took approximately 10 minutes. *Articles 3, 4 and 5* report findings specifically for the product description translations of high and low quality.

Eye-tracking data were pre-processed and extracted using Data Viewer (SR Research). Sentences in the text served as the Area of Interests (AOIs), resulting in eight AOIs per text. Eye-movement measures served as proxies for reader's cognitive effort (reception effort captured during the reading experience). Since the texts (HQ vs. LQ) and sentences (from 1 to 8) varied in length, global eye movement measures were character-adjusted to allow for comparisons.

Independent variables factored in across the stages of the study comprised:

- *total time taken by the translator to produce each target sentence* (character-adjusted including spaces; in milliseconds), derived from Translog II keylogging data collected during the previous studies in *the EDiT project* (reported in *Article 1* and *2*), and taken as proxy for translator's cognitive effort (translator's production effort) factored in *Article 3* and *5,*
- *translation quality* (factored in with its two levels: HQ vs. LQ condition),
- *reader's L2 proficiency* (proficiency in the source text language: English, being readers' L2), self-rated with Language History Questionnaire (LHQ 3.0). Also, tested as a mediator variable in the moderated mediation analysis,
- *reader's years of L2 use* (number of years of L2 use), self-rated with LHQ 3.0. Also, tested as a moderator variable in the moderated mediation analysis,
- additionally, in Article 3 *sentences* (items S2-S8) and *participants* were entered into the model as random effects (while computing the LME model).

Reader's cognitive effort, understood as the allocation of mental resources during text processing in reading (cf. Kruger 2016: 27; in *Article 3, 4 and 5* also referred to as *reader's effort*, *reader effort*, *reception effort*, and *processing effort*), was measured using sentence-level Areas of Interest (AOIs) and operationalised through several eye-tracking measures. Key **dependent variables** included proxies for more global processing and late-stage processing involved in higher-order meaning integration (Clifton et al. 2016; Rayner 1998):

(1) *global processing measures* – proxies for overall processing effort (character-adjusted, including spaces whenever analysed alongside a character adjusted translator's effort measure that included spaces):
    - *dwell time* (total fixation duration in the AOI divided by the number of characters),
    - *fixation count* (total number of fixations divided by the number of characters).

(2) *late processing measures* – proxies for re-processing and meaning integration effort (not character-adjusted as re-reading is not systematic but rather an adaptive response triggered by comprehension monitoring when processing difficulties arise; Hessel and Schroeder 2022; Inhoff et al. 2019; Stafura and Perfetti 2017):
    - *number of runs (passes):* how many times the eyes returned to the AOI after exiting it (indexing re-analysis and re-viewing),

- *re-reading dwell time:* total dwell time without first-run dwell time (total time spent re-viewing an AOI). It contains the values of dwell time from the second, third- and other runs,
- *second-run dwell time:* dwell time during the second re-viewing of the AOI (taken as a proxy for comprehension monitoring),
- *third-run dwell time:* dwell time during the third re-viewing of the AOI (a proxy for comprehension monitoring).

To explore not only reading experience but also response or reception (as advocated by Walker 2021a), the following behavioural measures were also collected and analysed as **dependent variables**: *comprehension accuracy scores* (true/false scores), *response times* to comprehension statements (RTs), and an answer to a question probing behavioural intention (willingness to buy the product described in the text: yes/no).

Statistical analyses conducted across three *Articles 3, 4 and 5* primarily employed linear mixed-effects models to examine main effects and interaction effects on the reader's cognitive effort (e.g. between translator's effort and translation quality on the reader's dwell time). As detailed in the respective articles, statistical analyses reported in exploratory *Article 3* also included t-tests, non-parametric tests where data distributions deviated from normality (Mann–Whitney U tests, Wilcoxon tests) and Spearman's correlation analyses. *In Article 4*, independent-samples t-tests, Mann–Whitney U tests, and chi-square tests were performed. Additionally, moderated mediation analysis was used to further explore the mediating role of L2 proficiency and moderating role of translation quality for the reader's cognitive effort in *Article 5*. The statistical analyses were performed using Jamovi (ver. 2.3.21 and 2.3.28), SPSS (ver. 27), and JASP (ver. 0.17.3).

Building upon the methodological framework outlined above, the following sections provide a summary of the five research articles that form the empirical core of this thesis. These articles are presented in a sequence that mirrors the integrated research trajectory. *Articles 1 and 2* present the findings from *the translation process-and-product study* (*EDiT project*), detailing the cognitive effort involved in lexical selection processes and information searching of professional bidirectional translators. *Articles 3, 4, and 5* shift focus to *the translation reception study* (*Read Me project*), investigating how the translator's effort and translation quality, and linguistic background modulate the reader's cognitive effort, reading experience, and text comprehension.

2.3. Research Article 1 (Tomczak and Whyatt 2022): Directionality and lexical selection in professional translators: Evidence from verbal fluency and translation tasks

A substantial body of research in TPR has empirically tested whether cognitive effort exerted into translation is modulated by *directionality* (e.g. Buchweitz and Alves 2006; Ferreira et al. 2016, 2021). While *L1→L2 translation direction* has generally been found to be cognitively more demanding than *L2→L1 translation direction*, recent evidence on directionality reveals a mixed and inconclusive picture (e.g. Hunziker Heeb 2020; Pavlović and Jensen 2009; Whyatt 2018a, 2019). What warrants further fine-grained empirical investigation is thus an interest in precise manifestation of this (a)symmetry in the cognitive demands of lexical selection among professional bidirectional translators. The present study is motivated by the well-documented "L2 cognitive disadvantage" observed in psycholinguistic research on bilingual lexical retrieval on verbal fluency and picture naming tasks (e.g. Gollan et al. 2005; Kroll and Tokowicz 2001; Luo et al. 2010). Studies on single-word and sentence-level translation confirm increased cognitive effort and decreased accuracy in the L1→L2 translation direction (for a review of studies see Muñoz et al. 2019). Yet, an unresolved question is whether these effects extend to the complex, situated task of whole-text translation by professional bidirectional translators, individuals whose language networks may be uniquely wired (Halverson 2017; Paradis 2009). The key research gap, therefore, is to understand whether, and how, the "L2 cognitive disadvantage" (an asymmetry in cognitive processing and lexical access) manifests throughout lexical selection in the translation process and in the final product delivered by professional bidirectional translators.

Article 1 aimed to address this gap by investigating and directly comparing the process of *lexical selection* (*cognitive effort* involved indexed by speed and its *outcome* indexed by accuracy) in professional bidirectional translators across L2→L1 and L1→L2 translation directions. The overarching research question of how directionality affects the process of lexical selection in experienced bidirectional translators (professionals frequently translating in both directions) was further subdivided into narrower areas of investigation and operationalised through specific metrics: *the number of unsuccessful lexical choices* (expert-evaluated), *the number of searches (consultations) in online resource (OR)* during the translation task (indexing information searching effort), *the number of times the translators change their lexical decision*, and *the number of*

unsuccessful lexical choices that are automatic (i.e. under 5 sec) vs. *non-automatic* (i.e. over 5 sec, more effortful). In total, five focused directional research questions (and five corresponding implied directional hypotheses) guided this investigation – most on the influence of directionality on the speed and accuracy of the lexical selection process in professional bidirectional translation. These questions are detailed within the respective *Article* 1 of this thesis. To contextualise the process- and product-oriented data, the study first established translators' profiles through tasks assessing their language dominance, L2 proficiency, and typing speed. Two verbal fluency (VF) tasks (letter-cued and category-cued) in their L1 and L2 were employed to evaluate the professional bidirectional translators' ability to access and retrieve words in each language (see Luo et al. 2010) and thus to determine their language dominance. The LexTALE test (Lemhöfer and Broersma 2012) was used to index their L2 proficiency (English), and a text-copying task to gauge their typing speed in L1/L2.

The study employed a mixed-method experimental design with 30 professional translators. The inclusion criteria adopted to ensure sufficient professional translation experience included: language pair L1 (Polish) and L2 (English), at least 3 years of professional experience of translating, translating at least 50 pages of text per month. The 26 data sets were complete and suitable for statistical analysis. The research design incorporated four translation tasks (per participant) for which four texts were used (each approx. 162 words) – they all served as source texts (ST) in the experiment. The translators' task was to translate each text into their L1 or L2. Two STs were in English, and two in Polish, allowing for experimental testing of the two translation directions. Two text types were used: descriptive (functional) and expressive. The two descriptive texts were *product descriptions* (of a ceiling fan – to be translated into Polish, of a mop cleaning set – to be translated into English). The two expressive texts were *film reviews* (a review of the film "Silence" directed by Martin Scorsese – to be translated into Polish, a review of the film "Powidoki" directed by Andrzej Wajda – to be translated into English). To avoid data contamination, special care was taken to use texts very similar in their word length and readability scores. The translation tasks (translating two texts into English, translating two texts into Polish) were blocked with VF tests and text copying tasks, the blocks were counterbalanced and the text order was randomised, with a short break in between both translation directions (the exact procedure is also discussed in Whyatt 2018a: 95). Questionnaires distributed at the very end of the experimental procedure included:

subjective assessments of the level of text difficulty (on a 5-point Likert scale), years of professional experience, their everyday exposure at work to L2 translation direction, types of texts they usually translate, and other demographic data.

The whole translation task was recorded using keylogging in *Translog II* (Carl 2012; Jakobsen 2011) and eye-tracking (*EyeLink 1000 Plus*, SR Research), thereby providing a rich triangulated dataset on the translation process both in the L2→L1 and L1→L2 direction. To document the translators' use of online resource (OR), screen-recording software (*Morae*) was employed. The produced target texts (TTs) were subjected to a quality assessment protocol involving two experienced proofreaders for each translation direction, and additional proofreader-accuracy evaluator (professional translator). All proofreaders were native speakers of the target language and were instructed to evaluate and correct the respective translation end products so that the texts can be published. Data analysis employed a combination of repeated-measures ANOVA, linear mixed-effects models, and Wilcoxon tests to account for the multi-level nature of the data.

The statistical analyses revealed that professional bidirectional translators had higher VF in their L1 than L2 but only in the category-cued VF task (vs. letter-cued). They also typed category-cued words faster in L1 (vs. L2). Based on the neuroimaging evidence showing that category fluency scores reflect verbal ability and letter fluency scores reflect executive control more strongly (Shao et al. 2014), these results point to translators' higher *verbal ability* in L1 than L2. Overall, the analyses revealed no effect of *directionality* on the number of unacceptable lexical errors, but a significant effect of *text type*, as well as interaction effect of translation direction and text type. The translators made more lexical errors (more unacceptable vocabulary that needed to be corrected, as evaluated by the proofreaders) when translating *product description texts* than film reviews, in particular in the L2 translation direction. Yet, in the L1 translation direction, they made more vocabulary errors when translating the expressive texts (film reviews) than product descriptions.

It is noteworthy that – in the case of product description texts – the translators made a significantly higher number of online changes to initially selected vocabulary items when drafting the target text in the L2→L1than L1→L2 translation (as if being 'spoilt for choice' in their native language). On the other hand, in the L1→L2 translation direction, the lexical choices were made by the translators fairly quickly but they were also corrected most

frequently by the proofreaders: the majority of the unsuccessful lexical choices were automatic (i.e. decisions made under 5 sec).

Finally, the pre-liminary analysis of translators' use of OR showed three significant effects: the effect of *translation direction*, of *text type*, and *the interaction* of the two on the *number of searches* entered in the Internet browser, with, in general, more searches in the browser in the L2 translation direction (than L1), and, more searches in the case of product description texts (than film reviews), especially when translating into their L2.

The results of a close and detailed investigation of translation tasks reported in *Article 1* suggest that the L1→L2 translation direction is more cognitively taxing than the L1→L2 direction. This finding confirms the "L2 cognitive disadvantage" (see Muñoz et al. 2019) assuming greater processing demands in L2 than L1. At the same time, the finding is far from indicating that translating into one's native language is effortless, only that it is less cognitively demanding than L2 translation, specifically during the process of lexical selection, which in L1 translation relies more on the translator's internal resources. This discrepancy in the amount of exerted cognitive effort between the two directions persists despite translators' extensive experience in bidirectional translation. It likely stems from translators' larger vocabulary size and faster speed of connections between items in their semantic activation network (McNamara 2005), as indicated by higher scores on verbal fluency category-cued tasks in their L1 than L2. Also noteworthy is the lack of evidence that translation experience significantly changes language dominance and asymmetry of professional bidirectional translators, which corroborates similar conclusions reached from research on bidirectional conference interpreters (e.g. Chmiel 2018).

Selecting words during a translation task appears more cognitively demanding in the L1→L2 translation, yet lexical choices made when translating a product description text into L2 were less acceptable by proofreaders than in the L1 translation, and than L1→L2 translations of film review. This finding underscores the importance of reporting both the directionality effects alongside the types of texts used in translation studies. Lexical errors present in the L2 translation more frequently resulted from an automatic selection (but flawed) rather than prolonged decision-making. This can be explained by the "gravitational pull" of highly salient items in the source language (Halverson 2017: 14), and likely the effect of semantic priming, where entrenched but not optimal, not appropriate L2 connections are automatically activated (Langacker 2008; McNamara 2005). Conversely, in the L1 translation direction, it was not lexical access that appeared to be challenging, but

rather the whole word selection process. The translators tended to revise and change (online) their initial L1 lexical choices more frequently, which can be attributed to their richer network of semantic competitors in their dominant L1 (McNamara 2005). These finding may indicate that a process of lexical selection is a process of decision-making that is recipient-oriented. The study highlights the practical need to address the challenges inherent in L2 lexical selection during translation. This could be achieved through current translator training programmes and foreign language curricula that would develop in their agendas and formally integrate explicit directionality-dependent strategies designed to prevent errors (see Wu and Liao 2018).

The presented study has several limitations that affect the generalisability of its findings. Firstly, while the study offers valuable insights and pedagogical implications for the Polish-English bidirectional translation context, the focus on a single language pair yields insights about a lexical selection process and information searching effort in translation that are specific to that linguistic context, these insights may not necessarily extend to other language pairs, especially typologically more distant pairs such as English-Chinese. Secondly, the use of only two text types (product descriptions and film reviews) also narrows the scope and applicability of the conclusions that can be drawn from the study. A more comprehensive discussion of methodological constrains and limitations of the present study is provided in *section 3.4* in this thesis.

Research reported in *Article 1* revealed that the cognitive effort invested in the process of lexical selection is affected by directionality and text type. Although the lexical choices were more accurate in the L1 direction, not all of them were perfect. The translations of the product description text from English into Polish still needed corrections from proofreaders. Without the corrections which were deemed necessary by the proofreaders the target texts could prove difficult to read and understand. This could only be tested in the actual reading experiment. Therefore, two L1 translations from the study described in *Article 1* and *Article 2* of high and low quality were selected to provide empirical evidence on how the translators' decisions might affect the reading process and comprehension by the end-users if the target texts are not checked by proofreaders.

2.4. Research Article 2 (Whyatt, Witczak, and Tomczak 2021): Information behaviour in bidirectional translators: Focus on online resources

In today's digital era, translation as a complex and effortful cognitive process heavily relies on how effectively translators find and use information. Human information behaviour is guided by two core principles of information processing: *the uncertainty principle* (Dervin 1998) and *the principle of least effort* (Zipf 1949). The former posits that information seeking is triggered by cognitive uncertainty (a knowledge gap that impedes completing a task). The latter assumes that information seeking follows a cost-benefit analysis where the effort (i.e. the cost) of a search must not outweigh its perceived benefits. These two principles are directly applicable to translation. When a source text (ST) presents a problem, it triggers cognitive uncertainty, motivating a search for information. Increased cognitive uncertainty prompts translators to consult external resources to bridge knowledge gaps. Yet, this uncertainty during problem-solving is frequently tempered by a tendency to minimise cognitive effort. This tension can be observed in the translation process in both directions, especially where a language of low diffusion (LLD) is paired with a non-native global lingua franca. In such translation markets, professional translators often work bidirectionally (Chmiel 2018; Pavlović 2007). This involves translating not only into their native, dominant language (L1), but also into their non-native, weaker language (L2). Translating into one's non-native language (L1→L2) entails "greater linguistic and extralinguistic processing demands", or the so-called "L2 cognitive disadvantage" (Muñoz et al. 2019: 9), which presumably generate greater information needs than translating from L2 to L1. However, empirical evidence on how bidirectional translators use online resources (OR) across the two translation directions remains both scarce and contradictory. Some studies find a heavier reliance on OR in L1→L2 translation (e.g. Pavlović 2007), while others report the opposite for L2→L1 translation (e.g. Ferreira et al. 2016). Addressing these inconclusive findings on translators' information behaviour is vital. Information behaviour is not merely a practical concern but a core component of contemporary models of translation competence (e.g. EMT 2009; Kuznik 2017; PACTE 2009). A clear understanding of how translators use online resources in bidirectional translation, where the pull of uncertainty works against the push of least effort, remains a pressing gap in the research.

As a direct continuation of the research question from *Article 1*, *Article 2* addresses this research gap by examining how *translation direction* (L1→L2 vs. L2→L1) alongside

text type (descriptive/functional vs. expressive) affect how professional bidirectional translators (L1 Polish, L2 English) use *online resources*. More specifically, it examines how the use of OR modulates translators' overall *cognitive effort* exerted in L2→L1 and L1→L2 translation, and whether OR use correlates with *the quality of the translated texts* (end products in L1 and L2). *Article 2* is a direct follow-up to the observations made in *Article 1* that L2 translation requires more frequent use of information sources. In the investigation in *Article 2*, three focused non-directional research questions (and three corresponding implied non-directional hypotheses) were formulated (the are detailed in the respective article). The description of the reported study is provided in the previous sections (see *section 2.2.2. Method in the translation process-and-product study*, and *section 2.3. Research Article 1*). Several metrics were analysed as dependent variables, including *time in OR* (in sec and % of total task time), *number of searches in OR*, *average fixation duration*, *range of consulted OR*, *kind of consulted OR, complexity of searches*, and *translation quality.*

As evidenced by keylogging data, the authors found a strong positive correlation between *total task duration* and *time spent in OR*. This correlation was stronger for L2 translation and for the product description texts than for L1 translation and film reviews, respectively. *The number of searches in OR* correlated positively with the number of pauses (> 10s: strong correlation; > 5s: moderate), and this pattern held for both translation directions and text types. Eye-tracking data revealed that, irrespective of the translation direction and text type, translators' *average fixation durations* were modulated by the area of focus (source text, target text, online resources), with significantly longer average fixation durations in OR than in ST, suggesting increased cognitive effort when using OR. Yet, average fixation durations in OR were comparable to those observed in the TT.

Linear mixed-effects analyses revealed that *translation direction* had a significant effect on how professional bidirectional translators use OR. While the percentage (%) of total task time in OR was not affected by direction, the number of performed searches was higher in the L2 translation. Interestingly, this effect was translation phase-dependent (*orientation*, *drafting*, *revision*): more searches in OR in L1 translation during orientation, whereas in L2 translation more searches during drafting. No significant effect of directionality was observed in the *revision phase.* There was also a significant effect of *text type*, overall, with product description texts prompting a higher % of time in OR and more searches in OR than film reviews.

The kind of the examined online resources in this study varied. The key findings are that bilingual resources were used more frequently in L2 translation, with a significant interaction effect of direction and text type: the translators reached for bilingual resources more often in L2 translation when working on product description translations, and more frequently in L1 translation when translating film reviews. Finally, L2 translation direction prompted significantly more complex searches in OR (both double and multiple searches) that also involved cross-language checks, pointing to greater cognitive uncertainty. No significant effects of directionality or text type were found for the use of online knowledge resources, monolingual resources, single searches, or for the range of OR used.

Lastly, the analyses examined the relationship between the use of OR (operationalised as the total time spent in OR) and *translation quality* of the end product (operationalised as the time proofreaders needed to make texts publishable). A negative correlation was found: moderate for L2 translation and weak for L1 translation. This suggests that higher-quality translations (i.e. requiring less proofreading time) were associated with longer consultation time in OR, particularly when translating into one's non-native language (L2).

The results of the present study conducted with professional bidirectional translators indicate that consulting OR is cognitively demanding (it increases total task time), which is in line with Hvelplund's (2017b) study. The study shows that using OR is particularly effortful when translating in one's L2, thereby corroborating the findings of Pavlović 2007) and Kuznik and Olalla-Soler (2018), as well as the conclusions from the meta-analysis of behavioural and neurolinguistic studies conducted by Muñoz et al. (2019). Moreover, translators' information needs and search complexity are greater when working into the weaker L2. To verify language choices, translators frequently reach for bilingual resources, which is consistent with Hvelplund (2017b). Bilingual resources are consulted significantly more in L2 than L1 translation. Not only does translators' information behaviour shift with translation direction, but also with translation phase. In the orientation phase, more initial OR consultation is needed to construct meaning from a source text that is in L2 while working into L1, which aligns with findings of Duyck and Brysbaert (2004). Translating into L2, on the other hand, involves more OR searches during the drafting phase, a pattern also observed in PACTE group studies (Kuznik and Olalla-Soler 2018). Text type further modulates IB, with functional/technical texts demanding a greater reliance on OR. While a moderate relationship was found between increased OR use and higher translation quality

(less proofreading needed), this relationship is more complex and its interaction with translation expertise requires further study (see Livbjerg and Mees 2003; Pokorn et al. 2020). Drawing on these findings, the authors propose the IBiBT model that can be used to describe, explain, and predict information behaviour in bidirectional translation. The IBiBT model visualises how uncertainty experienced at different stages of the translation process may drive different OR consultation patterns for each direction (for details see *Article 2*).

The findings of the present investigation (*Article 2*) underscore that translator training should integrate directionality and text type explicitly into their training programmes (Gough 2019), particularly meant for future bidirectional translators. Information needs differ significantly between the two directions: L2 translation entails greater uncertainty, requiring more cross-checks of bilingual resources. To raise their awareness of these differing needs relative to translation direction and text types, translation trainees should therefore log and compare their searches in L1 and L2 (Pym 2013). Of help in this awareness-building process may also be practical exercises, such as building the DIY corpora (Bernardini 2016) or pre-translation tasks focusing on rich points, and using OR in a way that is consistent with their personal style (Gough 2019).

Article 2 provided empirical evidence that the translator's cognitive effort includes the effort invested in consulting information sources. A detailed analysis of how the time and effort spent on information searching is affected by directionality and text type complements the study reported in *Article 1*. Both articles also point to possible relationships between effort invested in the process and the quality of the target text as the end product. These relationships are then explored in the translation reception studies reported in *Articles 3, 4 and 5*.

2.5. Research Article 3 (Whyatt, Witczak, Tomczak, and Lehka-Paul 2023): The proof of the translation process is in the reading of the target text: An eye-tracking reception study

Over the past three decades, Translation Process Research (TPR) has extensively utilised keylogging and eye-tracking to tap into the cognitive processes of translators (Jakobsen 2003; Xiao and Muñoz 2020). *Articles 1 and 2* are examples of such multi-method approaches in TPR which have contributed a more nuanced understanding of the translator's cognitive effort when producing a target text. However, as noted by Walker

(2021a), the question of how translated texts are read and received by their target language readers remains markedly understudied empirically. This divide becomes particularly conspicuous, given that translation's primary aim is to elicit specific cognitive effects from the audience (Chesterman 1998), effects which are rarely empirically validated. Although pioneering eye-tracking reception studies (e.g. Kruger 2013; Walker 2019, 2021a, 2021b) have demonstrated that specific translation strategies, such as foreignisation, affect reader processing effort, their rather exclusive focus on selected aspects of final translation products bypasses the translation process itself. Consequently, the relationship between the cognitive costs of translation *production* (i.e. translator's effort or production effort) and those of translation *consumption* (i.e. reader's effort or reception effort) remains largely unaddressed empirically and is not yet understood. The critical research gap here lies not in measuring translator or reader's effort in isolation, but in empirically mapping the translation process-oriented data onto reception-oriented data to test the hypothesis that the reader's cognitive effort serves as proof of how successful the very process of translation has been.

Article 3 is a direct response to this research gap, by pioneering a methodology that concurrently integrates data across three realms of translation: the *process*, the final *product*, and its *reception* (including both reading experience and reception, as distinguished by Walker 2021a). *Article 3* introduces an innovative design that reframes a translated text from a passive end-product to a dynamic object of empirical inquiry, analysed through its 'lifecycle stages' (states): emergent (during translation), finalised (end product), and read and received (during reading experience and reception).

The authors achieve this by integrating data from two complementary experiments: keylogging data and translation-quality evaluation data (of the TT) from the prior translation process-and-product study, and new eye-tracking data from the current translation reception study. The combined approach allows them to address a core overarching research question: does a diligently produced, high-quality translation yield a less effortful, more fluent reading experience? Specifically, the study examines whether, and how, different levels of a *translator's cognitive effort* exerted in translation and the resulting *translation quality* (low vs. high) affect the reader's cognitive effort and thus fluency of the reading of the TT. This aim is pursued through three main research questions: (RQ1) *Is there a systematic relationship between the translator's and reader's cognitive effort?* (RQ2) *Are the sentences that required the least translator's effort also*

read with ease (i.e. with little reader's cognitive effort)? (RQ3) *Are the sentences that required the most translator's effort also read with increased cognitive effort?*

The eye-tracking study employed a between-participants design. Twenty Polish (L1) university students with high proficiency in English (L2), confirmed by their LexTALE scores (Lemhöfer and Broersma 2012) were randomly assigned to read either a low-quality (LQ) or high-quality (HQ) L2→L1 translations (into Polish) of the same English source text (10 participants per each condition). The two translated texts (HQ, LQ) were produced during the experiment described in *Article 1 and 2*. Unaware of the translation quality-related experimental manipulation, participants read the text silently while their eye movements were recorded. Immediately after reading, they answered four comprehension questions about the text (true/false), and indicated their purchase intention for the described product (yes/no). The description of the reported translation reception study is presented in *section 2.2.3.* (*Method in the translation reception study*). It is important to note that this translated text (i.e. a product description of a ceiling fan) was one of five texts read in a larger experiment. ***Article 3*** presents the preliminary findings from the analyses of experimental data collected from this experimental text.

Through an exploratory small-scale study, the authors construct their first bridge from translation process to translation reception by factoring in – as independent variables – *translator's effort* (operationalised as the total time to produce a target sentence in *ms*, divided by the number of characters with spaces in the target text; measured at sentence level) and *translation quality* (the number of corrections made by the proofreaders, which also correlated with time taken to correct them, with two levels: low quality containing errors vs. high quality – hardly any errors, i.e. there were two minor errors). The dependent variables were eye-tracking metrics serving as proxies for readers' cognitive effort (including meaning-integration processes): *readers' character-adjusted dwell time* (a global processing measure), *the number of runs (passes)*, and *re-reading dwell time* (dwell time during the second and third runs). To allow for a more direct mapping of cognitive effort independent of sentence length, character-adjusted metrics were used for translator's and overall reader's effort. Additionally*, text comprehension accuracy* was analysed as a behavioural measure of reception (a dependent variable).

The main analyses used linear mixed-effects models with translator's effort and translation quality as fixed effects, and participants and sentences (S2-S8) as random effects. The key results for the formulated RQs were as follows: there was no statistically

significant main effect of the translator's cognitive effort on the reader's effort across the entire dataset, pointing here to no direct systematic relationship (RQ 1). However, a significant main effect of translation quality was found, with readers' increased cognitive effort (longer character-adjusted dwell time) for reading the text of LQ than the HQ translation. Complementary correlational analyses provided further nuance. There was a weak negative correlation between translator's effort and reader's effort only for the LQ translation, indicating that higher reader's effort is associated with lower translator's effort (and vice versa) but only when the translated text of low quality is read. Noteworthy, the following detailed sentence-level analyses (RQ 2) indicated that in the LQ translation, the least-effortful-to-translate sentence (*sentence no. 7*) required significantly more effort from the reader than the sentence that was most effortful to translate (*sentence no. 3*), as evidenced by the increased character-adjusted dwell time, higher number of runs, and increased dwell time in the third run (i.e. third pass reading). No comparable patterns or differences were found for the reading experience of the HQ translation (RQ 3), where *sentence 3* was the least effortful and *sentence 2* the most effortful to translate. Interestingly, the preliminary analyses also showed positive correlations between reader's effort and text comprehension accuracy found for reading the HQ translation (of moderate strength), as well as for the LQ translation (a weak correlation).

From a broader perspective, the exploratory study reported in *Article 3* sought to examine whether the reader's cognitive effort measured with eye-tracking could serve as an empirical validation of how efficient the translation process has been. The main findings indicate that the translator's cognitive effort does not directly predict or modulate how cognitively demanding a translated text is for its readers. Instead, a significant modulator of the reader's cognitive effort is translation quality. The study reveals reading an LQ translation – particularly sentences resulting from low translator's effort – is significantly more cognitively taxing for readers during meaning integration, suggesting that readers engaged in intensive re-processing to resolve coherence issues (Graesser et al. 2004; Hessel and Schroeder 2022). Conversely, for the HQ translation, no such correlation emerged. Overall, reading the HQ translation required lower effort from the reader (regardless of translator's effort level) than when reading the LQ translation, despite the fact that the HQ translation was a more complex text in terms of readability measures, possibly suggesting that sufficient diligence of the translator results in a uniformly reader-friendly text. The LQ

translator's lower expertise along with very brief end revision (low professional diligence) likely caused inconsistencies that increased cognitive effort during meaning integration.

The reception study reported in *Article 3* is not free from limitations that are intrinsic to its exploratory nature. The described experiment is modest in size – it involved only 20 readers in total (10 per each condition), and the translation process data entered into the study design were sourced from only two professional translators. This limited sample size inherently constrains the generalisability of the described findings, and thereby rules out more confident and broader generalisation to wider population of readers (and translators).

To conclude, the exploratory study reported in *Article 3* bridges translation production and reception by exploring the role of translator's cognitive effort and translation quality in the reading experience (processing effort) and reception (post-reading comprehension) of L1 TTs. It found no direct effect of the translator's effort on the reader's cognitive effort. Yet, translation quality emerged as the key factor significantly affecting reading fluency: access to the translation process data showed that the HQ translation was diligently produced with substantial time for end revision while the LQ translation was not. These results tentatively suggest that that proof of the translation process can indeed be found in the reader experience of translated texts, but it is affected by translation quality of final product of the translation process rather than the amount of cognitive effort put into translating it. The authors explicitly acknowledge the exploratory nature of the study, its limitations on external validity, and preliminary nature of the findings. In *Article 3,* the authors emphasise that increasing the sample size is a primary objective for authors' future research.

The methodological bridge from the *translation process-and-product study* to *translation reception* – first conceptualised and constructed in the present *Article 3* – is further developed in subsequent *Article 4 and 5*. The three articles further explore the effect of the translator's decisions on the process of reading and reception by the target readers.

2.6. Research Article 4 (Whyatt, Tomczak-Łukaszewska, Witczak, and Lehka-Paul 2025): Readers have to work harder to understand a badly translated text: An eye-tracking study into the effects of translation errors

The fundamental assumption that translations are produced to be read contrasts sharply with scarce experimental research exploring how readers process and cognitively receive translated texts. This scarcity of research on the experience of reading translations (Walker 2021a) is all the more striking given the robust body of research documenting how translated language differs from non-translated original language (e.g. Baker 1993; Baroni and Bernardini 2005; Chesterman 2004; Corpas Pastor et al. 2008; Koppel and Ordan 2011; Laviosa 2002; Xiao and Hu 2015). These distinct features of translated language (Toury 2004), often discussed in terms of 'translation universals' such as explicitation, simplification, normalisation, and levelling-out (Baker 1993) or as 'translationese', i.e. features unique to translated language (Gellerstam 1986) – could have a dual effect on the reading process: they may facilitate reading (e.g. through simplification) or hinder it (e.g. due to errors, unnatural word combinations, odd words or structures violating target language norms). Translation quality, which remains a complex and relatively subjective construct (Koby and Lacruz 2018; Waddington 2001b), has been shown to affect the reading experience and thus cognitive effort of readers of *machine translated* (MT) texts. While MT research has made an extensive use of eye-tracking to quantify how translation quality and translation errors affect text readability (e.g. Colman et al. 2022; Doherty et al. 2010; Kasperavičienė et al. 2020; Stymne et al. 2012), the cognitive effects of errors inherent to *human translation* (HT) remain acutely under-researched (Kruger and Kruger 2017). This research gap is striking, especially given that cognitive effort – mental activity with observable behavioural correlates such as eye-movements (Jakobsen 2014) – is a central construct in Translation Process Research (TPR).

The study reported in *Article 4* directly addresses this research niche, leveraging eye-tracking methodology to investigate the effects of human translation errors on reader's cognitive effort and text comprehension, thereby bridging corpus-based findings on 'translationese' with models of the reading process. The study rests on the assumption that unpredictable, high-surprisal elements in the text increase its processing difficulty (Wilcox et al. 2023; Van Berkum et al. 2005), and that inconsistencies in the text tend to trigger re-processing of its problematic parts (Inhoff et al. 2019; Stafura and Perfetti 2017). The primary goal of the study was to determine if reading a low-quality (LQ) human translation

requires more cognitive effort than reading a high-quality (HQ) human translation. The secondary aim was to explore how translation errors affect text comprehension and readers' intention. The authors assume that problems with localisation (cultural adaptation errors) or logic contained within a translated text of LQ will function as elements of surprisal, and therefore reading the translated text of LQ will require higher cognitive effort from readers, compared to reading an HQ translation of the same ST. This empirical investigation was guided by four primary research questions addressing four ways in which the effects of translation quality on readers can be observed: their overall text processing effort (RQ1, an effect on cognitive effort at whole-text level), processing effort recorded at sentence level (RQ2, effects on sentence-level cognitive effort), text comprehension accuracy and time taken to respond to comprehension checks (RQ3), as well as readers' willingness to buy the product described in the translated text (RQ4) – see *Article 4* for a more detailed formulation of research questions.

The eye-tracking reception study (see *section 2.2.3* for a detailed description of the study) employed a between-participants design to investigate the impact of *translation quality* on reader's cognitive processing and reception, with 64 Polish (L1) university students, highly proficient in English (L2), assigned to read either an LQ or HQ L1 translation (into Polish) of the same ST in English (a product description of a ceiling fan). The eye-tracking study reported in *Article 4* shares its design, reading task, methods, tools and materials with the exploratory study described in *Article 3*. However, the focus of the investigation shifts to examining translation quality alone (i.e. without combining translation quality and translator's effort). The independent variable entered into the statistical model was *translation quality*, with two levels: an LQ translation containing errors and an (almost) error-free HQ translation. The dependent variables in the study were eye-tracking metrics indexing cognitive effort, including the reader's character-adjusted *dwell time*, character-adjusted *fixation count,* and measures of re-reading (i.e. late-stage processing measures, Rayner 1998) such as *number of runs (passes)*, *re-reading dwell time*, *second- and third-run dwell time.* Dwell time and fixation count were character-adjusted also in the eye-tracking MT studies exploring the effects of MT errors on reader experience (Doherty et al. 2010; Stymne et al. 2012). Alongside eye-tracking variables, behavioural measures of text comprehension (*accuracy scores* from four true-false statements, and *response times*), and *reader's answer* to a question probing intention (a yes-no answer as to the purchase of the described product) were analysed.

The eye-tracking reception study reported in *Article 4* confirmed that an LQ translation imposed a greater cognitive burden on its readers as compared to its HQ counterpart. At the whole-text level (RQ 1), reading the LQ translation required significantly more processing time (evidenced by longer dwell time), yet not more fixations than the HQ translation. The analysis of the three targeted sentences (RQ 2) revealed that different types of errors affect cognitive processing differently. To illustrate, sentences with non-adapted measurement units (i.e. with no cultural adaptation) induced intensive and localised processing, evidenced by strong increases in both dwell time and fixation count. Conversely, a sentence containing a logical error stemming from an incorrect verb aspect did not increase dwell time and fixation count significantly, but instead promoted re-reading, indicating that re-processing and re-analysis for meaning integration was needed. Interestingly, readers' accuracy in text comprehension checks turned out to be unaffected by translation quality (RQ 3) – no global differences emerged in comprehension accuracy scores or response latencies (on comprehension checks) between the groups reading LQ and HQ translations. However, at a local level, the logical error (*sentence 7*) led to significantly longer comprehension response times for that specific sentence. Intriguingly, the non-adapted measurement error in *sentence 8* paradoxically resulted in higher comprehension scores for this sentence among the readers of the LQ translation (vs. HQ translation). This likely suggests that – rather than to confuse the readers (who knew both Polish and English metric systems) – the conspicuous non-adapted unit error made the numerical detail more memorable. Finally, in answer to RQ 4, although translation quality increased reader's cognitive effort, it did not yield a statistically significant effect on the readers' willingness to buy the described product. Yet, a descriptive trend that emerged showed a lower inclination in the group reading the LQ translation (LQ: 30% positive responses vs. HQ: 41.18% positive responses).

The findings of the study reported here demonstrate that translation errors systematically increase reader's cognitive effort, but their effects on text comprehension and readers' intentions are rather nuanced and less straightforward. Cognitive effort levels and comprehension appear to be highly contingent on specific types of errors. In the study, logical errors prompted re-reading and re-analysis (consistent with the 're-viewing for re-processing' hypothesis by Inhoff et al. 2019), whereas the local errors (problems with cultural adaptation) induced rather immediate and intensive cognitive processing.

The conclusions from the study reported in *Article 4* are, however, constrained by several primary limitations. Firstly, the participants consisted exclusively of English language students, whose advanced proficiency (likely) equipped them with more refined cognitive strategies that could have been used to overcome comprehension problems and a higher tolerance for a lack of localisation, cultural non-adaptation, compared to the general population. As a matter of fact, the conclusions from the study may not be fully generalisable to other populations. Secondly, the granular sentence-level analysis in the study was confined to specific error types placed within a single text type (genre: a product description). Hence, the impact of other types of errors, other features of translated text ('translationese' or TUs) than examined in the present study, and in the context of other text genres, remains an open question and direction for future research.

To conclude, the present empirical investigation adopted a multidimensional approach to study the reader experience and overall translation reception. It moved beyond the focus on cognitive effort in reading behaviour, and examined other valuable indicators of translation reception, including text comprehension accuracy and post-reading individual intentions. Such a holistic design and approach has the potential to provide more comprehensive insights into how translations are processed and received.

To build upon the approach developed in *Articles 3 and 4*, the empirical investigation naturally extends to examine not only how the translator's effort and translation quality shape the reading experience and reception, but also how readers' own linguistic profiles, such as proficiency in the ST language (L2 proficiency) and L2 exposure and use, modulate their cognitive effort involved in reading the TT of high and low quality. Individual differences of translators and readers are factored in the following article (*Article 5*), which also tackles the methodological challenges of combining data across the entire translation process-product-reception lifecycle. *Article 5* provides methodological conclusions for the entire cycle of publications which constitute the present PhD thesis.

2.7. Research Article 5 (Tomczak-Łukaszewska 2025): Spotlight on the reader: Methodological challenges in combining translation process, product, and translation reception

The cognitive processes underpinning translation have been extensively mapped through keylogging and eye-tracking, revealing how expertise and effort shape the translation

product (Hvelplund 2011; Muñoz Martín 2014). Concurrently, the "reception turn" in Translation Studies has been shifting scholarly attention towards the reader, acknowledging that the translation's lifecycle is rather incomplete without understanding the audience's experience (cf. Muñoz Martín 2024; Walker 2021b). *Article 5* sides with the recent research trends in CTIS, whose aim is to shift empirical focus toward the recipient: the reader, viewer, and listener (Walker 2019, 2021a). This contribution to CTIS bridges process-, product-, and reception-oriented research to investigate the intricate interplay between the translator's cognitive effort, translation quality, and reader's cognitive effort. Resting on the premise that there is a link between visual attention and information processing (see Just and Carpenter 1980; Rayner and Liversedge 2011), it assumes eye movement measures such as longer fixation durations and longer re-reading may serve as proxies for processing difficulty and higher reader's cognitive effort, which, in turn, can indicate poor text quality (including poor translation quality). As explained and predicted through interactive models of reading, this cognitive effort involved in language processing is modulated by the interaction of bottom-up textual features (including features of the translated language and translation errors) and the reader's top-down cognitive processing which, as documented in reading research, is affected by reader-related factors (including their linguistic background).

The present contribution first addresses several *methodological challenges* involved in combining translation process, product, and reception data. The challenges emerge primarily from the need to accurately define and measure the key translation constructs that are elusive in their nature: *cognitive effort*, *translation quality*, *translation expertise*, and *language proficiency and use*. The choice of appropriate experimental texts, tasks, (indirect) indicators of cognitive effort (metrics) to ensure valid comparisons are also discussed.

Operating in the research niche where studies that combine data across these domains are still scarce, the primary objective of *Article 5* is to investigate the interplay between the translator's cognitive effort, translation quality (high vs. low), and reader linguistic background, along with their effects on the reader's cognitive effort during reception of L2→L1 translations. The study employs eye-tracking methodology to address two primary research questions. RQ 1 examines the interaction of translator's effort, translation quality, and reader linguistic background on reader meaning integration effort. RQ 2 investigates more precisely how readers' proficiency in the source-text language

(their L2: the language from which the translations were done) and the number of years of L2 use participate in this complex relationship. In greater detail, through RQ 1, the study seeks to find out how *translator's effort* (operationalised as the character-adjusted time taken to deliver each target sentence including spaces), *translation quality* (high vs. low), and *reader linguistic background* (proficiency in the source text language and number of years of L2 use) shape readers' meaning integration effort (*dwell time*, *re-reading dwell time*, *number of runs*) during the reception of the L1 whole-text translation. Through RQ 2, it investigates how readers' source-text language proficiency (i.e. in L2) and the number of years of L2 use participate in this complex relationship, testing for a moderating role of translation quality and for a mediating role of reader L2 proficiency in the relationship between the number of years they have used their L2 and their meaning integration effort while reading L1 translations.

This study shares its design, reading task, and methodology with the investigation detailed in *Article 4* and an earlier exploratory investigation reported in *Article 3*, as described in *section 2.2.2*. The statistical analyses were conducted on 63 highly proficient Polish (L1)-English (L2) university students of English reading either a high-quality (HQ) or low-quality (LQ) professional L2→L1 translation of the same ST. The TTs selected for the reading comprehension task were product descriptions, chosen (over expressive texts) to minimise the potential for emotional arousal and engagement.

The analyses revealed a rather intricate relationship between translator production metrics (i.e. translator's effort, TT quality) and translation reception metrics. Regarding RQ 1, a significant interaction effect of *translator's effort* and *translation quality* was observed across all three measures of reader's effort (RQ 1). Readers invested significantly more cognitive effort (indexed by higher character-adjusted dwell time, increased number of runs, higher re-reading dwell time) when reading the LQ translation (vs. HQ translation), but only for those target sentences where the translator's effort was low. This confirms that a low translator's effort often results in inaccuracies or flaws (Gile and Lei 2020) which increase the processing difficulty for the reader. Intriguingly, when translator's effort was high, readers showed higher dwell time and re-reading dwell time only for the HQ TT (vs. LQ TT). This finding emerges only when readers' linguistic background is factored in the analysis, and may suggest that the substantial effort invested by the experienced HQ translator might have led to specific syntactic structures in the TT that were denser or overly complex, unintentionally increasing parsing difficulty and meaning integration

effort. It appears that in such cases translator's high effort did not necessarily reduce the reader's cognitive effort. The study also found that readers' individual *linguistic background* significantly modulates their cognitive effort (RQ 2). The number of years of L2 use was negatively related to reader late-stage processing effort. This indicates that readers with more L2 exposure invested less cognitive effort in the process of reading a translation.

Crucially, L2 proficiency (in the ST language: English) was found to mediate the relationship between L2 years of use and reader's cognitive effort (RQ 2), but only for the LQ translation. For the LQ TT, riddled with translation errors, participants with more years of L2 use exhibited higher L2 proficiency, and their higher L2 proficiency, in turn, significantly correlated with their lower cognitive effort (lower dwell time, fewer runs, lower re-reading dwell time). This finding indicates that high L2 proficiency may act as a facilitating factor. Possibly owing to cross-language activation (Spivey and Marian 1999) and their high proficiency in the ST language, readers were able to infer the intended meaning of the sentence and text, even in the context of translational flaws and despite them. In this way, by lowering the need for strenuous re-processing, the readers circumvented high demands of reading LQ texts. When reading the HQ translation, the level of L2 proficiency did not turn out to matter (at least at the .05 level of significance), suggesting that the compensatory role of L2 proficiency was not required.

This research reinforces the interactive view of translation reception, as shaped by an intricate bidirectional process, where the reader's top-down profile (e.g. L2 proficiency, skills, and expectations) interacts with bottom-up textual features resulting from the translator's cognitive effort and expertise, and the quality of the final product.

Several limitations of the present investigation should be considered. The participants comprised a homogenous group: all university students, highly proficient in their L2 (English), and avid readers. The scope of generalisability of the conclusions from the study is thus limited, and the external validity of the study somewhat compromised and the results are valid only for the participants of comparable profiles. Moreover, using a reading-for-comprehension task in the eye-tracking experiment aimed to ensure careful reading. At the same time, however, it, again, limited the generalisability to natural reading behaviour (i.e. without comprehension checks that follow), lowering the ecological validity of the study. Yet, such comprehension checks are standard procedure in reading research. Lastly, study relied on translations from only two professional translators (varying greatly

in expertise: 3 years vs. 25 years, and in their LexTALE L2 proficiency scores). This suggests that the investigated translation quality may be conflated with the individual profiles, styles, and idiosyncrasies of the translators. Disentangling the unique effect of translation quality from these variables (e.g. translator's unique style), therefore, presents a methodological challenge that limits a more confident attribution of its effects.

To conclude, by bridging the translation process, product, and reception scopes, this research confirms that the cognitive effort that the reader exerts in the reading process is profoundly shaped by the interaction between translator's effort and resulting translation quality. While low quality combined with low translator's effort severely strains the cognitive resources of the reader, excessive effort in the translation that overall turned out to be high-quality, may introduce complexity. That may, in turn, increase reading difficulty. Most importantly, the study highlights the compensatory (or perhaps protective) role of individual differences, showing that the reader's proficiency in the language of the source text can mitigate the challenges and obstacles imposed by low-quality translations. Overall, the findings of the present study may be employed to advocate for integrating the human reader into comprehensive frameworks of translation quality assessment. Yet, taking into account the modulating role of reader-related factors (well-documented in reading research) appears to further complicate the investigation of translation effects.

Part 3: General Discussion

The previous sections of the present PhD thesis provided an overview of the theoretical background and key concepts, rationale behind the studies, main research objectives, and methodologies of the two large-scale studies. The key findings were presented in five research articles related by the theme of cognitive effort of translators and readers of translated texts, with an overarching aim to search for the possible relationships and effects. This aim is further validated by the fact that the products of the translators' effort invested in the translation process (*Articles 1* and *2*) – the translations – were used as materials (i.e. the texts to be read) in the reception study (*Articles 3, 4* and *5*).

The primary aim of the third part of this PhD thesis is to offer a general discussion of the selected key findings on *translator's cognitive effort* (as indexed by keylogging coupled with screen-recording, and eye-tracking) and *reader's cognitive effort* (as indexed by eye-tracking) from all five research articles (*Articles 1–5*), and evaluate them in relation to the research objectives of the entire thesis. The final part addresses the selected limitations that emerge from the entire research cycle submitted as this PhD thesis: from translation process and product to reception (the limitations of each study are already discussed in respective articles). It also overviews methodological considerations and proposes directions for future research.

3.1. Translator's cognitive effort in the translation process

The investigation of translator's cognitive effort in this thesis is situated within the specific context of the Polish-English language pair. This combination of a global lingua franca (English) and a language of low diffusion (Polish) creates a professional environment

where translation is frequently required in both directions. This bidirectional context makes the questions of asymmetry of the translator's cognitive effort between these directions (or *which direction imposes greater cognitive demands, and to what extent)* not only legitimate and highly relevant for understanding the translator's task, but also of practical significance for the translation industry and translation education. The common aim of *Article 1* and *Article 2* was to investigate and establish whether translator's cognitive effort exerted in a translation task is modulated by translation direction and the text type. As part of a larger *EDiT project*, these two investigations provide complementary evidence on how translation directionality and text type affect cognitive effort in professional bidirectional translators working into Polish (L1) and English (L2). By triangulating methods and integrating data from keylogging, eye-tracking, and screen-recording, these two explorations offer a multifaceted view of the cognitive challenges inherent in professional bidirectional translation. While the studies present a common overarching goal, they focused on different aspects related to translator's cognitive effort. While *Article 1* primarily investigated the cognitive effort (in terms of speed and accuracy) involved in translators' process of lexical selection (hence, lexical selection effort), *Article 2* primarily focused on how translators use online resources (OR), framing translators' information-seeking behaviour as one of the components of their overall cognitive effort invested in translation (hence, information searching effort). The key convergent finding across both investigations is that translator's cognitive effort is asymmetrical between the directions: it is higher for the L1→L2 translation. In other words, translating from one's native language (L1) to non-native (L2) was found to be more cognitively taxing than translating from L2 to L1. This aligns with a substantial body of earlier psycho- and neurolinguistic research (e.g. Kroll and Tokowicz 2001; Muñoz et al. 2019). Performance on verbal fluency (VF) tasks (*Article 1*) provides direct evidence showing that even experienced bidirectional translators, with Polish as L1 and high proficiency in English (their L2), have significantly lower category-cued VF in their L2. This may indicate that not only is their L2 mental lexicon less rich but also accessed with more effort (compared to their L1 mental lexicon). This asymmetry manifests in the translation process: L2 translation yielded more lexical errors, particularly in product description texts. This finding resonates with earlier empirical investigations by Buchweitz and Alves (2006) and Ferreira et al. (2018), who also reported that translators experience more difficulty with lexical decisions in the L2 translation. Noteworthy, the L1 translations were also far from being flawless.

Complementing the above-mentioned finding, *Article 2* demonstrates how this lexical uncertainty may drive observable behaviour in translators, pointing to a significantly greater reliance on OR in L2 translation, especially in the drafting phase. As explained and predicted by information-seeking behaviour theories and models (Dervin 1998; Kuhlthau 2008), the more intensive information-seeking behaviour is a (strategic) response to cognitive uncertainty. The need for external support from OR highlights that the L2 mental lexicon tends to have limitations, and thus greater cognitive effort is required to land on an optimal lexical solution. The finding that bilingual online resources were consulted significantly more often in L2 translation supports the lexical selection difficulties reported in *Article 1*. The more complex search patterns (i.e. double and multiple searches with cross-language checks) in the L2 direction (as reported in *Article 2*), reveal increased levels of caution, additionally supporting the assumption about higher cognitive uncertainty when translating into the weaker (non-dominant) language. The more intensive and complex searches require more time and therefore add to larger cognitive effort in the L2 direction. This pattern also emerges in studies exploring L2 writing strategies (e.g. Manchón et al. 2007), where writers also focus intensely on refining lexical items so that these become more appropriate.

Another complementary finding across *Article 1* and *Article 2* is an interaction effect of translation directionality and text type. Both empirical investigations found that translating product descriptions made the directionally effects more pronounced. *Article 1* showed that more lexical corrections occurred in L2 translation of product description. Likewise, *Article 2* revealed the highest number of searches in OR was performed during translation exactly for the same combination (i.e. product description in L2 translation). This may suggest that text-specific demands additionally intensify and exacerbate the cognitive effort involved in L2 translation, possibly because an error in terminology is perceived as very costly. To mitigate the risk of making a terminological error, translators purposefully engage in more extensive searches in OR.

Yet, the two empirical investigations also present contrasting findings. The most intriguing finding concerns online lexical changes. Contrary to what might be expected – given the higher rate of unsuccessful lexical choices in L2 translation – *Article 1* found that translators made significantly more online changes to their initial lexical choices during the drafting phase when they were translating from L2 to L1. This can be perceived through the lens of spreading activation theory of semantic processing, and more specifically through

semantic competition (Collins and Loftus 1975; McNamara 2005). In the case of L1 translation, the L1 mental lexical (richer than L2 mental lexicon) activates a large pool (cohort) of semantic competitors including near synonyms (Edmonds and Hirst 2002). Being "spoilt for choice", translators produce a higher number of online lexical changes to refine their initial choices. This also results in more time and effort needed to make decisions during drafting. This also could be the reason that in terms of time needed to translate in both directions there were no significant differences. In contrast, the smaller L2 mental lexicon offers fewer semantic competitors. This results in fewer online lexical changes; however, as noted in *Article 1*, a higher number of these unrefined choices were ultimately suboptimal. This specific finding can be interpreted through the prism of Halverson's (2017) *Gravitational Pull Hypothesis*: an automatic and often incorrect lexical selection in L2 may be driven by the salience of a direct translation equivalent of that word in the source text. Although most salient in the source language, the equivalent is not equally salient in L2, and not appropriate in a given context, which might have been noticed if a more effortful search had been performed.

Finally, both investigations contribute to the discussion on the relationship between *translation expertise* and *translation quality*, assumed in research and practice (Gough 2019). Despite their extensive experience in the translation profession, the translators exhibited a clear L2 (cognitive) disadvantage – the finding corroborating Chmiel's (2018) research results on interpreters, revealing that professional experience does not necessarily override asymmetries in language dominance. Yet, the translators' expertise emerged and was clear in their efficient use of online resources. Investigation in *Article 2* found a moderate negative correlation between time spent in OR and the time proofreaders required to correct each translation, suggesting that the translators' information-seeking behaviour, to an extent, was effective. Moreover, *Article 1* revealed the lack of significant changes in lexical decisions in the revision phase and more intensive refining during drafting (even if not always perfectly accurate). Interestingly, all participants were professional translators, and their all translations required corrections by external proofreaders to be publishable. While their translation expertise is evident in efficient translation process, it does not eliminate the need for revision. This finding underscores that translation expertise rather entails effective workflow management than perfect, flawless output.

In conclusion, the converging and complementary evidence from the two discussed empirical investigations within the TPR paints a coherent picture. Compared to L1

translation, it appears that translating into L2 is more cognitively demanding at the lexical level, which leads to greater cognitive uncertainty in bidirectional translators (even those very experienced), more intensive use of online resources, a higher error rate – especially in texts that are more technical (such as product descriptions). These effects show despite the translators' high levels of professional expertise. The compelling conclusion that emerges from both investigations is that translation process is shaped by the intricate interplay of translation direction, text type, and the translator's asymmetrical proficiency in their working languages. The interplay of these factors results in the end product – translated texts of varying quality, irrespective of the translation direction. Without proofreading and revision to filter out errors such texts are likely to be challenging to process by the target readers. This is precisely what is tested in the reception study.

3.2. Reader's cognitive effort in the translation reception

For Polish readers, engaging with translated texts is a routine part of cultural and informational life. It is not an exception but the norm. A substantial proportion of the published materials available in Poland, from literature, news, and film subtitles to technical manuals are predominantly 'consumed' in translation (in Polish – a language of low diffusion), primarily from a global lingua franca (English). This makes the Polish context particularly relevant for studying how translated texts are cognitively received.

This section synthesises findings from a series of investigations into translation reception (*Articles 3, 4 and 5*) that share a common overarching research goal and common methodological framework. They all aim to provide valuable insights into the cognitive experience of the actual recipient and end-user of translated texts (i.e. the reader) – an area largely unaddressed empirically (Kruger and Kruger 2017; Walker 2021a). In parallel, they all aim to bridge the field of TPR and the emerging field of translation reception studies.

Article 3 acts as the methodological bridge between the translation process-and-product study and the translation reception study. It introduces an innovative approach of correlating translation process data with the reader's eye-tracking data. Such an integrative approach makes it possible to trace and compare the effects of cognitive effort exerted in translation onto the cognitive effort experienced by the readers of translated texts. The line of empirical investigation launched in *Article 3* is extended in *Article 4*, which spotlights

translation quality assumed to be related to the translator's effort. It specifically examines the impact of translation errors on translation reception, primarily through the lens of the reading process and text comprehension. *Article 5* introduces additional statistical models that allow for integrating the reader linguistic profile into the picture of translation reception that has emerged from *Articles 3 and 4*. The statistical models tested in the study factored in readers' proficiency in the source-text language (L2: English) and readers' number of years of L2 use. The study reports on the outcome of testing the moderated mediation model to explore the relationship between L2 use and eye-tracked reader's cognitive effort as moderated by translation quality and mediated by L2 proficiency. The final *Article 5* completes the entire *translation process-product-reception* research trajectory, and contains an overview of methodological challenges involved in combining the three scopes.

The key finding that emerges across all three investigations is that translation quality affects the reader's cognitive effort: the LQ translation consistently required significantly more cognitive effort from its readers, as evidenced primarily by longer (character-adjusted) dwell time (cf. RQ1 in all articles). This aligns with the coherence assumption in reading research (e.g. Graesser et al. 2004), which posits that when errors and other inconsistencies disrupt the reading process (Hessel and Schroeder 2022; Stafura and Perfetti 2017), readers struggle to build a coherent mental model of the text (Kintsch 1998). As a result, they invest more effort into re-reading: metacognitive comprehension-monitoring mechanisms are triggered (van den Broek et al. 1995), which, in turn, activates processes of re-analysis attempting to resolve comprehension difficulties (see Tibken and Tiffin-Richards 2025), leading to more re-reading, as captured by the late-stage processing eye-tracking measures (Inhoff et al. 2019; Rayner 1998). This finding may be taken as evidence that translation quality is indeed visible in the eyes of the readers – their eye-movement behaviour has been observed to be modulated by low-quality features of the translated text such as errors.

A more fine-grained analysis reveals that the cognitive strain imposed on readers by low translation quality is not uniform. *Article 4* demonstrates that, while reading, different types of errors induce different eye movement behaviour taken as proxies for reader's cognitive effort. As a case in point, the error that disrupted logic (e.g. contradictory instructions to turn on the fan when leaving the room in *sentence 7*) prompted intense local processing effort, indexed by higher dwell time percentage, more fixations to the

problematic sentence (AOI), and its frequent re-reading (a higher number of runs). Higher values of these eye-tracking metrics here are, again, interpreted as a sign of a failure in meaning integration, where comprehension-monitoring processes force the reader to re-analyse the problematic text or take more time integrating the meaning (Inhoff et al. 2019). Conversely, errors in cultural adaptation (e.g. unit conversion failures in *sentence 4* and *sentence 8*) increased overall processing time of the problematic sentence but did not consistently induce the same level of re-reading as in the illogical sentence. This complementary finding suggests that the cognitive strain imposed on readers by an error is an effect of an interaction between the error type and reader-specific factors which help to overcome confusion and perhaps even "surprisal" (Wilcox et al. 2023) it generates for the reader.

The relationship between translator's effort and translation quality is not straightforward, yielding a significant interaction effect of translator's effort and translation quality on the reader's cognitive effort (*Article 5*). This means that the effect of the translator's effort on the reader's experience is more nuanced as it turns out to be significantly moderated by translation quality. Readers exert higher cognitive effort (indexed as more dwell time, more runs and re-reading) into reading only those LQ sentences which had been produced with low translator's effort (i.e. fast, unrevised translation). It can thus be interpreted that a lack of due diligence in the translation process (in the present studies revealed as fast production of translations: leaving them unrevised and unrefined) yields translations that are most cognitively taxing for the readers. This complements the findings of Kruger (2013) and Walker (2021b) who also through eye-tracking showed how specific decisions on the part of the translator (e.g. foreignisation) affect local processing. The study extends these findings by studying non-literary functional texts linking the effects of errors on the reading process to the translator's effort recorded during the translation process. The LQ translation might stem from a combination of lower cognitive effort invested in translation and the translator's individual profile (considerably less professional experience, and lower L2 proficiency as indexed by the LexTALE score), both contributing to the observed increase in reader's effort.

Noteworthy, to select an HQ and LQ translation (produced in the translation process-and-product study) to test their effects on reading experience in the reception study, the criterion followed was the number of errors (based on corrections made by the expert proofreaders). Only after recovering the process data and the profiles of professional

translators, the additional information about the translators' professional years of experience and their LexTALE scores proved useful to explain the differences in translation quality and levels of exerted cognitive effort. Interestingly, for the HQ translation, the increased translator's effort turned out to be linked to the increased reader's effort, possibly because the experienced translator produced more syntactically complex, albeit accurate and judged adequate for the source text, sentences. In a way, the most likely interpretation is that the complexity of some parts of the ST required the translator to work harder to successfully create an equivalent effect on the readers and that is why the complexity was reflected in the end product (TT). The translator who produced the HQ translation was probably consistent in adjusting cognitive effort to the task demands. The translator who produced the LQ translation was probably less consistent. Therefore, this nuanced interplay reveals that in the context of an LQ translation, higher translator's effort benefited the reader, but lower effort did not, a finding that resonates with research on translation expertise (e.g. Dragsted 2010; Hvelplund 2011).

Finally, the role of the reader's individual differences, a research avenue explored in *Article 5*, adds an additional crucial layer to the picture of translation reception studies. The computed statistical models extended the previous findings by integrating readers' linguistic profiles into the investigative framework. The analyses confirmed that a diligent process of translation yields an HQ end product, and this, in turn, promotes overall a less effortful and thus more fluent reading experience. The very finding that a reader's higher proficiency in the ST language (i.e. higher L2 proficiency, English) mediated reader's cognitive effort, but only for the LQ translation, is highly revealing and intriguing. It suggests that being a very proficient speaker of the language from which the text was translated (the ST), may act as a compensatory mechanism, helping readers to disambiguate confusing areas in the target text by implicitly activating the language of the source text (along with its conventions, lexical and syntactic patterns, etc.). This aligns with psycholinguistic research on cross-language activation (e.g. Spivey and Marian 1999) and underscores that translation reception is not a uniform process but is rather filtered through the reader's own background (including the linguistic background). This result also complements the previous findings on the influence of translator's profile (verbal fluency and language dominance) on translator's cognitive effort involved in translating whole texts in both translation directions, reported in *Article 1*. It shows that both the translation

producer's and translation receiver's expertise and language background are integral to the translation reception process.

An important caveat emerged from standard readability metrics: while all three investigations (*Articles 3, 4 and 5*) corroborate that the LQ translation required significantly more cognitive effort from its readers, according to readability metrics, the HQ translation exhibited greater complexity (a higher Gunning Fog Index). This finding is pivotal as it indicates that standard readability formulas, evaluating surface-level features (e.g. word, sentence length) and frequently used for assessment of whole texts, are insufficient for predicting processing difficulty in reading when text quality is compromised by translation errors.

In conclusion, the complementary evidence from the three investigations devoted to the process of translation reception supports the assumption that translation quality is a critical predictor of reader's cognitive effort. The three articles shift the focus beyond the process-and product-oriented view, showing that the ultimate validation of how successful a translation of a functional text (product description) is lies in the ease with which it can be read and received. The present findings confirm that inconsistencies and errors (such as problems with cultural adaptation and logic) force the readers to work harder to comprehend the text through more effortful re-processing, re-analysis, and meaning integration. While the relationship between the translator's effort and reader's effort is moderated by translation quality, the results of the studies give a strong support to the assumption that a diligent and careful translation process resulting in high-quality final product (the TT) promotes overall less effortful and thus more fluent reading experience.

Building on this foundation, future studies could definitely explore a wide range of text types, error typologies, as well as reader profiles to find out more about the complex cognitive dialogue between the three voices: the translator, the translated text, and its reader.

3.3. Evaluating translator's keystrokes in readers' eye movements: Bridging the gap

The initial pragmatically-charged questions that inspired research trajectory outlined in this PhD thesis have been the questions of whether the translator's effort put into a translation process helps the reader to process and receive the translated text and; whether the process

of reading of the end product of the translation process can serve as a means of evaluating its translation quality and as the proof of the translation process in itself. This trajectory, metaphorically framed as tracing and evaluating translator's keystrokes in readers' eye movements, foregrounds the connection between the challenges inherent in producing a translation and their tangible consequences for the end-user. Just as tiny keystrokes may have larger effects on translation quality of the TT, seemingly minor errors or disfluencies in TTs may amplify into processing difficulty, considerably distorting reading experience and fluency and/or hindering the TT's reception (e.g. inaccurate text comprehension).

The findings suggest that the translator's keystrokes and pauses during the translation process are often the physical traces of a more laborious, elongated path to lexical selection, resolving uncertainty, and problem-solving. Lower translator's effort, along with lower translator's experience and translation expertise may converge to compromise the quality of the TT – as TTs requiring more extensive proofreaders' corrections are likely to be produced with less (overall) time and minimal end-revision (see *Articles 3 and 4*). This lack of due diligence on the part of a translator allows for translation errors to creep in. In the analysed TTs in the present PhD thesis, these translation errors range from logical inconsistencies, lexical errors, inaccuracies, to failures in cultural adaptation. The resulting text thus possesses the features of translated language that may possibly hinder and disrupt the reading experience, fluency, and overall translation reception (see *Article 4*). In a sense, the translation product becomes the physical output that carries forward the unresolved difficulties and problems from the translation production phase to the reading experience and reception phase.

Eventually, the proof of the translation process is found in the reading experience of the TT, where advanced eye-tracking methodology offers a peek into the reader's cognitive effort. Readers quite consistently exert more cognitive effort to process and understand the LQ translation (vs. HQ), evidenced by longer character-adjusted dwell times on the text. At a more fine-grained, micro-level analysis, it appears that LQ sentences containing specific errors (problems with logic or cultural adaptation) trigger increased cognitive processing, reflected in the increased re-reading as readers struggle to integrate confusing or even contradictory information (*Articles 3 and 4*). This corroborates the pattern of results obtained in the studies investigating the processing and meaning integration while reading whole texts containing translation errors (including incorrect words) in human and MT translation output (see Stymne et al. 2012) and inconsistencies (e.g. Tibken and Tiffin-

Richards 2025). It also appears that the relationship between the translator's effort and the reader's subsequent cognitive effort is complex and contingent on its product's final translation quality. A key finding of this project is an interaction effect between the translator's cognitive effort and translation quality. It reveals a compensatory dynamic: in the case of LQ translation, lower translator's effort per sentence correlates with higher reader's effort for processing it. Conversely, for the HQ translation, higher translator's effort turns out to correlate with higher reader's effort, possibly due to the more complex (though still accurate) structure of the translated sentences (see *Article 3 and 5*). This may suggest that what promotes fluent reading is not translator's cognitive effort per se, but rather effort that results in a coherent and accurate text – in other words, more effective effort. Furthermore, a reader's individual profile, such as higher proficiency in the source language (L2), can lower the amount of cognitive effort required for reading a low-quality translation, acting as another compensatory mechanism for making sense out of poor translation quality.

The findings from *Articles 3, 4 and* 5 in this thesis show that the interplay of factors affecting the reader's cognitive effort is far from straightforward. For instance, a high-quality translation may contain complex syntax yet be processed fluently, while a low-quality translation with simpler syntax may demand high effort due to translation errors (see *Article 4* for a discussion of readability metrics and their potential to predict processing effort). Similarly, a difficult text-level feature (e.g. a HT error in L2→L1 translation) may not significantly impact a highly L2 proficient reader, whose high L2 proficiency may compensate for translational shortcomings and thus attenuate the cost of reading a suboptimal translation, while it may severely disrupt processing for another reader. This finding underscores the need to consider both text-related and key reader variables (and interaction thereof), and assessing, measuring, and possibly controlling for both in experimental designs of translation reception research.

In conclusion, tracing the whole path and 'lifecycle' of the translated text, from the translator's keystrokes and pauses to readers' eye movements, reveals how cognitive effort is managed in both highly complex processes. The inherent difficulties of the translation process and the strategic, effortful information behaviour they induce (e.g. frequent consultations in OR) shape the translation quality of the final product. The quality of this product, in turn, regulates the cognitive costs of reception for the reader. This empirical link validates the tested assumption that the reader's eye movements are a faithful, (indirectly)

measurable record of the success (or failure) of the translator's earlier decisions and problem-solving processes. Bridging these three scopes (process, product, reception data) not only enriches our theoretical understanding of the transition process (i.e. mediated communication), but also highlights the importance of translation quality, along with professional translation diligence, for an effective mediated communication process (Halverson and Muñoz Martín 2020).

The research trajectory traced here, from the translator's cognitive effort involved in the processes of lexical selection and information-seeking, to the reader's cognitive effort reflected in their reading behaviour, reading experience, and translation reception in their native language, offers a powerful lens on translation quality. While the integration of keylogging and eye-tracking data collected across two projects provides valuable insights about the translator-to-reader cognitive path, the methodological choices and designs of the reported studies inevitably delineate the boundaries of these findings. The following section, therefore, critically examines the inherent limitations of the conducted studies, the methodological considerations that shape (and limit) their interpretations, and the promising avenues these insights open for future empirical work.

3.4. Limitations, methodological considerations, and future research directions

The studies that comprise the present PhD thesis are not without limitations. The following paragraphs present and discuss several limitations of the conducted translation process-and-product study and translation reception studies. These limitations are used to highlight directions for future research in the overlapping area.

The translation process-and-product study (*Articles 1 and 2*), while providing valuable empirical insights into the asymmetry in cognitive effort in bidirectional translation, is inevitably bounded by several limitations. One of the constraints arises immediately from the methodological framework, which is anchored to a single language pair: Polish as L1 and English as L2. This specific combination (a language of low-diffusion and a global lingua franca), while chosen intentionally to match the needs of the translation industry and the readership in Poland, restricts the generalisation and applicability of the findings on lexical selection and information-seeking behaviour to other language pairs, particularly those with comparable diffusion. Moreover, to enable a more

in-depth investigation of how the professional translators invest their cognitive effort while translating, the very scope of analysis was deliberately focused on lexical selection and the use of online resources (investigated while translating two specific text types: product description and film review). The very detailed (and most laborious) qualitative analyses of the lexical choices (*Article 1*, RQ 4 and 5) were performed only for product description texts. All this, as a decision and methodological trade-off, offers a deep but relatively narrow view of the cognitive effort distribution in the translation process. Also, the operationalisation of translation quality through corrections and revision time from two expert proofreaders and one accuracy evaluator, provides a practical yet relatively limited metric based on a deficit-oriented model of error detection. Common in product-oriented research as it is, when used in future studies, this method could benefit from a greater number of expert judges to mitigate any individual styles or biases in evaluation, and supplementing this approach with an additional TQA method (corpus-based analysis or detailed rubric scoring) to capture more nuanced aspects of functional adequacy and readers' reception. Finally, as with most experimental lab-based studies, the controlled setup (though necessary for data collection through keylogging and eye-tracking and for maintaining high internal validity), even with access to OR enabled, may still not fully reflect the dynamics of how the professional bidirectional translators exert their cognitive effort across the translation task when they work in their natural workspace (e.g. with more personalised tools).

In the translation reception studies, the experimental focus on L1 translation reception reflects the most common real-world scenario for readers in Poland (a low-diffusion language market). Polish translators routinely work bidirectionally, yet the published texts the public consumes are predominantly translated into Polish (L1). Studying the reception of these L1 translations therefore ensures high ecological validity and yields findings with direct practical implications for the local readership and translation industry. Nevertheless, the exclusive focus on L1 translation reception alone leaves a research gap: an unexplored relationship between a translator's decision-making processes in L2 translation and readers' cognitive processing of L2 end products. Investigating this relationship emerges as a necessary next step, precisely because prior research has established a clear 'L2 cognitive disadvantage' (Muñoz et al. 2019). *Articles 1 and 2* reveals lexical selection and information-seeking to be processes that are more effortful and less successful (more vocabulary errors in the TT) when translating into L2 than into L1.

To address this research gap, future research could pursue two key directions. First, to investigate the consequences of the 'L2 cognitive disadvantage' for readers, the follow-up studies could employ the existing whole-text L2 translations (e.g. from *the EDiT project*). Testing the same hypotheses about the effects of translator's cognitive effort and translation quality on the reader's cognitive effort with two distinct reader groups (Polish users of English as highly proficient L2 readers, and native English speakers as readers of the TT in their L1) would yield crucial comparative data. This design would also isolate how readers' language status modulates the reception of texts born from a more cognitively effortful translation process.

A second, related limitation concerns the text type used in the discussed reception studies. Advancing this research agenda requires testing its hypotheses with more expressive text types (e.g. film reviews, literary excerpts) to move beyond the functional product descriptions analysed thus far. For such texts, the theoretical framework must expand further to include reader variables such as their empathy level and narrative engagement (see Walker 2021a, 2021b). Collecting and analysing this participant profile data would considerably advance our understanding of how individual differences shape the reception of translated literary and expressive texts.

Another limitation of the conducted translation reception studies stems from the focus on specific error categories, namely problems with logic and failures in cultural adaptation. While this targeted approach successfully demonstrates how these particular flaws disrupt reading experience and comprehension monitoring, it necessarily excludes a broader spectrum of translation errors that may influence translation reception. What remains unexamined are other problematic issues, such as subtle stylistic flaws, syntactic awkwardness, register mismatches, or the consequences of translation universals (e.g. explicitation and simplification). Consequently, the current findings offer a detailed but partial map of how translation quality may shape the reader experience. Future research employing a more comprehensive error taxonomy, potentially combined with comparing the reception of translated texts before and after proofreaders' corrections, would provide a more holistic understanding of the weights various error types carry in modulating reader's cognitive effort and reception.

The readers were possibly not the ideal audience for the text type chosen (a ceiling fan description) but were instead young, academically-oriented, and bilingual (highly proficient in both Polish and English). Data collection took place over the autumn-winter

season in Poland, a seasonal context that might have made the hypothetical purchase decision less relevant and less engaging for participants (see Kaakinen et al. 2003). The participants' high L2 proficiency means that they could potentially rely on the source language if dissatisfied with the translation, which is not an option for a monolingual end-user. This naturally limits the ecological validity of the study, as the measured reading experience and post-reading responses may not accurately reflect those of the text's genuine target audience (consumers) in a real-world setting.

To increase the ecological validity of the reception study, future research avenues and designs should prioritise recruiting participants who represent the genuine target audience of the translated text, including potential consumers for the described product. Where relevant and possible, studies should focus on monolingual readers to eliminate the potential confounding of access to ST (through L2), thereby more accurately simulating real-world translation reception conditions. Yet, finding truly monolingual participants, that is those who have no command of English might be challenging since English is taught in Poland from the kindergarten now.

A critical methodological consideration for both translation process and reception studies involves the interpretation of eye-tracking data. The landmark "eye-mind hypothesis" (Just and Carpenter 1980), which posits a link between visual attention and information processing, offers a compelling but ultimately simplified model (see Walker 2021a) that could be used as a useful heuristic rather than an unquestionable premise. Its application to the complex tasks of reading whole-text translations requires caution, since attention allocation can be influenced by a plethora of individual top-down (expectations, prior knowledge, strategies, reading skills, to name but a handful) and more bottom-up (e.g. perceptual) factors not directly tied to the central language processing task. Rather than a single, easy-to-isolate cognitive operation, the observed pattern of fixations may index a confluence of processes, including perceptual decoding, lexical access, meaning integration and coherence building, arousal, and even distraction. This interpretive challenge highlights that eye-tracking research, especially in TPR, is "a rather complex field (…) not only because of the number of participants in this sort of experiment but also because eye fixations tend to vary among subjects" (Ferreira et al. 2016: 63) due to individual differences in reading style and strategy, cognitive style, and oculomotor control, to name but a handful. Therefore, in reception studies eye-tracking metrics serve as powerful but relatively noisy proxies for cognitive processing, ones that benefit from triangulation with

complementary data sources such as retrospective protocols or comprehension responses, and from rigorous statistical modelling to draw valid inferences about the underlying cognitive processes.

Conclusion

The present PhD thesis rests on the premise that a comprehensive understanding of the translation process requires looking beyond the process to encompass its outcome (product) and its reception. The cognitive effort is conceptualised as the unifying thread that connects the translator's decisions to the reader's experience. The five *Research Articles*, informed by theoretical underpinning from CTIS, TPR, cognitive psychology, psycholinguistics, models of reading and information processing, and powered by triangulated methodology, argue for adopting an integrative paradigm in Translation Studies. Each study builds upon the previous one to create a comprehensive whole.

This thesis presents a novel, integrated investigation designed to connect translation process, product, and reception. The novelty of the thesis lies in its first-of-its-kind approach that integrates the three domains – translator's cognitive effort (process data), the quality of the translated text (product data), and the reader's experience and reception (reception data) – within a unified empirical framework.

Empirical evidence from the translation process-and-product and reception studies comprising the present thesis indicates that the cognitive effort of professional bidirectional translators invested in the translation process – shaped by factors such as directionality and text type – reflects in the quality of the translated text, which, in turn, modulates the cognitive effort exerted by its readers. In broad terms, the adopted research trajectory helps to demonstrate that translator's decisions at the stage of the translation process have tangible consequences that 'ripple through' to the translation end product, shape its translation quality, and, finally, affect the cognitive cost of reading and receiving a translated text. The emphasis here is not merely on how translators perform their work, but rather on how their work may benefit the reader.

By implementing more than one methodology to collect data on translation process, end product quality, and reader experience and reception, the studies reported in the present PhD thesis offer convergent and complementary findings that spotlight the complex nature of the relationship between translation production effort and translation reception effort. By adopting this triangulated and integrative approach, this thesis aims to provide a holistic, and, at the same time, empirically grounded account of translation as a mediated communication process (cf. Halverson and Muñoz Martín 2020) or simply as a communicative act.

Abstract

Translation is a complex cognitive act aimed at producing a functionally effective text for its readers (Chesterman 1998; Shreve 2009). Over the past decades, *Translation Process Research* has focused on the *cognitive effort* that translators invest in transforming a source text into a target text (Alves 2015; Jakobsen 2014; Kruger 2016). To gauge *cognitive effort*, understood as the amount of mental resources exerted in performing a translation task (Hunziker Heeb 2020; Hvelplund 2011), researchers have used advanced methodologies such as keylogging and eye-tracking. In parallel, product-oriented studies have focused on analysing the features and quality of translated texts (Baker 1993; Koby et al. 2014), also in relation to translation process data and metrics that serve as a proxy for cognitive effort (Dragsted 2012; Whyatt 2019). While profound insights have been gained into both the translator's cognitive effort and translation quality of the product, the reception of the translated text by the reader has been theoretically assumed rather than empirically tested (Kruger and Kruger 2017; Walker 2021a). A crucial link has been missing in this equation: empirical evidence of whether, and how, the translation process and the quality of the product affect the way readers read and receive the translated text (Kruger and Kruger 2017; Walker 2021a). An empirical gap thus persists in understanding whether, and how, the translator's cognitive effort and the resulting translation quality affect the reader's cognitive effort put into the process of reading and receiving translated texts (*translation reception*). This highlights the need for developing an integrated approach that empirically connects the domains of translation process, product, and reception.

To address this research gap, the primary aim of the present PhD project is to investigate whether and how the translator's cognitive effort invested in the whole-text translation process, and the resulting quality of that translated text, affect the cognitive

effort readers exert when reading that translation. To this end, this PhD thesis proposes a novel, integrated research trajectory that bridges the empirical domains of translation process, product, and reception within a unified conceptual and methodological framework. The thesis rests on **two complementary experimental studies** carried out to trace cognitive effort in translation production and reception. First, the **translation process-and-product study** examined the *cognitive effort* of professional bidirectional translators (Polish L1, English L2). To examine the cognitive effort during the translation of whole texts in both directions (L1→L2 and L2→L1), two process-oriented methods were applied: *keylogging* and *eye-tracking*. Then, the **translation reception study** used eye-tracking to examine the *cognitive effort* of readers who were native speaker of Polish (the target language of the translation) with high proficiency in the source language (L2 English) of the translated text. The primary focus of the investigation and analysis centred primarily on their *cognitive effort* as they read the whole-text translations of high and low quality produced into their L1 in the first study.

The results of the studies were reported across five constituent *Research Articles* investigating the cognitive effort of the translators and of the readers. ***Article 1*** (Tomczak and Whyatt 2022) established the linguistic profile of professional bidirectional translators (their language dominance and L2 proficiency) and focused on their cognitive effort during the process of lexical selection (i.e., the process of selecting the word which, in the translator's judgment, best conveys the meaning of a word from the source text; *lexical selection effort*) and the quality of their lexical choices. The findings showed a pronounced asymmetry dependent on translation direction and text type: lexical selection was cognitively more demanding and less successful in L1→L2 translation, in particular for more descriptive (*product descriptions*) than expressive texts (*film reviews*), as evidenced by lower verbal fluency scores in L2, more frequent (and automatically produced) vocabulary errors, and a greater reliance on online resources (OR) in this direction (longer and more frequent use of OR), confirming the L2 cognitive disadvantage.

Building on this, ***Article 2*** (Whyatt, Witczak, and Tomczak 2021) zoomed in on the translators' cognitive effort associated with their information-seeking behaviour. It found that consulting OR is itself a cognitively taxing process (*information searching effort*), significantly increasing overall task duration and translators' average fixation durations, taken as proxies for cognitive effort, particularly for more descriptive texts (vs. expressive). Crucially, this cognitive effort was modulated by directionality and text type: translators

performed significantly more OR searches, including more complex, cross-linguistic checks, and consulted bilingual resources more often when working into their L2, particularly for descriptive texts. This may indicate that resolving uncertainty in the weaker language requires greater cognitive effort.

Having investigated the translators' cognitive effort, this thesis advanced towards its main integrative objective. The foundation laid by *Articles 1 and 2* set the stage for the thesis's turn towards translation reception and reader experience. ***Article 3*** (Whyatt, Witczak, Tomczak-Łukaszewska, and Lehka-Paul 2023) served as a methodological bridge, pioneering the integration of translators' keylogging data from the *translation process*, assessed translation quality data (*product*) with eye-tracking data from readers of those same translations (*reception*). The reported exploratory study found no straightforward relationship between the translator's cognitive effort and the reader's cognitive effort. However, it revealed that translation quality significantly affected the reading experience: readers exhibited increased cognitive effort (longer *dwell time*) when reading a low-quality (LQ) translation compared to a high-quality (HQ) one. ***Article 4*** (Whyatt, Tomczak-Łukaszewska, Witczak, and Lehka-Paul 2025) extended these results with more participants, confirming that readers had to work harder (longer *dwell time*) to understand an LQ translation containing translation errors. A fine-grained analysis showed that different error types (e.g. logical inconsistencies vs. lack of cultural adaptation) elicited distinct patterns of increased processing effort during reading for comprehension.

Finally, ***Article 5*** (Tomczak-Łukaszewska 2025) introduced the dimension of reader-specific factors into the interplay. The analyses reveal that the reader's linguistic profile, particularly more years of using the source language (L2 English), was associated with lower cognitive effort during the reading of a translation into their native language (L1 Polish). Furthermore, it revealed a significant interaction between the translator's cognitive effort and translation quality in shaping the reader's experience: readers exerted more cognitive effort while reading the translation containing errors (LQ) when the translator's effort was low, whereas for the HQ translation, higher translator's cognitive effort led to the increased reader's cognitive effort, possibly due to more complex syntax reflecting the complexity of the ST. Additional moderated mediation analyses carried out to further explore the relationships between the reader's linguistic profile and their cognitive effort during reading a translated text revealed that a reader's proficiency in the source language (their L2) mediated the relationship between their number of years of L2 use and cognitive

effort during the reading of the translated text, but only when the translation was of low quality (LQ). This may suggest a compensatory effect: higher proficiency in the source language may mitigate the processing difficulty of reading a suboptimal translated text, partially compensating for flawed translation quality. The finding underscores that individual reader characteristics fundamentally affect the reception of translated texts, thereby corroborating the assumed interaction between text and reader (Kruger and Kruger 2017). The reader's cognitive effort during translation reception is thus not determined solely by text and its features, but arises from a complex interplay between translation quality, the translator's invested cognitive effort, and the reader's individual resources, including their linguistic profile.

All in all, the findings of this PhD project offer novel, evidence-based insights into the intricate interplay and relationships between translation production and reception. They show that the cognitive effort invested during whole-text translation and the quality of the resultant product are indeed reflected in the reader's cognitive effort, but this relationship is complex and dependent on the type of error and the reader's own linguistic background. By empirically integrating data from process, product, and reception, this thesis moves beyond studying these domains in isolation and provides a unified framework for understanding how the translator's cognitive effort and decisions ultimately shape and resonate with the reader's experience. It thereby demonstrates the value of an integrated approach for obtaining a fuller picture of mediated communication in Translation Studies.

Streszczenie

Tłumaczenie jest złożonym procesem poznawczym, którego celem jest stworzenie funkcjonalnie efektywnego tekstu dla jego odbiorców (Chesterman 1998; Shreve 2009). Na przestrzeni ostatnich dekad badania nad procesem przekładu (*Translation Process Research*) koncentrowały się na wysiłku poznawczym (*cognitive effort*) wkładanym przez tłumaczy pisemnych w przetworzenie tekstu źródłowego (oryginału) w tekst docelowy (Alves 2015; Jakobsen 2014; Kruger 2016). Wysiłek ten rozumiany jest jako ogół zasobów mentalnych angażowanych w wykonanie zadania tłumaczeniowego (Hunziker Heeb 2020; Hvelplund 2011). Do jego pomiaru korzystano m.in. z zaawansowanych metodologii, takich jak rejestracja aktywności tłumaczy na klawiaturze (*keylogging*) i śledzenie ruchu gałek ocznych (*okulografia*, *eye-tracking*). Równolegle, badania zorientowane na produkt tłumaczenia analizowały cechy i jakość tekstów przetłumaczonych (Baker 1993; Koby i in. 2014), również w odniesieniu do danych z procesu tłumaczenia jako przybliżonych wskaźników wysiłku poznawczego (Dragsted 2012; Whyatt i in. 2018). Uzyskano w ten sposób pogłębioną wiedzę o wysiłku poznawczym tłumacza i jakości stworzonego w wyniku procesu przekładu produktu tłumaczenia. Recepcja przetłumaczonego tekstu przez czytelnika pozostawała jednak głównie przedmiotem rozważań i założeń teoretycznych aniżeli badań empirycznych (Kruger i Kruger 2017; Walker 2021a). Brakuje zatem empirycznych dowodów na to, czy i w jaki sposób proces tłumaczenia oraz jakość przekładu wpływają na proces czytania i odbioru tegoż przekładu (Kruger i Kruger 2017; Walker 2021a). Luka ta dotyczy zwłaszcza zrozumienia, czy i jak wysiłek poznawczy tłumacza oraz wynikająca z niego jakość przekładu wpływają na wysiłek poznawczy czytelnika włożony w proces czytania i odbioru tekstów przetłumaczonych (*translation*

reception). Wypełnienie tej luki badawczej wymaga wypracowania zintegrowanego podejścia, które empirycznie połączy obszary procesu, produktu i recepcji przekładu.

Głównym celem niniejszego projektu doktorskiego jest zatem zbadanie, czy i jak wysiłek poznawczy tłumacza zainwestowany w proces tłumaczenia tekstu oraz wynikająca z tego procesu jakość przekładu wpływają na wysiłek poznawczy, jaki czytelnicy wkładają w lekturę tegoż przekładu. W odpowiedzi na to pytanie niniejsza rozprawa doktorska proponuje nową, zintegrowaną ścieżkę badawczą. Jej istotą jest połączenie empirycznych perspektyw procesu, produktu i recepcji tłumaczenia w oparciu o spójne ramy konceptualne i metodologiczne. Podstawę empiryczną pracy stanowią **dwa komplementarne badania eksperymentalne,** których celem było zbadanie wysiłku poznawczego podczas produkcji i recepcji tłumaczenia. Pierwsze badanie, koncertujące się na **procesie i produkcie przekładu**, mierzyło *wysiłek poznawczy* zawodowych tłumaczy dwukierunkowych (L1 polski, L2 angielski). Do pomiaru wysiłku podczas tłumaczenia tekstów w obydwu kierunkach (L1→L2, L2→L1) zastosowano metody procesualne: *keylogging* i *eye-tracking*. W drugim badaniu, poświęconym **recepcji tekstów przetłumaczonych**, zastosowano *eye-tracking* do zbadania *wysiłku poznawczego* czytelników tłumaczenia – rodzimych użytkowników języka polskiego (język docelowy przekładu) o wysokiej biegłości w języku źródłowym (L2 angielski) czytanego tekstu. Przedmiotem badania i analiz był przede wszystkim *wysiłek poznawczy* podczas procesu czytania przekładu wykonanego na język ojczysty czytelników, przy czym materiał badawczy stanowiły teksty przetłumaczone o wysokiej i niskiej jakości tłumaczenia powstałe w pierwszym badaniu.

Wyniki badań przedstawiono w pięciu artykułach analizujących wysiłek poznawczy tłumaczy i czytelników. ***Artykuł 1*** (Tomczak i Whyatt 2022) określił profil językowy zawodowych tłumaczy dwukierunkowych (ich dominację językową i biegłość w języku drugim) i skupił się na ich wysiłku poznawczym podczas procesu selekcji leksykalnej (tj. procesu wyboru słowa, które najlepiej w uznaniu tłumacza odda znaczenie słowa z tekstu źródłowego; *lexical selection*) oraz na jakości dokonywanych wyborów leksykalnych. Wyniki wykazały wyraźną asymetrię zależną od kierunku tłumaczenia i typu tłumaczonego tekstu: selekcja leksykalna była bardziej wymagająca poznawczo i mniej udana w tłumaczeniu na język drugi (L2), szczególnie w przypadku tekstów bardziej opisowych (*product descriptions*) niż ekspresyjnych (*film reviews*). Wskazywały na to m.in. niższe wyniki płynności słownej w L2, częstsze błędy leksykalne (i częściej popełniane

automatycznie), oraz częstsze (i dłuższe) korzystanie z zasobów internetowych (*use of online resources*) w tym kierunku, co potwierdza tzw. niekorzyść poznawczą w języku drugim (*L2 cognitive disadvantage*).

Bazując na ww. wynikach, ***Artykuł 2*** (Whyatt, Witczak, Tomczak 2021) koncentruje się na wysiłku poznawczym tłumaczy związanym z wyszukiwaniem informacji w zasobach internetowych podczas realizacji zadania tłumaczeniowego. Wyniki przeprowadzonego badania wykazały, że wyszukiwanie informacji online jest samo w sobie procesem kosztownym poznawczo, istotnie wydłużającym całkowity czas zadania tłumaczeniowego oraz średni czas fiksacji oka (przybliżone wskaźniki wysiłku poznawczego), szczególnie w przypadku tekstów opisowych. Co istotne, wysiłek ten zależał od kierunku tłumaczenia i typu tekstu: odnotowano istotnie większą liczbę wyszukań (w tym bardziej złożonych) oraz częstsze korzystanie ze słowników dwujęzycznych podczas tłumaczenia z języka ojczystego na język drugi, szczególnie w przypadku tekstów bardziej opisowych niż ekspresyjnych. Wyniki te mogą sugerować, że poczucie niepewności w słabszym języku wymaga większego nakładu zasobów poznawczych.

Po zbadaniu wysiłku poznawczego tłumaczy (*Artykuły 1 i 2*), kolejnym, a zarazem głównym celem pracy, było zbadanie procesu recepcji tłumaczenia wśród czytelników. W badaniu tym, którego pierwszy, eksploracyjny etap przedstawia ***Artykuł 3*** (Whyatt, Witczak, Tomczak-Łukaszewska i Lehka-Paul 2023), zastosowano podejście integracyjne. Podejście to zakłada włączenie danych z procesu tłumaczenia i oceny jakości tłumaczenia tekstów (badanie omówione w Artykułach 1 i 2) do zbadania procesu recepcji tłumaczenia. ***Artykuł 3*** stanowi pomost metodologiczny między produkcją a recepcją tłumaczenia. W sposób pionierski łączy dane (*keylogging*) z rejestracji pracy tłumacza podczas tłumaczenia (*proces*), ocenę jakości tłumaczenia (*produkt*) oraz dane eye-trackingowe dokumentujące proces czytania tłumaczeń tych tekstów przez czytelników (*recepcja*). Badanie eksploracyjne nie wykazało prostego, bezpośredniego związku między *wysiłkiem poznawczym tłumacza* a *wysiłkiem poznawczym czytelnika*. Ujawniło jednak, że jakość tłumaczenia istotnie wpływa na proces czytania: czytelnicy wykazywali większy wysiłek poznawczy (dłuższy *dwell time*, tj. całkowity czas fiksacji oka) podczas lektury tłumaczenia niskiej jakości (LQ) w porównaniu z tłumaczeniem wysokiej jakości (HQ). ***Artykuł 4*** (Whyatt, Tomczak-Łukaszewska, Witczak i Lehka-Paul 2025) poszerzył wyniki eksploracyjnego badania omówionego w Artykule 3. W badaniu na większej liczbie

czytelników, potwierdzono, że podczas czytania przekładu zawierającego błędy (tj. przekład niskiej jakości), wysiłek poznawczy był większy (dłuższy *dwell time*). Szczegółowa analiza wykazała, że różne typy błędów (np. niespójności logiczne, brak adaptacji kulturowej) wpływały na zwiększenie wysiłku poznawczego czytelników w odmienny sposób: wywoływały innego rodzaju wzmożony wysiłek podczas czytania tekstu ze zrozumieniem.

Ostatni z artykułów w cyklu publikacji, ***Artykuł 5*** (Tomczak-Łukaszewska 2025), poszerzył analizę o wymiar czynników specyficznych dla czytelnika. Analizy wykazały, że profil językowy odbiorcy, w szczególności dłuższy okres używania języka źródłowego (L2 angielski), wiązał się z mniejszym wysiłkiem poznawczym podczas lektury tłumaczenia na język ojczysty (L1 polski). Ponadto, wykazano istotną interakcję między wysiłkiem poznawczym tłumacza a jakością tłumaczenia w kształtowaniu procesu czytania: czytelnicy wykazywali większy wysiłek poznawczy podczas lektury tłumaczenia zawierającego błędy (LQ), gdy wysiłek tłumacza był niski. W przypadku tłumaczenia wysokiej jakości (HQ), większy wysiłek poznawczy tłumacza towarzyszył zwiększonemu wysiłkowi poznawczemu czytelnika, prawdopodobnie z powodu bardziej złożonej składni odzwierciedlającej złożoność tekstu źródłowego. Dodatkowe analizy moderowanej mediacji przeprowadzone w celu dalszego pogłębienia analizy związków profilu językowego czytelnika z jego wysiłkiem poznawczym podczas lektury wykazały, że biegłość w języku źródłowym (L2) pośredniczyła w relacji między liczbą lat używania L2 a wysiłkiem poznawczym podczas lektury przetłumaczonego tekstu, ale wyłącznie w przypadku tłumaczeń niskiej jakości (LQ). Może to sugerować efekt kompensacyjny: wyższa biegłość w języku oryginału może łagodzić trudności przetwarzania, częściowo rekompensując niską jakość tłumaczenia. Odkrycie to podkreśla, że indywidualne cechy czytelnika w znaczący sposób kształtują recepcję tekstów tłumaczonych, potwierdzając zakładaną interakcję między tekstem a czytelnikiem (Kruger i Kruger 2017). Wysiłek poznawczy czytelnika podczas recepcji nie jest zatem determinowany wyłącznie przez cechy tekstu, lecz stanowi wynik złożonej interakcji między jakością tłumaczenia, wysiłkiem poznawczym tłumacza oraz indywidualnymi zasobami czytelnika, w tym profilem językowym.

Podsumowując, niniejszy projekt doktorski dostarcza nowych, opartych na dowodach empirycznych wniosków dotyczących złożonych zależności między produkcją a recepcją tłumaczenia. Wyniki przeprowadzonych badań wskazują, że wysiłek poznawczy

włożony w proces tłumaczenia tekstów oraz jakość powstałego produktu (tj. tłumaczenia) znajdują swoje odzwierciedlenie w wysiłku poznawczym czytelnika, jednak związek ten jest złożony i zależy od typu błędu oraz indywidualnego profilu językowego czytelnika. Dzięki empirycznej integracji danych z procesu, produktu i recepcji, niniejsza rozprawa wykracza poza badanie tych obszarów osobno i dostarcza spójne ramy dla zrozumienia, w jaki sposób decyzje po stronie tłumacza ostatecznie kształtują doświadczanie lektury po stronie czytelnika. Ukazuje tym samym wartość zintegrowanego podejścia dla uzyskania pełniejszego obrazu komunikacji zapośredniczonej w przekładoznawstwie.

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Appendix A: Research Article 1:
Author Contribution Statement (English)

Poznań, 02.02.2026

Author Contribution Statement

Tomczak, Ewa and Bogusława Whyatt. 2022. "Directionality and lexical selection in professional translators: Evidence from verbal fluency and translation tasks", *Translation and Interpreting* 14, 2: 120-136. DOI: 10.12807/ti.114202.2022.a08.

All co-authors of the research article titled "**Directionality and lexical selection in professional translators: Evidence from verbal fluency and translation tasks**," published in *Translation and Interpreting* on 29th July 2022, hereby declare that they have contributed to the research article in the following way:

Ewa Tomczak (60%): conceptualisation, methodology, formal analysis, resources, data curation, writing – original draft, writing – review & editing, visualisation;

Bogusława Whyatt (40%): conceptualisation, methodology, validation, investigation, resources, data curation, writing – original draft, writing – review & editing, supervision, project administration, funding acquisition.

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Appendix B: Research Article 1:
Author Contribution Statement (Polish)

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Oświadczenie o Wkładzie Autorek

Tomczak, Ewa and Bogusława Whyatt. 2022. "Directionality and lexical selection in professional translators: Evidence from verbal fluency and translation tasks", *Translation and Interpreting* 14, 2: 120-136. DOI: 10.12807/ti.114202.2022.a08.

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Bogusława Whyatt (40%): konceptualizacja, metodologia (projekt badania), walidacja, zbieranie danych, zasoby (przygotowanie materiałów), przechowywanie danych, przygotowanie danych do analizy, napisanie manuskryptu (przygotowanie oryginalnego tekstu), napisanie tekstu manuskryptu (recenzja i redagowanie tekstu), nadzór, administracja projektu, pozyskanie funduszy.

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Appendix C: Research Article 2:
Author Contribution Statement (English)

Poznań, 02.02.2026

Author Contribution Statement

Whyatt, Bogusława, Olga Witczak and Ewa Tomczak. 2021. "Information behaviour in bi-directional translators: Focus on online resources", *The Interpreter and Translator Trainer* 15, 2: 154-171. DOI: 10.1080/1750399x.2020.1856023.

All co-authors of the research article titled "**Information behaviour in bi-directional translators: Focus on online resources**," published in *The Interpreter and Translator Trainer* on 14th January 2021, hereby declare that they have contributed to the research article in the following way:

Bogusława Whyatt (33%): conceptualisation, methodology, validation, investigation, resources, data curation, writing – original draft, writing – review & editing, supervision, project administration, funding acquisition;

Olga Witczak (33%): conceptualisation, methodology, software, validation, investigation, resources, data curation, writing – original draft, writing – review & editing;

Ewa Tomczak (33%): conceptualisation, methodology, formal analysis, resources, data curation, writing – original draft, writing – review & editing, visualisation.

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Appendix D: Research Article 2: Author Contribution Statement (Polish)

Poznań, 02.02.2026

Oświadczenie o Wkładzie Autorek

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Bogusława Whyatt (33%): konceptualizacja, metodologia (projekt badania), walidacja, zbieranie danych, zasoby (przygotowanie materiałów), przechowywanie danych, przygotowanie danych do analizy, napisanie manuskryptu (przygotowanie oryginalnego tekstu), napisanie tekstu manuskryptu (recenzja i redagowanie tekstu), nadzór / superwizja, administracja projektu, pozyskanie funduszy;

Olga Witczak (33%): konceptualizacja, metodologia (projekt badania), programowanie eksperymentu, walidacja, zbieranie danych, zasoby (przygotowanie materiałów), przechowywanie danych, przygotowanie danych do analizy, napisanie manuskryptu (przygotowanie oryginalnego tekstu), napisanie tekstu manuskryptu (recenzja i redagowanie tekstu);

Ewa Tomczak (33%): konceptualizacja, metodologia, analiza formalna (statystyczna analiza danych), zasoby, przechowywanie danych, przygotowanie danych do analizy, napisanie manuskryptu (przygotowanie oryginalnego tekstu), napisanie tekstu manuskryptu (recenzja i redagowanie tekstu), wizualizacja danych.

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Appendix E: Research Article 3:
Author Contribution Statement (English)

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Author Contribution Statement

Whyatt, Bogusława, Olga Witczak, Ewa Tomczak-Łukaszewska and Olha Lehka-Paul. 2023. "The proof of the translation process is in the reading of the target text: An eye-tracking reception study", *Ampersand* 11, 100149. DOI: 10.1016/j.amper.2023.100149.

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Ewa Tomczak-Łukaszewska (30%): conceptualisation, methodology, software, validation, formal analysis, investigation, resources, data curation, writing – original draft, writing – review & editing;

Olha Lehka-Paul (10%): conceptualisation, validation, investigation, writing – original draft, writing – review & editing.

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Appendix F: Research Article 3: Author Contribution Statement (Polish)

Poznań, 02.02.2026

Oświadczenie o Wkładzie Autorek

Whyatt, Bogusława, Olga Witczak, Ewa Tomczak-Łukaszewska and Olha Lehka-Paul. 2023. "The proof of the translation process is in the reading of the target text: An eye-tracking reception study", *Ampersand* 11, 100149. DOI: 10.1016/j.amper.2023.100149.

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Olga Witczak (30%): konceptualizacja, metodologia (projekt badania), programowanie eksperymentu, walidacja, zbieranie danych, zasoby (przygotowanie materiałów), przechowywanie danych, przygotowanie danych do analizy, napisanie manuskryptu (przygotowanie oryginalnego tekstu), napisanie tekstu manuskryptu (recenzja i redagowanie tekstu);

Ewa Tomczak-Łukaszewska (30%): konceptualizacja, metodologia (projekt badania), programowanie eksperymentu, walidacja, analiza formalna (statystyczna analiza danych), zbieranie danych, zasoby (przygotowanie materiałów), przechowywanie danych, przygotowanie danych do analizy, napisanie manuskryptu (przygotowanie oryginalnego tekstu), napisanie tekstu manuskryptu (recenzja i redagowanie tekstu);

Olha Lehka-Paul (10%): konceptualizacja, walidacja, zbieranie danych, napisanie manuskryptu (przygotowanie oryginalnego tekstu), napisanie tekstu manuskryptu (recenzja i redagowanie tekstu).

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Appendix G: Research Article 4:
Author Contribution Statement (English)

Poznań, 02.02.2026

Author Contribution Statement

Whyatt, Bogusława, Ewa Tomczak-Łukaszewska, Olga Witczak and Olha Lehka-Paul. 2025. "Readers have to work harder to understand a badly translated text: An eye-tracking study into the effects of translation errors", *Perspectives* 33, 5: 1085-1105. DOI: 10.1080/0907676X.2024.2418016.

All co-authors of the research article titled "**Readers have to work harder to understand a badly translated text: An eye-tracking study into the effects of translation errors**," published in *Ampersand* on 13th November 2024 (online first) | 1 October 2025 (printed), hereby declare that they have contributed to the research article in the following way:

Bogusława Whyatt (30%): conceptualisation, methodology, validation, investigation, resources, writing – original draft, writing – review & editing, supervision, project administration, funding acquisition;

Ewa Tomczak-Łukaszewska (30%): conceptualisation, methodology, software, validation, formal analysis, investigation, resources, data curation, writing – original draft, writing – review & editing, visualisation;

Olga Witczak (30%): conceptualisation, methodology, software, validation, investigation, resources, data curation, writing – original draft, writing – review & editing, visualisation;

Olha Lehka-Paul (10%): conceptualisation, validation, investigation, writing – original draft, writing – review & editing.

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Appendix H: Research Article 4: Author Contribution Statement (Polish)

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Oświadczenie o Wkładzie Autorek

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Bogusława Whyatt (30%): konceptualizacja, metodologia (projekt badania), walidacja, zbieranie danych, zasoby (przygotowanie materiałów), napisanie manuskryptu (przygotowanie oryginalnego tekstu), napisanie tekstu manuskryptu (recenzja i redagowanie tekstu), nadzór / superwizja, administracja projektu, pozyskanie funduszy;

Ewa Tomczak-Łukaszewska (30%): konceptualizacja, metodologia (projekt badania), programowanie eksperymentu, walidacja, analiza formalna (statystyczna analiza danych), zbieranie danych, zasoby (przygotowanie materiałów), przechowywanie danych, przygotowanie danych do analizy, napisanie manuskryptu (przygotowanie oryginalnego tekstu), napisanie tekstu manuskryptu (recenzja i redagowanie tekstu); wizualizacja danych;

Olga Witczak (30%): konceptualizacja, metodologia (projekt badania), programowanie eksperymentu, walidacja, zbieranie danych, zasoby (przygotowanie materiałów), przechowywanie danych, przygotowanie danych do analizy, napisanie manuskryptu (przygotowanie oryginalnego tekstu), napisanie tekstu manuskryptu (recenzja i redagowanie tekstu), wizualizacja danych;

Olha Lehka-Paul (10%): konceptualizacja, walidacja, zbieranie danych, napisanie manuskryptu (przygotowanie oryginalnego tekstu), napisanie tekstu manuskryptu (recenzja i redagowanie tekstu).

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Appendix I: Research Article 5:
Author Contribution Statement (English)

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Author Contribution Statement

Tomczak-Łukaszewska, Ewa. 2025. "Spotlight on the Reader: Methodological challenges in combining translation process, product, and translation reception", *Poznan Studies in Contemporary Linguistics* 61, 4: 623-652. DOI: 10.1515/psicl-2025-0074.

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Tomczak-Łukaszewska, Ewa. 2025. "Spotlight on the Reader: Methodological challenges in combining translation process, product, and translation reception", *Poznan Studies in Contemporary Linguistics* 61, 4: 623-652. DOI: 10.1515/psicl-2025-0074.

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Appendix K: Research Article 1

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Directionality and lexical selection in professional translators: Evidence from verbal fluency and translation tasks

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Abstract: Lexical selection is a key process in any language-based communicative event, but in translation it occurs in the semantic network activated by two languages. The question asked in this article is how the direction in which translation proceeds affects the process and outcome of lexical selection by experienced bidirectional translators. The prediction from the available empirical evidence that lexical selection when translating into the translator's L2 (learned language) is more cognitively demanding than when working into L1 (native language) is tested in an experimental study with translators who regularly translate into their L1 (Polish) and L2 (English). The participants performed verbal fluency tasks and translated two texts (a product description text and a film review) into their L1 and L2 (four texts in total). The entire process was recorded by key-logging, eye-tracking and screen capture programs. The results confirm that lexical selection is more demanding and less successful in L1→L2 translation, thus confirming the L2 cognitive disadvantage. Equipping translation students with effective error-preventing strategies and encouraging collaboration between translators and proofreaders could optimise lexical selection in L1→L2 translation.

Keywords: Directionality, verbal fluency, lexical selection, bidirectional translators, expertise, key-logging, eye-tracking, screen capture.

1. Introduction

Lexical selection or lexical choice is about choosing words which we consider the best fit for the meaning we want to share with our interlocutors. The ability to access, select and produce (articulate or write) words is a part of vocabulary retrieval and of general verbal ability. Lexical selection is essential in any language-based communicative event including translation. In simple terms, it is a process of mapping meaning, or concepts onto words. In everyday language use, people are "subject to selection pressure from within language alternatives (e.g., *cup* vs. *mug*)" and have to resolve semantic competition (Friesen et al., 2016, p. 1). When monolingual speakers face lexical choices and alternative words are activated in their mental lexicon, the selection process is more demanding. Psycholinguistic research, which taps into how language is processed by the human mind, has demonstrated that participants in controlled experiments when faced with alternative words take longer to name pictures (Schriefers et al., 1990) and fixate more on semantic competitors in visual world

paradigm studies compared to trials with no semantic competitors (Huettig & Altmann, 2005).

The cognitive cost of processing semantic competition is much higher for bilingual speakers. Gollan et al. (2005) showed that bilingual speakers take longer to name pictures than monolinguals, although both groups do not differ in simple nonverbal semantic classification tasks. This is explained by spreading activation across the language-independent conceptual store which activates words in both languages (Collins & Loftus, 1975). Bilinguals have more options to consider and language control mechanisms are needed to select the word in the language chosen for communication (Green & Abutalebi, 2013).

In translation, language control and efficient lexical selection are of key importance both for the fluency of the process and the effect of the translated text on its readers. When reading a source text (ST) for translation, activation is spreading across the semantic network (Schaeffer et al., 2016), and theoretically all the translator needs to do is choose the target language words and structures to compose a new target text. Jakobsen and Jensen (2008) demonstrated that translators' reading patterns show more processing effort when they read for translation than when they read for comprehension (see also Macizo & Bajo, 2006). Yet, selecting words from the target language is often the most painstaking aspect of the translation process and it is still unclear how translators deal with unequal proficiency in their working languages. This article investigates to what extent the process of lexical selection is modulated by directionality in experienced bidirectional translators, that is translators who frequently translate into their L1 and L2. Section 2 focuses on translation directionality, section 3 explains the complexity of semantic activation networks, and sections 4-6 discuss a study which measures the effect of translation direction on the process of lexical selection in professional bidirectional translators.

2. Directionality matters

There is a common consensus that translating single words and sentences into L2 is cognitively more demanding than translating into L1. Muñoz et al. (2019, p. 8) review neurocognitive and behavioural studies (e.g., Fabbro & Paradis, 1995; Klein et al.,1995) and show that L2 translation of isolated words recruits additional subcortical mechanisms responsible for executive and linguistic functions in comparison with L1 translation. Further evidence that translating isolated words into L2 is more demanding than translating into L1 comes from psycholinguistic reaction time studies which repeatedly reported that participants take longer to translate in the L2 direction, and the level of accuracy is much lower than in the opposite direction (Kroll & Tokowicz, 2001, p. 54). Chmiel (2018) investigated bidirectional interpreters using semantic priming in a single word recognition task and reported that despite their bilingual expertise, they showed the effect of L1 dominance. If translating single words and sentences into L2 is cognitively more demanding and error-prone than translating into L1, can this finding be extrapolated to full text translation?

Directionality-related problems with lexical choices have been reported by participants in some studies. Buchweitz and Alves (2006, p. 254) analysed the retrospective protocols of 10 students who translated into L2 and into L1 and revealed that in the revision phase, the participants were mostly concerned with lexical choices. Ferreira et al. (2018, p. 112) analysed the retrospective protocols of 8 professional translators working into L1 (Spanish) and L2 (English) and stated that the larger difficulty with L1→L2 translation was ascribed to lexical decisions.

Interestingly, similar findings are reported in L2 writing research. Manchón et al. (2007) present a comprehensive review of research on lexical retrieval in L2 writing and underscore the central role of vocabulary in text composing processes at the stage of planning, formulation and revision. They refer to Porte (1997) who reported that L2 writers were mostly concerned with vocabulary usage during their revision stage. Stevenson et al. (2006) showed that their participants revised their L2 compositions with more focus on vocabulary than their L1 compositions to filter out undesired words. A more profound understanding of the effect directionality has on the process of lexical selection requires more insight into the nature of semantic activation networks.

3. Semantic activation networks in the translating mind

Undoubtedly, "the scope and strength of the two bilingual vocabularies is a critical factor" (Diamond & Shreve, 2017, p. 490) for translators and it can be expected that through practice the two vocabularies become not only richer but also more closely knit than for non-translating bilinguals (Paradis, 2009). Halverson (2017, p. 14) talks about *connectivity* understood as "the nature and strength of links between elements in a bilingual's two languages" which is the effect of the frequent co-occurrence of a translation pair and will lead to the so-called default translation – fast and effortless solutions. On the other hand, the high activation of the translator's working languages creates perfect conditions for cross-linguistic interference effects at the conceptual and lexical level (Toury's law of interference, 1995, p. 275). Even though translation is always situated, and context narrows down the most desirable lexical choices, there are many sources of difficulty which require conflict resolution.

The first source of difficulty is that the lexical resources in the translator's two languages are uneven because they reflect different language experience and culturally unique mental representations. Martín de León (2017, p. 115) suggests that mental representations "may be differently organised by source and target groups, and that translators must identify these differences to create mappings or to make explicit the incongruences between the knowledge structures evoked by source and target texts." For example, Cifuentes-Férez (2009) tested Slobin's (2004) observations concerning manner-of-motion verbs in English and Spanish, and reported that English has far more motion verbs which include fine-grained information about the manner of motion than Spanish. In effect, the fine-grained information about the manner of motion is frequently lost when translating from English into Spanish. Cifuentes-Férez and Rojo (2015, p. 293) confirmed that around 50 percent of manner-of-motion information was either lost or modified in the Spanish target texts. Yet, in their think aloud protocols, the translators did not verbalise any concerns about disregarding the information about the manner of motion. Cifuentes-Férez and Rojo (2015, p. 278), conclude that "thinking-for-translating might colour translators' construals and expressions of motion events in the target language that are different from what is expressed in the source text." The authors refer to Slobin (1996), who noted that when translating from Spanish into English translators tended to add descriptions of the manner of motion (Cifuentes-Férez & Rojo, 2015, p. 277). It is not clear to what extent translators are aware of what is explicitly available and what is implicit in the two lexicons of their working languages.

The second area of difficulty in lexical selection when translating lies in the implicit process of semantic priming, which means that when we see a word, activation spreads across the semantic network and words with similar meanings become activated (McNamara, 2005). Even if the translator fairly

quickly selects a potentially good translation equivalent, research shows that semantic competitors will be also activated in the target language and might need to be considered. Most words come in cohorts of near synonyms which, although sharing similar prototypical meaning, differ in terms of shades and nuances including connotations, implications or attitudes (Edmonds & Hirst, 2002, p. 105), for example, *error, mistake, blunder, slip, lapse, boner,* or *faux pas* (p. 106).

Langacker (1987, p. 385) noted that some elements of the network are more prominent (salient) than others because they are more frequently used, their activation patterns become entrenched and are therefore more likely to be selected for production (Langacker, 2008, p. 226). However, what is more salient in the source language may not overlap with what is more salient in the target language, and the translator may have a different awareness of the salience in their L2, the usually weaker language.

Halverson (2003), building on Langacker's model of semantic structure, formulated the *gravitational pull hypothesis* which explains that translators' choices have cognitive underpinnings. As she explains, salience can be "metaphorically understood as a true form of cognitive gravity, i.e. a cognitive force that makes it difficult for the translator to escape from the cognitive pull of highly salient representational elements in the source language" (Halverson, 2017, p. 14). On the other hand, some lexical (and grammatical) choices can be steered by salience in the target language which Halverson metaphorically terms *magnetism*. Both forces might play an important part in how the activation spreads across the semantic network and the elements more salient in the ST might be selected, which may not be contextually the most appropriate for the TT (see also Levý, 2008).

The need for conflict resolution in translation is especially pressing when one ST word activates many potential target language words (one-to-many). Kroll and Tokowicz (2001, p. 61) demonstrate that participants take longer to translate concrete and abstract words which have more than one translation equivalent than words with only one translation equivalent. Schaeffer et al. (2016) showed that when translators read words in the ST which had multiple translation equivalents (*word translation entropy*), their eye movements reflected more effortful cognitive processing, which they ascribed to the co-activation of both lexicons. However, translators need to remember that only some meanings (or senses) of a ST word may overlap with those activated by a target language word. Finkbeiner et al. (2004, p. 8) give an example of the word 'black' in English and Japanese (*kuroi*) to show that translation equivalents in two languages usually share some senses but not all. Most often L2 users know many meanings of their L1 words but they might be aware only of some meanings evoked by the L2 translation equivalents. Therefore, a stronger semantic priming effect is typically found in the L1→L2 direction.

Although there is a clear understanding of asymmetry in how semantic networks are activated in L1 and L2, the answer to the question of how the direction of translation affects the process of lexical selection in professional bidirectional translators is far from clear. To address this gap, we report on an experimental study in which we test the verbal fluency of experienced translators and explore their process of lexical selection when translating into L1 and L2.

4. The study

The study presented here is a part of a large-scale research project designed to

test the effects of directionality in the translation process and the end product – the EDiT project (Whyatt 2018, 2019).[1]

4.1. Research questions

Five research questions referring to the impact of directionality on the speed and accuracy of lexical selection were formulated:

1) Do experienced bidirectional translators have lower verbal fluency in their L2 than in their L1?
2) Are the unsuccessful lexical choices more frequent in L1→L2 than in L2→L1 translation?
3) Do translators need more support from external resources (e.g., online dictionaries) in L1→L2 than in L2→L1 translation?
4) Do translators change their lexical decisions more often in L1→L2 than in L2→L1 translation?
5) Are the unsuccessful lexical choices in L1→L2 translation made automatically or do they follow more effortful decision-making?

The research questions respond to the assumptions discussed in sections 2 and 3 about the effect of language dominance on lexical selection in terms of speed and accuracy – slower and less successful in the L2 direction. The questions are operationalised in the following way: To answer RQ1 and establish which language is dominant, verbal fluency (VF) is measured by the number of words and speed of typing them when performing a series of standard VF tasks (described in detail in section 4.2). To answer RQ2-5, the translation process and the target texts are analysed. For RQ2, lexical choices are considered unsuccessful if they were corrected by experienced proofreaders in all four experimental texts. To answer RQ3, all instances of dictionary use (typing a word in the Internet browser) are calculated and taken as evidence for problems with lexical selection when translating the four texts. Answering RQ4 and RQ5 required a very laborious manual analysis of the entire translation process, therefore we decided to focus on the product description texts as this type calls for more terminological accuracy than a more creative text type – a film review. To answer RQ4, we count all instances when translators delete a partially or completely typed word and replace it with a different word during drafting and end revision. To answer RQ5, we focus on the translation of product description texts only into L2 (the translator's weaker language) as this direction is more likely to result in less accurate lexical choices, as discussed in section 2. The manner in which the unsuccessful selection proceeded is classified as automatic (fast) or effortful (preceded by a pause longer than 5 seconds assumed to reflect conscious problem solving).[2]

4.2. Participants and materials

Thirty professional bidirectional translators with at least three years of experience in translation participated in the study. The participants worked in experimental conditions and translated 2 texts into their L1 (Polish) and 2 texts

[1] EDiT stands for Effects of Directionality in the Translation process and product. The EDiT project (2016-2019) combines TPR methodology with product assessment to investigate how directionality affects professional translators' performance.

[2] We are aware that the length of pauses classified as indicative of conscious problem solving varies in TPR studies (see Kumpulainen, 2015). Although the choice of a 5 second pause might seem arbitrary (Jakobsen, 2016), such pauses have been considered in other studies as unlikely to represent minor distractions or slow typing (Buchweitz & Alves, 2006, p. 249).

of comparable level of complexity into their L2 (English). The texts were about 162 words long and represented two text types: a product description text (of a mop cleaning set and a ceiling fan) and a film review (of *Afterimage* by Andrzej Wajda and *Silence* by Martin Scorsese). They also performed verbal fluency tasks (VF) – three letter fluency tasks and three category fluency tasks in their L1 and L2. [3]

Verbal fluency tasks are an objective measure of verbal ability (vocabulary size) and executive control ability. The participants are asked to generate as many meaningful words as they can within 1 minute. There are two types of cues used to elicit words – a letter and a category cue. For example, participants may be asked to produce words beginning with the letter 's' or belonging to the category 'fruit' (Luo et al., 2010). The more words produced mean the higher verbal ability score and better verbal fluency performance. Luo et al. (2010) compared the verbal fluency scores of monolingual English speakers with two groups of bilingual speakers and found that monolinguals outperformed the bilingual speakers in terms of the number of correct responses and the timing of the first response. Shao et al. (2014, p. 2) refer to neuroimaging evidence pointing out that "verbal ability may be more strongly reflected in category than in letter fluency scores, and that, conversely, executive control ability may be more strongly reflected in letter fluency scores." VF tasks are usually performed orally but since our participants are written translators, we asked them to type the words.

4.3. Methods and procedure

All of the participants worked in Translog II (Jakobsen, 2011; Carl, 2012) and performed the verbal fluency tasks in their L1 before they translated two texts into their L2. After a short break, they performed the verbal fluency task in their L2 and translated comparable texts into their L1. It was our intention that the verbal fluency task was carried out first and in the language in which the participants later on read the ST for translation. The directions were counterbalanced and the order of texts was randomised to minimise task order effects. The participants came for individual sessions which lasted up to 120 minutes, they received a translation brief, had access to an Internet browser and were remunerated for their work. Their task performance was recorded by the key-logging program (Translog II), an eye-tracker (EyeLink 1000 Plus) and a screen-capture program (Morae). The target texts, which they produced, were later corrected by experienced proofreaders (two for each translation direction) who are native speakers of the target language. When inserting their corrections, the proofreaders were asked to use the 'track changes' function in Microsoft Word. The corrections by the proofreader were classified as either minor –1 penalty point (only slightly affecting the meaning construal) or major –5 penalty points (gravely distorting the meaning construal). In this paper we focus on the corrections to vocabulary (for more details see Whyatt, 2019).

4.4. Data trimming and analysis

Out of 30 data sets, 26 were suitable for analysis (4 sets were discarded due to being incomplete or of poor quality). In the verbal fluency task, one participant produced words in English (L2) when performing a verbal fluency task in Polish (L1). The key-logging data from 25 participants were analysed to obtain results for the verbal fluency tasks. A two-way repeated measures analysis of variance (ANOVA) with planned comparisons was performed to test whether the

[3] For a detailed description of the experimental procedures, participants and materials see the project website at: http://wa.amu.edu.pl/EDiT/index.html

differences in the verbal fluency scores obtained for the letter-cued and category-cued tasks were statistically significant (RQ1). The analysis of the corrections classified as 'vocabulary' (RQ2) and the use of external resources (RQ3) was performed on 26 data sets, that is 52 texts translated into L1 and 52 texts translated into L2. The statistical analysis used linear mixed-effects models (LMM) with translation direction and text type as fixed factors and the translators and proofreaders as random factors. The analysis of the process data for RQ4 and RQ5 is based only on the product description texts. This decision was motivated by two factors. The decision was made to focus on product description texts because being a more technical type they require more standardised vocabulary than the more creative texts, i.e. film reviews. The second reason was pragmatic – because of the laborious manual data extraction needed to see how the online changes in the lexical selection occurred in real time, the idea of analysing all of the experimental texts was abandoned.[4]

To answer RQ4, all the instances when the participants deleted an already typed or partially typed word were counted and compared for both directions of translation. We had to make decisions when the change was not to be classified as lexical – we excluded grammatically motivated changes (grammatical transformations, morpho-syntactic modifications), stylistic adjustments, typos and unclear single letters typed and deleted which could not be assumed as being potential lexical alternatives. For example, in the following section of the key-logging file, in which black arrows show deleted letters, the word 'a few' was replaced by 'several': [push•a••few◄◄◄◄◄several•times] and was classified as a change in lexical selection. Similarly, a change in lexical selection was counted in the following sentence: [The•process•takes•place••• pracita◄◄◄◄◄◄◄almost•effortlessly] – the translator most likely abandoned the idea to use the word 'practically' and went for 'almost effortlessly'. However, in the following excerpt from the key-logging file: [The•process•requires•practicell◄◄◄ally•no•as◄◄s◄force•], the two letters typed (underlined) could not be counted as a change in lexical selection and were not included in the analysis. Also grammatically motivated transformations were excluded, for example the following excerpt shows a deletion in the key-logging file: [uses•an•in•tegrated•◄◄◄◄◄◄◄◄◄◄◄◄◄◄◄•system•integrated•in•the•na◄◄handle] – the initially planned 'integrated system' was deleted and reformulated as 'system integrated in'. Such changes were not counted.

For RQ5 all the corrections to vocabulary made by the proofreaders in the L1→L2 translations were entered in an excel sheet and aligned with the process data from respective key-logging files. The length of the pause before the translator typed the word which was later corrected by at least one proofreader (and therefore judged as unsuccessful) was measured – if the same word was corrected by both proofreaders, it was counted only once. If the pause was shorter than 5 seconds, the lexical selection was classified as automatic; if the pause was longer than 5 seconds, the lexical selection was classified as non-automatic.

To illustrate how the classification of pauses indicating automatic and non-automatic lexical selection was done, let us look at two examples. In the following sentence, 'Simply place it in a special chamber, release the rod and press several times', the underlined word 'rod' was corrected and replaced by 'lever' by a proofreader. The key-logging record shows how the sentence was

[4] Noting online changes required the use of the replay function in Translog and watching video recordings from the eye-tracker (EyeLink 1000 Plus) and the screen capture software (Morae) when confirmation was needed.

typed: [Simply•place•it•in•a•special•chamber,•••release•the••••**handle**•and• press•several•times[•20.296][▼][▲][▼][▲]•rod••[▼][▲]•••••]. The word 'rod' (underlined) was in fact the translator's second choice – first the word 'handle' (in bold) was selected very quickly/automatically (4 dots before it was typed show that it took 4 seconds – one dot is one second). The word 'rod' was chosen after over 20 seconds (time in square brackets) and therefore the lexical selection was classified as effortful/non-automatic. In another sentence, 'Its robust design withstands up to 150 kg,…' the word 'withstands' was corrected by a proofreader and replaced by 'can take'. The key-logging record: [It•◄s•robust•design••••withstands•••up•to•150•kg] shows that the unsuccessful choice of the word was fairly fast – 4 seconds and therefore classified as automatic.

The significance of the results for RQ4 and RQ5 was established with the Wilcoxon matched-pairs signed-rank test.

5. Results

5.1. Translators have lower verbal fluency in their L2 than in their L1

The results obtained on the verbal fluency tasks in the participants' L1 and L2 showed no statistically significant main effect of language (F (1, 24) = 2.48, p = 0.128, η^2 = 0.09), and a significant main effect of the cue (F (1, 24) = 16.50, p < 0.001, η^2 = 0.41), namely the significant differences in performance (the number of words) appeared only on the VF task cued by category. Additionally, a statistically significant interaction effect was observed between the cue and language (F (1, 24) = 12.40, p = 0.002, η^2 = 0.34), as shown in Figure 1. In response to three category cues the participants generated more words in their L1 (M = 43.80, sd = 10.44) than in their L2 (M = 38.76, sd = 7.42) and the difference was statistically significant (t = 3.06, df = 24, p = 0.005). For total user keyboard events per minute (TUE/min), the main effect of language turned out to be statistically significant (F(1, 24) = 30.38, p < 0.001, η^2 = 0.56), and the main effect of the cue not significant (F(1, 24) = 0.26, p = 0.618, η^2 = 0.01). Also, the interaction effect between the cue and language was found to be significant (F(1, 24) = 24.79, p < 0.001, η^2 = 0.51). The words cued by category were typed significantly faster in terms of total user keyboard events per minute (t = 6.60, df = 24, p < 0.001) in L1 (M = 152.96, sd = 25.74) than in L2 (M = 120.52, sd = 18.07). Following Shao et al. (2014, p. 2), it can be concluded that the translators who participated in this study have larger vocabularies in L1 and are faster in accessing L1 words than L2 words – better verbal fluency.

Yet, in the letter fluency task (three letter cues) they produced almost an equal number of words in both languages (M = 48.28, sd = 12.29 for L1 and M = 49.36, sd = 12.12 for L2; t = -0.77, df = 24, p = 0.446) and there was no statistically significant difference in the speed with which the words were typed (M = 142.92, sd = 32.36 for L1 and M = 136.50, sd = 28.59 for L2; t = 1.69, df = 24, p = 0.104). This confirms that being professional translators, they have very high executive control ability (Shao et al., 2014, p. 2), which they use to switch efficiently between languages in the process of translation but, as confirmed by the response to the category-cued task, their access to L2 vocabulary might be more effortful and less effective (less acceptable). The results reported in sections 5.2 to 5.5 will test if this is indeed the case.

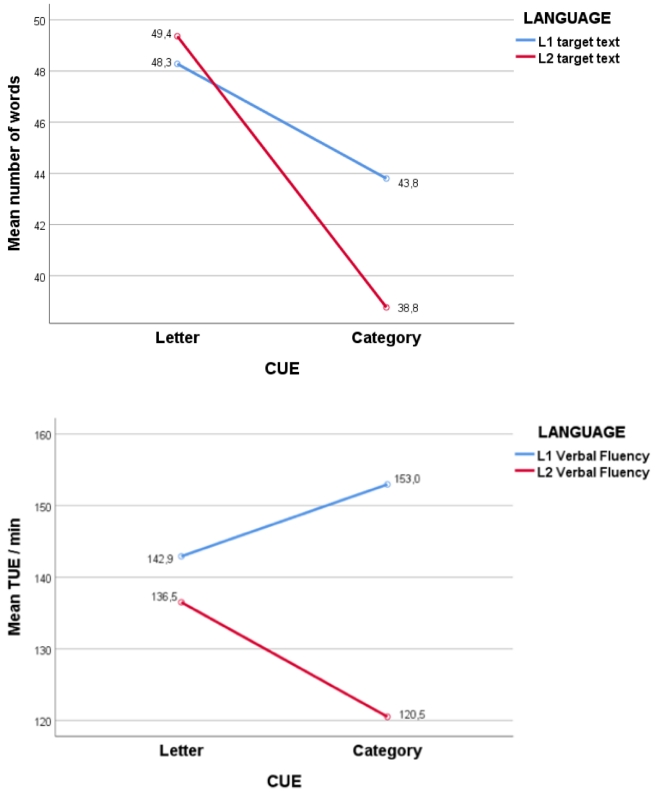

Figure 1. The mean number of words and mean number of total user keyboard events per minute (TUE/min) in verbal fluency tasks performed in translators' L1 and L2 in response to letter cues and category cues

5.2. Less acceptable lexical selection in L1→L2 translation of product description texts

Figure 2 shows that out of all the penalty points granted for misused vocabulary by the four proofreaders (two for each direction of translation), more penalty points were given to the lexical choices the translators made when translating into L2 (English) than into L1 (Polish).

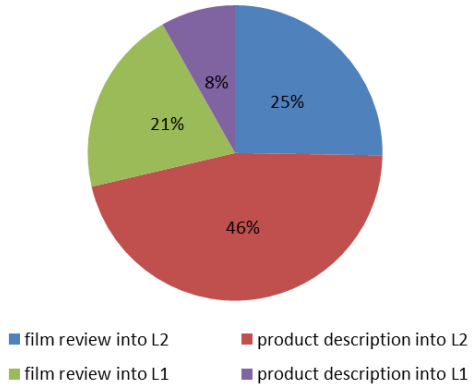

Figure 2. Proportion of the sum of penalty points from both proofreaders for corrections to vocabulary per text

The linear mixed-effects model (LMM) showed that directionality did not have a statistically significant effect on the number of penalty points scored for

unacceptable vocabulary items, but the effect of the text type proved to be significant. More vocabulary items were corrected in the product description texts ($M = 3.06$) than in the film reviews ($M = 2.58$), with $b = 2.35$, $SE = 0.40$, $t = 5.89$, $p < 0.001$. The interaction effect of translation direction and text type reached statistical significance ($b = -3.73$, SE = 0.56, $t = -6.62$, $p < 0.001$). See Table 1.

Table 1. Inferential statistics (LMM) for the effect of translation direction and text type on the acceptability of lexical selection

Fixed effects					
Effect	*b*	*SE*	*df*	*t*	*p*
Intercept	2.85	0.62	2.71	4.56	0.025
Direction	-0.54	0.86	2.50	-0.62	0.586
Text Type	2.35	0.40	177	5.89	< 0.001
Direction* Text Type	-3.73	0.56	177	-6.62	< 0.001
Random effects					
Effect		*Variance*	*SE*	*Z*	*p*
Intercept [Participant]		0.40	0.27	1.52	0.129
Intercept [Proofreader]		0.59	0.67	0.88	0.378
Residual		4.13	0.44	9.41	< 0.001

Post-hoc tests (Bonferroni correction) showed that vocabulary needed to be corrected significantly more often in the product description texts ($p < 0.05$) in L1→L2 ($M = 5.19$) than in L2→L1 translations of the same text type ($M = 0.92$). There were significantly fewer ($p < 0.001$) vocabulary errors in the L1→L2 translations of the film reviews ($M = 2.85$) than of the product description texts in the same direction ($M = 5.19$). But when translating the film reviews, the participants' lexical choices were corrected significantly more often ($p < 0.01$) in L2→L1 ($M = 2.31$) than in the product description texts in the same direction ($M = 0.92$).

5.3. More external support needed in L1→L2 translation

The LMM analysis presented in Table 2 showed that translators turned for support to online resources significantly more ($b = -5.54$, $SE = 1.29$, $t = -4.30$, $p < 0.001$) when translating into their L2 ($M = 11.75$) than into their L1 ($M = 8.71$). Additionally, the effect of text type reached statistical significance ($b = -3.58$, SE = 1.29, $t = -2.78$, $p < 0.01$) – the participants typed a significantly higher number of words in the Internet browser when translating the product description texts ($M = 10.77$) than the film reviews ($M = 9.69$).

Table 2. Inferential statistics (LMM) for the effect of translation direction and text type on the number of entries in the Internet browser

Fixed effects					
Effect	*b*	*SE*	*df*	*t*	*p*
Intercept	13.54	1.29	59.55	10.51	< 0.001
Direction	-5.54	1.29	78	-4.30	< 0.001
Text Type	-3.58	1.29	78	-2.78	0.007
Direction* Text Type	5.00	1.82	78	2.74	0.008
Random effects					
Effect		*Variance*	*SE*	*Z*	*p*
Intercept [Participant]		21.51	7.51	2.86	0.004
Residual		21.61	3.46	6.25	< 0.001

There was also a significant interaction effect of directionality and text type pointing to the more frequent inability to select words when translating into L2 without the help of dictionaries and other online resources (for more details on information searching see Whyatt et al., 2021, pp. 162-163).

5.4. More online changes in L2→L1 translation direction

RQ 4 asked whether the translators change their mind when selecting a word more often when translating into their L1 or L2. The results show that when drafting the target text, the participants made significantly more changes in L2→L1 translations than in the L1→L2 direction. Figure 3 shows the differences in the number of online changes to initially selected vocabulary for each participant.

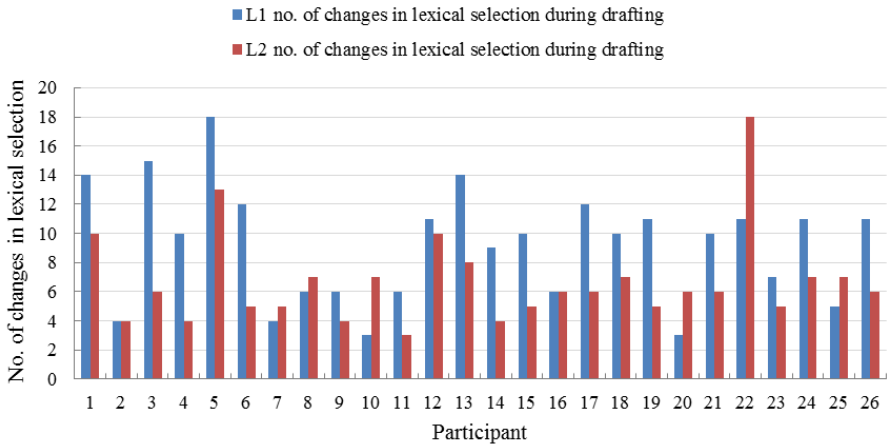

Figure 3. Number of changes in lexical choices during drafting in the L2→L1 (L1) and L1→L2 (L2) translation for the 26 participants

Despite the individual differences between the participants' tendencies to make changes when selecting words, the Wilcoxon matched-pairs signed-rank test showed that significantly more changes were made in the L2→L1 direction ($Z = -2.84$, $p < 0.01$; $Me_{L2→L1} = 10$, $Me_{L1→L2} = 6$). During end revision, however, the participants did not differ significantly in terms of the number of changes introduced when they worked in the L1→L2 direction vs. the L2→L1 direction ($Z = -0.133$, $p = 0.894$; $Me_{L1→L2} = 1$, $Me_{L2→L1} = 1$).

5.5. The majority of unsuccessful lexical choices in L1→L2 are automatic

In raw numbers, 223 words selected by the translators in the L1→L2 direction were corrected by the proofreaders and replaced with what was in their estimation a more suitable word. Out of the 223 unsuccessful lexical choices as many as 148 were classified as automatic and 75 as non-automatic. Figure 4 shows that the majority of unsuccessful lexical choices when translating into L2 were made fairly quickly (in less than 5 seconds).

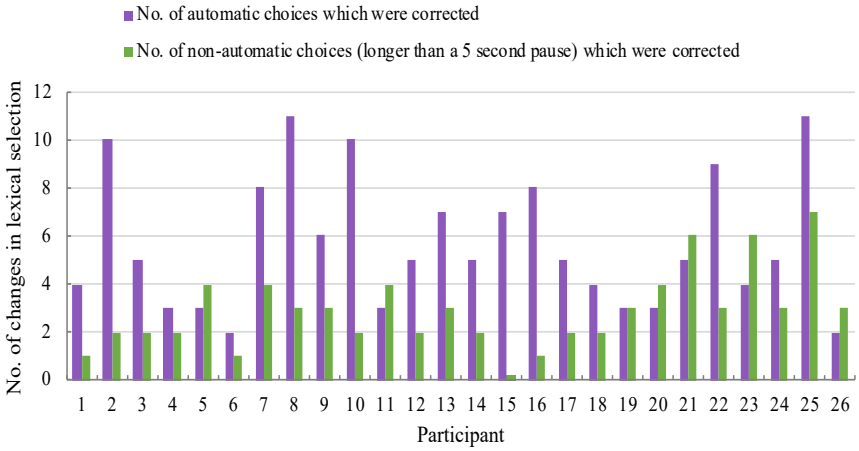

Figure 4. Number of automatic and non-automatic choices of vocabulary in the L1→L2 translations which led to unsuccessful solutions for the 26 participants

The Wilcoxon matched-pairs signed-rank test (Z = -3.61, $p < 0.001$; $Me_{automatic} = 5$, $Me_{non\text{-}automatic} = 3$) showed that significantly more corrections were made by the proofreaders to words which were selected by the translators fairly quickly (in less than 5 seconds) than to words for which they took more time to select. The results point to the need to exercise more caution when selecting vocabulary from the translator's weaker language (L2).

6. Discussion

The results obtained in the study reported here can be explained by the present insights from bilingualism research, psycholinguistic and neurolinguistic studies (García, 2013; Kroll & Tokowicz, 2001; Muñoz et al., 2019). What has been referred to as the L2 cognitive disadvantage (more effortful L2 processing) has been confirmed in experimental conditions involving professional bidirectional translators who participated in the EDiT project. Although, as reported in Whyatt (2019), there was no statistically significant effect of directionality on the time taken to translate the experimental texts, a close investigation of lexical selection in verbal fluency and translation tasks shows that L1→L2 translation is the more taxing, i.e. cognitively demanding direction.

Translators, despite their professional expertise, which makes them highly proficient in their working languages, still showed asymmetrical verbal fluency with significantly higher scores in L1 in the VF category-cued tasks than in their L2. Verbal fluency scores are a well-established indicator of the size of the vocabulary and the speed of connections between items in the semantic activation network. The results reported here are in line with the study on bidirectional conference interpreters by Chmiel (2018, p. 36) who concluded that "no evidence was found that interpreting experience alters their bilingual language profile and language dominance and asymmetry".

The evidence presented to answer research questions 2 to 5 shows that the statistically significant difference in verbal fluency in L1 and L2 has a bearing on the manner of lexical selection in the translation process, and, to a certain extent, on the acceptability of the final choices by the proofreaders. However, since more unsuccessful instances of lexical selection occurred in the product description texts translated into L2 than in the film reviews translated into L2, the type of text and its complexity might also play a role (Whyatt, 2019). It should also be mentioned that the vast majority of corrections to vocabulary

were classified as minor mistakes. For example, the word *rod* was replaced by *lever* in the phrase *unlock the rod*, the word *pleasant* was replaced by *enjoyable* in the sentence *cleaning can be a pleasant task*, or the word *structure* was replaced by *construction* in the phrase *durable structure*. All these unsuccessfully selected words were replaced by the proofreaders with words with very similar prototypical meaning but contextually more appropriate than the words selected by the translators. Following Halverson (2017), these examples might be the effect of the *gravitational pull* towards more salient items in the source language and a failure to recognise that they are not equally salient in the target (L2) language. A more detailed qualitative analysis of the unsuccessful lexical choices is worth pursuing as it would help to diagnose the root of the infelicitous decisions made by the participants in the study.

Lower verbal ability in L2 was reflected in more frequent use of external resources when translating into L2, whereas the translators' internal mental lexicon was more often sufficient when selecting words in the L2→L1 translation. However, looking up words in an online dictionary still requires the decision of which word to select and does not guarantee that a solution which is selected will be in fact contextually appropriate.

Although access to L1 vocabulary seems faster, the selection process is not devoid of difficulty – in a way, being spoilt for choice makes making a choice more time consuming. When typing the translations of the product description texts, the translators did change their mind more often when working into their L1 – they erased, either a completely or partially typed word, and replaced it with a word which they, most likely, considered more effective in its meaning making potential. Such online changes to the initially selected words were less frequent when translating into their L2 – most likely because fewer semantic competitors are activated in the weaker language (McNamara, 2005). On the other hand, words selected during drafting, irrespective of the translation direction, were rarely changed at the end revision stage and there was no statistically significant difference between the number of changes made in both directions. This lack of difference at the stage of end revision is different from the results reported by Buchweitz and Alves (2006) and Manchón et al. (2007) who showed that the concern for the appropriateness of lexical choices in L2 resulted in more changes when revising texts in the L2 direction. However, it needs to be remembered that the participants in the two studies were either translation students or L2 writing students. In the study reported here, the participants were experienced professional bidirectional translators who, most likely because of their expertise, rarely change their decisions concerning lexical choices at the end revision stage.

Finally, despite the fact that selecting words when translating into L2 seems more demanding, it is overall less successful, and directionality does matter in this respect (Kroll & Tokowicz, 2001). A more detailed look at the process of selecting words which were judged as unacceptable showed a very revealing observation that in most cases translators made wrong choices without much delay. This might suggest that the lexical decisions were fairly automatic and possibly activated by the semantic priming of entrenched connections which nevertheless did not result in optimum solutions when the target language was the translator's L2 (Langacker, 2008; Halverson, 2017). As put by Muñoz and Rojo (2018, p. 72), "translators need to be aware that words are only partial clues that they must interpret in combination with their own knowledge (culture) and needs, and their assumptions about what the author of the original wants and knows, and what the audiences of both texts also want and know". This approach requires strategic recipient-oriented decision making which will cancel the effect of cross-language priming to prevent undesired solutions (Shreve, 2009). The practical implications of the results reported in this article

might include a set of error-preventing strategies for lexical selection depending on translation direction (Wu & Liao, 2018).

7. Conclusion

The study presented in this article is not without limitations, which include one language pair and selected text types. Still, it seems justifiable to claim that directionality affects lexical selection even in professional bidirectional translators who are used to translating in both directions. Understanding the difficulty and uncertainty behind selecting words when translating into one's weaker language (usually L2) can contribute to raising awareness of the strong impact of language dominance on verbal fluency and its role in translators' decision-making processes. More focus on how translators use their bilingual resources and how the implicit priming mechanisms operate could become a part of translator training programs and lead to outlining effective error-preventing strategies. The findings are also relevant for foreign language didactics – if some aspects of lexical selection are problematic even for experienced bidirectional translators, they might require more attention in the context of foreign language teaching. Another indirect implication of the study presented here is that cooperation between translators and proofreaders is tantamount to ensuring good quality translation irrespective of directionality.

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Information behaviour in bidirectional translators: focus on online resources

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ABSTRACT

Effective information behaviour is crucial in all translation competence models but our understanding of how information skills develop and how translators interact with information found in online resources is still limited. In this article we focus on information behaviour (needs and use) of bidirectional translators who frequently translate into their native (L1) and their non-native language (L2). The theoretical underpinnings come from information studies: (1) information is needed when cognitive uncertainty arises and – when found – it allows the translator to make an informed decision; (2) translators are driven by economy of effort and will minimise the cost of searching for information. The empirical evidence comes from a study of 30 professional bidirectional translators who translated two texts into their native language of low diffusion (Polish) and into their non-native major language (English). A close analysis of their information behaviour included data obtained by keylogging, eye-tracking and screen recording, and showed that using online resources adds more cognitive effort when translators work into their L2. We use the results to draft a model of information behaviour which shows how the use of online resources is affected by the translation direction.

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Information behaviour; online resources; L2 translation; keylogging; eye-tracking; screen recording

1. Introduction

In small translation markets where the home language has a low diffusion translators need to be versatile and translate into their L1 and L2, that is they provide services in bidirectional translation (Pavlović 2007b; Whyatt and Kościuczuk 2013; Ferreira and Schwieter 2017; Chmiel 2018). It seems intuitive that when translating into L2, translators will rely more on external support – now this support usually comes from online resources (henceforth OR). To verify this intuition, it seems imperative to understand the cognitive consequences of searching for information in the translation process, especially with respect to the amount of information which is easily accessible in the digital era. This article is an attempt to go back to the basics of information behaviour research and see how the findings can be applied to the use of OR in translation, especially when one of the languages is an LLD – a language of low diffusion (Section 2). Section 3 explores the relationship between information skills and translation expertise, and argues for a better understanding of how directionality affects translation and information needs. To

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contribute to this cause, in Section 4 we report on the EDiT project in which we observed how translators interact with information in OR during the translation process. We discuss the results of the study and formulate a tentative model of information behaviour in bidirectional translation – the IBiBT model (Section 5), which can be further validated and used in the training of bidirectional translators. In Section 6 we share some suggestions on how our findings can be applied in translator training.

2. Information behaviour

Information literacy – defined as 'the ability to locate, evaluate and use information wisely' (Kuhlthau 2008, 71), has become indispensable in educational, personal and professional contexts. In the present digital era, translation as a complex cognitive process heavily relies on efficient skills to use information/documentation resources. In search of a solid theoretical footing, we review insights from information studies (Fisher, Erdelez, and McKechnie 2005; Case 2007). We focus on two main concepts which are of particular interest in the context of translation: the *uncertainty principle* and the *cost-benefit analysis*.

2.1. The uncertainty principle and knowledge construction

People look for information when they experience 'cognitive uncertainty', i.e. when they become aware that their knowledge is insufficient to reach an intended goal. For example, in Blom's (1983) Task Performance Model, information need is a task performance need essential for the task to be completed. Dervin (1998, 2003) in her 'Sense-Making Methodology' also sees information seeking as constructing knowledge in the process of achieving a desired outcome. The information when found acts as a *bridge* filling a gap between the *current situation* in which a problem arises and the desired *outcome*.

In Kuhlthau's (2008) Information Search Process (ISP) model, uncertainty, or even apprehension is experienced when a person becomes aware that information is needed to complete the task (stage 1). Stage (2) called selection, i.e. deciding what is needed, e.g. typing a query, brings optimism and the searching process starts, followed by exploration (stage 3) – believed to be the most difficult stage as the searcher may experience confusion because of inconsistent results. In stage 4, called focus formulation – the seeker confidently locates relevant information and is ready for collection and presentation (stage 5 and 6) – putting the information to use and completing the assignment. Kuhlthau's ISP model shows how the initial uncertainty of the information seeker is gradually replaced by confidence and the feeling of closure and satisfaction or dissatisfaction. Kuhlthau (2008) explains that depending on task complexity some stages may be skipped but in more complex tasks all the stages might be experienced.

The above approaches to information needs and use can be applied to translators who resort to information searching when they become uncertain and cannot solve a translation problem (Tirkkonen-Condit 2000; Angelone 2010). The desired information will fill a missing link in the translator's knowledge network (see Whyatt 2012, 199) and will lead to a decision until another problem arises and the searching–solution cycle starts again. The ISP model points to the cognitive, physical and affective costs of information seeking. Indeed, Hvelplund (2017) used eye-tracking and reported that

consulting digital resources takes up a considerable amount of the translation process and the increase in the cognitive load is reflected in 'longer fixations and larger pupils during resource consultation' (71).

2.2. A cost-benefit analysis

According to the Optimal Foraging Theory (Sandstrom 1994; Pirolli and Card 1999), users, in a metaphorical sense, hunt and gather information. As in any rational behaviour, the heuristics of information foraging is based on the principle that the cost of obtaining information cannot be higher than the benefit from the information. The user is interested in fast and easy access to information in line with the *principle of least effort* (Zipf 1949; Mooers 1996).

The cost-benefit analysis – the time needed to find and process information – has gained new meaning for translators in the digital age. Access to information is fast but the searching process might be tedious, and requires the decision whether to trust or mistrust the data (Pym 2013, 490). On the other hand, access to information is not equally rich for all languages. Kuusi, Koskinen, and Riionheimo (2019, 40–41) report on information seeking during translation involving Karelian, a minority language spoken in Finland and Russia. The authors choose the term *information seeking* to underline the fact that the information may not be found. To quote:

> In the context of minority language translation with limited diffusion and reduced domains, information seeking is, however, rarely a process of easy retrieval, or a straightforward matter of locating authoritative sources and using the most apt terminology, since such preexisting established vocabulary often does not exist.

Paradoxically, the authors conclude that even unproductive information searching leads to knowledge construction (forces students to improve their lexicon and phraseology). Translators' information behaviour can be embraced by translation pedagogy as a 'means towards self-discovery and lifelong learning' (Enríquez Raído 2013). Effective information skills are a key factor in translation expertise development (Hirci 2012; Pakkala-Weckström 2015).

3. Information behaviour and translation expertise

Information behaviour (IB) as a broad term to describe the use of external resources, both offline and online, is central to contemporary translation competence models – PACTE's instrumental competence (Kuznik 2017) and EMT's thematic and information mining competence (2009). IB is also at the core of the international translation services standard (ISO 17100 2015) and involves a number of behaviours exhibited by experienced translators.

Within the PACTE model, instrumental competence comprises the external support of the decision-making process during translation: the consultation of documentation sources and communication technologies. The use of instrumental resources is characteristic for translators, regardless of translation direction (Kuznik 2017). In the EMT model, the thematic and information mining competences are closely intertwined. Thematic competence is knowing how to search for specific information, but the

information mining sub-competence is most important: 'Knowing how to use tools and search engines effectively (e.g. terminology software, electronic corpora, electronic dictionaries)' (EMT expert group 2009, 6). Finally, the ISO standard (2015) states that professional translators should master research tools and efficiently use the information resources at their disposal.

3.1. Expert use of OR

It is tacitly assumed that the translator's IB develops parallel to the development of translation expertise and becomes a refined skill used with economy of effort (Proctor and Dutta 1995, 18). Experienced translators exhibit more complex and effective IB. Hvelplund (2017, 79) notes that information searching as a complex task is more resistant to automation and subject to individual variation. However, certain text types are more demanding as regards information searching than others, i.e. specialised texts will generate more research needs than general-purpose or literary texts (Hvelplund and Dragsted 2018). Enríquez Raído (2014, 109) pointed out that experts can skilfully coordinate 'ST [source text] reading, background research, translation interspersed with selected research, and problem-solving reporting' with less cognitive strain.

Experts use different types of OR, preferring search engines and parallel texts to dictionaries (Massey and Ehrensberger-Dow 2011, 198; Enríquez Raído 2014; Paradowska 2015). However, Gough (2017, 250) observed that most participants in her study adopted a bottom-up approach, i.e. started with known resources and then moved on to search engine queries. Gough's (2017) study examined the online behaviour of 16 freelance translators in their natural work environment, translating into their native language from English. One third of the searches involved a top-down approach, i.e. with keyword searches as an initial step (252). Experienced translators also knew about the trustworthiness of OR. They cautiously consulted Wikipedia, aware of its community-generated content (251).

Furthermore, professional translators know a wide array of OR and exhibit a more complex search behaviour as reported by the PACTE group (Kuznik 2017; Kuznik and Olalla-Soler 2018). Hvelplund's (2017) study explored search strategies and resource types used by 18 professional translators in L1 translation (English into Danish) of literary and specialised texts. Searching addressed terminological issues and 75% of the searching events referred to bilingual resources/term bases (80–81). The use of other tools indicated the awareness of how to solve a specific problem encountered in the ST (82). One third of the translators used reference websites for information about specialised terminology.

Expert searching involves certain strategies (Enríquez Raído 2014), often search engine queries and validations of hunches on different websites. Some experienced translators plan their research, while others operate in a less structured way (Gough 2017, 248). Hvelplund (2017, 82) noted that professional translators in his study seemed to 'make a guess' when faced with a low-frequency term, 'possibly because they do not have a set of strategies available to identify a likely translation equivalent'. Professional translators' searching is often 'deep', i.e. involves analysing a number of resources rather than scanning search engine result pages ('shallow'). It also means the readiness to reformulate and refine queries as new ideas emerge. Furthermore, the knowledge of search strategies increases the use of operators and tendency to validate

solutions as shown by Paradowska's (2015) study of the development of research competence in translation students. Interestingly, Hvelplund (2017, 81) reported that most of his participants performed shallow Google searches, rarely using specialised dictionaries. Moreover, Google images was a search strategy in Hvelplund's study, which may have some potential in terms of teaching diverse information searching. However, this type of searching is subject to personal preference and might depend on the text type and topic.

The key question in this article is how the direction of translation affects the translator's IB. It is important to bear in mind that most bidirectional translators work with languages in which they have unequal proficiency due to unequal experience of using both languages. In addition, the status and prestige of the two languages usually differs – e.g. a world major language like English with rich OR and a language of low diffusion (e.g. Polish, Croatian, Finnish) with limited resources.

3.2. The use of OR in L1 and L2 translation

Few translation process research (TPR) studies compare the use of external resources when working into L1 and L2 (Pavlović 2007a; Ferreira et al. 2016).[1] Buchweitz and Alves (2006) report that students used more resources in the orientation stage (before they started translating) when the ST was in their L2. Ferreira et al. (2016) studied four professional translators with more than six years of experience and found that, contrary to their expectations, three translators allocated more attention (as recorded by the eye-tracker) to the Internet browser when translating into their L1.

Pavlović (2007a, 138) analysed collaborative think aloud protocols and noted that students relied more on OR in L2 translation, and used the solutions they found more often than in L1 translation. She also observed that students displayed individual preferences for certain types of resources irrespective of directionality and commented that:

> [R]esources other than bilingual dictionaries (especially the electronic resources) can provide more help in L2 translation, at least when the L2 in question is English. This can easily be explained by the abundance of materials in English on the Internet, compared to the number of texts and tools available in a language of limited diffusion such as Croatian (138–139).

The imbalance in the available resources was also noted by Gough (2017, 247) who observed that translators reported dissatisfaction with the availability of OR while translating into Polish, Hungarian, and Dutch. Kuznik and Olalla-Soler (2018) compared translation trainees to professional translators and generally confirmed a greater reliance on external resources when translating into L2 for both groups. They also found a relationship between the 'number of resources, time taken on searches, and number of searches' (49), and the quality (acceptability) of L2 translations but only for professional translators. Livbjerg and Mees (2003, 127) conducted a TAP study and reported that for the students who translated a domain-general text from Danish into English (L2) access to dictionaries extended the time spent on translation by 26 minutes on average, but it did not correlate with the quality of the final product.

The prediction of larger information needs in L2 translation is in line with the current findings from neuroscience and bilingualism research which confirm the so-called L2

cognitive disadvantage. Muñoz, Calvo, and García (2019) review neurocognitive studies and conclude that, 'differential in vivo patterns for FT [forward translation meaning L2 translation] across methods and translation units suggest that this direction implies greater linguistic and extralinguistic processing demands' (9).

Christoffels, Ganushchak, and Koester (2013) conducted an event-related potentials (ERP) study of word translation in proficient bilinguals and concluded that translating into L2 was more effortful in terms of lexical retrieval and attentional demands whereas translating into L1 resulted in more effortful comprehension of L2 words (see also García, Mikulan, and Ibáñez 2016). Numerous reaction time studies reported that participants were much faster translating words from L2 into their L1 than the other way round (Kroll et al. 2010), although the speed of access is modulated by other factors, such as language proficiency, word frequency, concreteness or the degree of semantic overlap between translation equivalents (Duyck and Brysbaert 2004; Basnight-Brown and Altarriba 2007). Hatzidaki and Pothos (2008) tested English-Greek and English-French bilinguals in a sight translation task and found that more semantic information is activated when translating from L1 into L2 than the other way round, and the imbalance affects translation performance.

Summing up, bidirectional translators resort to external support not only to resolve lexical and conceptual problems, but also to speed up access to their internal mental lexicons (Diamond et al. 2014). Larger information needs and more taxing processing demands when working into L2 predict heavier reliance on online resources. Below we report on a study to assess if these insights can be empirically validated.

4. The study

The study is a part of a larger project designed to investigate the effects of directionality on the process of translation and its end product – the EDiT project (Whyatt 2018, 2019).

4.1. Aims and methods

The aim of the study is twofold. First, we want to see how the translator's information behaviour impacts the process of translation. Next, we want to see whether translating into L2 requires more support from online resources and is therefore cognitively more demanding than translating into L1.

The research design follows the assumptions that 'cognitive processing has measurable behavioural correlates' (Jakobsen 2014, 75). We use keylogging (Translog II) and eye-tracking (Eyelink 1000 Plus), which provide an insight into the temporal aspects such as: task duration, time needed to read the text before typing starts (orientation), time for drafting the TT, and time for end revision. Time is taken as a correlate of cognitive effort needed to perform the translation task. Longer pauses during typing and their duration reflect difficulties (uncertainty, indecision) experienced by the translator including searching for information in OR. The eye behaviour of the translator, i.e. the number of times the eyes focus on the ST, TT and on OR, and the duration of the fixations is taken as a correlate of the cognitive effort needed to process the textual input (Pavlović and Jensen 2009; Hvelplund 2017). The screen capture software (Morae) is used to monitor

the way translators interacted with information. We formulated three research questions (RQs):

(1) How does the use of OR affect the process of translation in terms of time and cognitive effort?

(2) Does the direction of translation affect the way translators use OR?

(3) Does the time spent in OR correlate with the quality of translated texts?

4.2. Participants, materials, procedure

Thirty professional translators participated in the study and 26 data sets were analysed.[2] At least three years of professional experience with regular translation (minimum 50 pages per month) was required and participation was remunerated.

The study materials comprised tests gauging language dominance and four STs (around 160 words each) – two in Polish and two in English (see Whyatt 2018, 2019 for details). Each translation direction featured two different text types (Reiss 1976): a product description (descriptive) and a film review (expressive). The texts were balanced in terms of their Gunning Fog readability scores (14.1 for the English texts and 14.2 for the Polish pair). Task order was counterbalanced and the order of texts was randomised to minimise the spill over effects (Mellinger and Hanson 2018). All our participants were dominant in Polish, their L1, but also highly proficient in English. They all performed the tasks individually and on the same computer with the screen divided into the Translog window on the left-hand side (ST at the top and the TT at the bottom) and the Internet browser on the right-hand side of the computer screen (see Figure 1). This set-up provided easy access to OR without the need to switch windows. To ensure

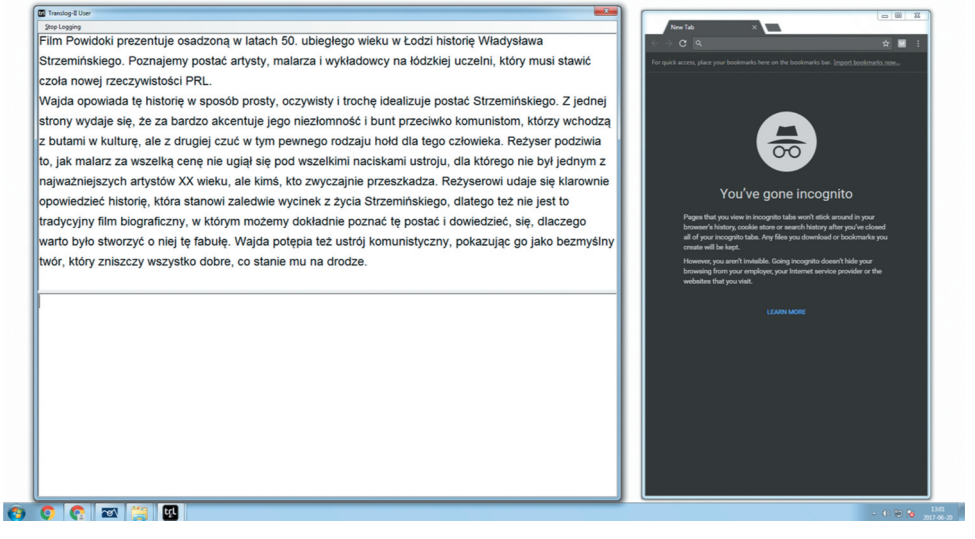

Figure 1. Experimental setup with Translog-II and Google Chrome.

no cross-participant interference regarding the choice of resources or phrasing of search queries, Google Chrome was in private mode.

4.3. Data analysis

The data from keylogging, eye-tracking and screen capture were analysed to answer the three research questions. To answer RQ1, a correlational analysis (Spearman's correlation) of total task time and time spent in the Internet browser was carried out. A three-way analysis of variance (ANOVA) with a repeated measures design was conducted to see if the average fixation duration as a correlate of cognitive effort is longer when using OR than when working on the ST and TT alone. To answer RQ2, linear mixed effects analyses (LME) were carried out, with participants as random effects and translation direction and text type as fixed effects. The following dependent variables for both directions of translation and text types were explored: time in OR (taken as a percentage of total task time), number of searches, i.e. queries typed in the browser throughout the entire task, number of searches performed in orientation, drafting and revision, the range of OR consulted (how many different sources were used), the kind of OR used (bilingual, monolingual, knowledge resources), and the type of searches performed (single, double or multiple). It was also noted whether the double and multiple look-ups involved a change of sites or a cross-language check (e.g. when an equivalent is found but the translator seeks reassurance in the target language context). In the case of significant interaction effects we conducted post-hoc tests using the Bonferroni correction to control for false positive results in multiple comparisons. Finally, to answer RQ3, Spearman's correlational analysis was applied: the time spent in OR by translators was correlated with the quality operationalised as the time needed by the proof-readers to correct the translated texts to make them publishable (Whyatt 2019).

4.4. Results

The results are presented with reference to each research question.

4.4.1. How does the use of OR affect the process of translation in terms of time and cognitive effort?

The use of OR adds up to the temporal and cognitive effort during the process of translation. There is a statistically significant strong positive correlation between *total task duration* [s] and *time in OR* [s] (r_s = 0.68, p< 0.0001). The observed relationship is stronger for L2 translation (r_s = 0.76) than L1 translation (r_s = 0.61), and stronger for product description (r_s = 0.82) than film reviews (r_s = 0.67). Bearing in mind that using OR disrupts the process of typing the TT, we correlated the number of performed searches with the number of pauses longer than 5 and 10 seconds. Correlation analyses revealed a statistically significant strong positive correlation between *the number of searches* and *the number of pauses longer than 10 s* (r_s = 0.53, p< 0.0001), and a slightly weaker positive correlation between *the number of searches* and *the number of pauses longer than 5 s* (r_s = 0.38, p< 0.0001). We found comparable correlation coefficients in both directions of translation and for both text types

A three-way ANOVA (the factors: area, direction, and text type) with a repeated measures design revealed a significant effect of *area* at which our participants looked (ST, TT, OR), F (2,184) = 155.64, $p< 0.0001$ on *average fixation duration*. Contrast analyses showed a significantly longer *average fixation duration* (greater cognitive effort, $p< 0.0001$) for the use of OR ($M= 320.30$ ms) than for the ST reading ($M= 222.03$ ms), and no significant differences for the use of OR and the visual attention to the TT (M = 313.81 ms), $p= 0.360$. Interestingly, the effect of the factor *area* was the only statistically significant effect found here (including all possible interaction effects). The results show that the use of OR (interacting with information) increases cognitive effort irrespective of the direction of translation or the text type.

4.4.2. Does the direction of translation affect the way translators use OR?

The LME analysis showed no statistically significant effect of translation direction ($b= -2.58$, SE = 2.09, $t= -1.24$, $p> 0.05$) in terms of *the percentage of the total task time spent in OR*. However, we observed a statistically significant effect of text type ($b= -7.54$, SE = 2.09, $t= -3.61$, $p< 0.01$), with our participants spending a significantly higher percentage of total task time in OR when translating product descriptions ($M= 23.79$) than the film reviews ($M= 15.19$). The interaction effect of translation direction and text type was not significant ($b= -2.11$, SE = 2.96, $t= -0.71$, $p> 0.05$).

With respect to *the number of entries into OR*, we found a statistically significant effect of translation direction ($b= -5.54$, SE = 1.29, $t= -4.30$, $p< 0.001$), and of text type ($b= -3.58$, SE = 1.29, $t= -2.78$, $p< 0.01$). The participants performed significantly more searches in OR in L2 translation ($M= 11.75$) than L1 translation ($M= 8.71$), and significantly more when translating product descriptions ($M= 10.77$) compared to the film reviews ($M= 9.69$). Also, an interaction effect of translation direction and text type yielded statistical significance ($b= 5.00$, SE = 1.82, $t = 2.74$, $p< 0.01$). Significant differences are illustrated in Figure 2.

Concerning the stages of the translation process when the translators searched for information, we observed a statistically significant effect of translation direction ($b= 0.62$, SE = 0.19, $t= 3.29$, $p< 0.01$). **In the orientation phase** the participants used OR significantly more

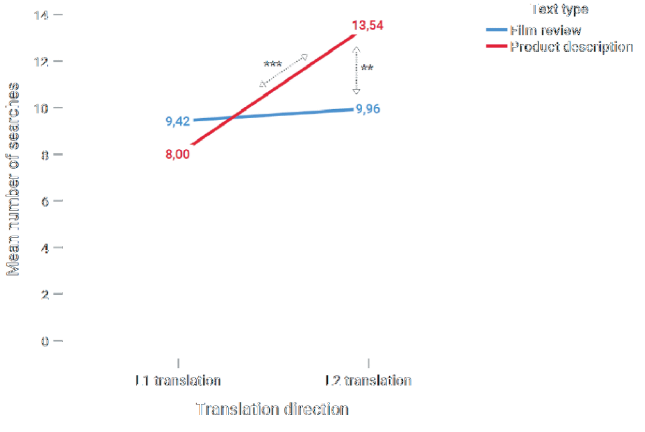

Figure 2. Effect of translation direction (x-axis) on the mean number of searches (y-axis) varying as a function of Text type (line) (**$p < 0.01$, ***$p < 0.001$).

Table 1. Effect sizes (bs), standard errors (SEs), and t-values for LME models across translation stages.

	Total			Orientation			Drafting			Revision		
Fixed effects	*b*	*SE*	*t*	*b*	*SE*	*t*	*b*	*SE*	*t*	*b*	*SE*	*t*
(Intercept)	13.54	1.29	10.51***	0.38	0.14	2.70**	12,19	1.27	9.63***	0.96	0.20	4.72***
Direction	−5.54	1.29	−4.30***	0.62	0.19	3.29**	−6,04	1.26	−4.80***	−0.12	0.23	−0.51
Text	−3.58	1.29	−2.78**	<0.01	0.19	<0.01	−3,27	1.26	−2.60*	−0.31	0.23	−1,35
Direction* Text	5.00	1.82	2.74**	−0.46	0.26	−1.75	5,62	1.78	3.15**	−0.15	0.32	−0.48
Random effects	***b***	***SE***	***Z***	***b***	***SE***	***Z***	***b***	***SE***	***Z***	***b***	***SE***	***Z***
Participants	21.51	7.51	2.86**	0.07	0.05	1.33	21.07	7.32	2.88**	0.41	0.16	2.52*
Residual	21.61	3.46	6.25***	0.45	0.07	6.25	20.62	3.30	6.25***	0.67	0.11	6.25***

*p< 0.05, **p < 0.01, ***p < 0.001

frequently in L1 translation (M= 0.77) than in L2 translation (M= 0.38). The effect of text type was not significant, and neither was the interaction effect (see Table 1).

The effect of translation direction was also found to be statistically significant (b= −6.04, SE = 1.26, t= −4.80, p< 0.001) **in the drafting phase**, with OR used more frequently in L2 (M= 10.56) than L1 translation (M= 7.33). The LME analyses also showed a statistically significant effect of text type (b= −3.27, SE = 1.26, t= −2.60, p< 0.05). While drafting, the participants used OR significantly more in the translation of product descriptions (M= 9.17) than the film reviews (M= 8.71). We also found a statistically significant interaction effect of translation direction and text type (b= 5.62, SE = 1.78, t= 3.15, p< 0.01). Figure 3 depicts the significant differences

Finally, **in the revision phase**, none of the investigated effects (translation direction, text type, the interaction thereof) reached statistical significance (see Table 1).

As regards the range of OR used by the participants, no significant effects were observed (translation direction: b= −0.35, SE = 0.29, t= −1.20, p> 0.05; text type: b= 0.15, SE = 0.29, t= 0.53, p> 0.05; interaction of the two: b= −0.23, SE = 0.41, t= −0.57, p> 0.05).

We classified the resources into three categories: knowledge resources (Wikipedia, Google searches for factual information, etc.), bilingual resources (dictionaries, bilingual corpora) and monolingual resources (monolingual dictionaries, thesauri, language

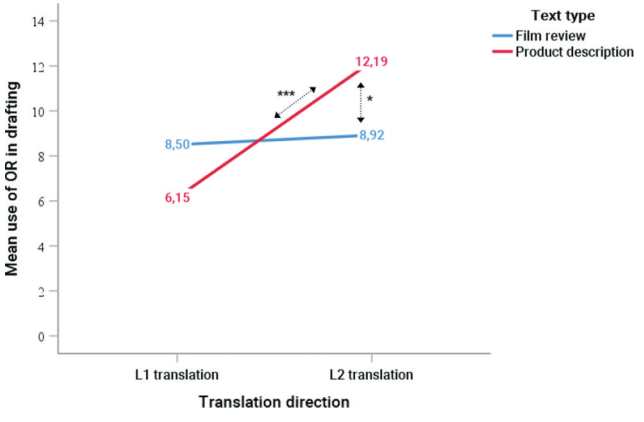

Figure 3. Effect of translation direction (x-axis) on the mean use of OR in drafting (y-axis) varying as a function of Text type (line) (*p < 0.05, ***p < 0.001).

Table 2. Effect sizes (bs), standard errors (SEs), and t-values for LME models across three kinds of resources.

	Knowledge resources			Bilingual resources			Monolingual resources		
Fixed effects	*b*	*SE*	*t*	*b*	*SE*	*t*	*b*	*SE*	*t*
(Intercept)	3.65	0.56	6.47***	9.50	1.27	7.45***	0.27	0.13	2.01*
Direction	1.27	0.75	1.69	−5.88	1.27	−4.64***	−0.19	0.18	−1.04
Text	−1.12	0.75	−1.49	−2.23	1.27	−1.76	0.08	0.18	0.42
Direction* Text	−2.04	1.06	−1.92	6.04	1.80	3.36**	0.19	0.26	0.74
Random effects	***b***	***SE***	***Z***	***b***	***SE***	***Z***	***b***	***SE***	***Z***
Participants	0.97	0.83	1.17	21.28	7.40	2.87**	0.03	0.04	0.63
Residual	7.32	1.17	6.25***	20.96	3.36	6.25***	0.44	0.07	6.25***

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

advice sites). For *the use of knowledge OR*, the LME analysis showed no statistically significant effect of translation direction or text type (see Table 2), and no statistically significant interaction effect of these two factors ($b = -2.04$, SE = 1.06, $t = -1.92$, $p = 0.58$).

For the use of *bilingual OR*, the LME analysis revealed a statistically significant effect of translation direction ($b = -5.88$, SE = 1.27, $t = -4.64$, $p < 0.0001$) and no statistically significant effect of text type (see Table 2). The participants used bilingual resources significantly more frequently in L2 ($M = 8.38$) than L1 translation ($M = 5.52$). The interaction effect of translation direction and text type yielded statistical significance ($b = 6.04$, SE = 1.80, $t = 3.36$, $p < 0.01$) – the participants used bilingual OR significantly more only when translating product descriptions into L2 ($M = 9.50$) ($M = 3.62$ for L1) ($p < 0.0001$. When translating into L1, our participants used bilingual OR more frequently ($p < 0.01$) when working on the film reviews ($M = 7.42$) versus product descriptions ($M = 3.62$). No other differences were found to be statistically significant.

Finally, there was no statistically significant effect of translation direction, text type, or their interaction effect on the number of times the translators used *monolingual resources* (see Table 2).

The last aspect of the IB we tested was the complexity of searches performed when consulting OR. *Single searches* (i.e. one source provided sufficient information to solve a problem) were by far the most frequent irrespective of the translation direction ($b = -1.15$, SE = 0.79, $t = -1.46$, $p > 0.05$) and text type ($b = -1.15$, SE = 0.79, $t = -1.46$, $p > 0.05$). A statistically significant effect of translation direction was found only with a higher number of double ($b = -0.42$, SE = 0.15, $t = -2.83$, $p < 0.01$) and multiple searches ($b = -0.58$, SE = 0.12, $t = -4.64$, $p < 0.0001$) followed by a cross-language check in L2 translation. This points to more cognitive uncertainty when working into L2.

4.4.3. Does the time spent in OR correlate with the quality of translated texts?

RQ3 asks about the impact of IB on the quality of the translated texts. There is a statistically significant moderate negative correlation ($r_s = -0.353$, $p < 0.0001$) between the time spent in OR by the translators and the time the proof-readers needed to make the translated texts publishable. The negative correlation for L2 translation is moderate ($r_s = -0.326$, $p < 0.05$) and becomes weaker for L1 translations ($r_s = -0.295$, $p < 0.05$). It is noteworthy that the recorded negative correlation is not strong.

5. Discussion and sketch of the IBiBT model

The results of the empirical study with experienced bidirectional translators working from Polish (L1) into English (L2) and vice versa show that searching for information in OR has cognitive costs which naturally add up to the complexity of the translation process. The positive correlation between the time spent in the Internet browser and total time needed to translate the experimental texts was slightly stronger for L2 than for L1 translation. Furthermore, reading while searching for information is much more demanding (less linear and in need of dynamic reorientation) than reading the ST, and comparable to the visual attention paid to the emerging TT. These results are in line with Hvelplund (2017), and Livbjerg and Mees (2003, 127) in terms of increased effort when using OR and consistent with Pavlović (2007a) and PACTE (Kuznik and Olalla-Soler 2018) in terms of more effort in OR in L2 translation.

Translation direction and its interaction with text type has a significant impact on the information needs and use by the translators but the network of effects is quite complex and dynamic. Significantly more queries were typed in OR when translation was done into L2, and more often in product description texts. This shows more uncertainty when translating into the weaker language (L2), which is justified by neurolinguistic and behavioural studies (Muñoz, Calvo, and García 2019). However, bearing in mind the lack of a significant effect of translation direction on the percentage of time in OR, it seems that a lot of consultations were brief but sufficient to act as a *bridge* in constructing knowledge to make a decision. This confirms the cost-benefit approach in the translator's IB (Pirolli and Card 1999). However, significantly more complex searches (double and multiple with a cross-language check) were needed in L2 translation, most likely to verify the appropriateness of L2 words or phrases. This kind of pronounced uncertainty was not present when working into L1 – most likely because of the richer semantic representation and more reliable language intuition (Kuznik and Olalla-Soler 2018).

A more fine-grained approach to the kind of resources used (knowledge, bilingual, and monolingual) shows that most information needs are satisfied by turning to bilingual resources (Hvelplund 2017), but this happens significantly more in L2 translation (M= 8.38) than in L1 translation (M= 5.52). Again, directionality interacts with text type, and translating the technical texts requires more support from bilingual resources (dictionaries, bilingual corpora, translators' forums such as proz.com). Interestingly, there were no significant differences in the use of monolingual resources and knowledge resources. Although the translators rarely used OR in the orientation stage, they used them significantly more often in L1 translation, i.e. when the ST was in their L2 showing the L2 cognitive disadvantage with more information searching in OR to construct meaning (Duyck and Brysbaert 2004).

The more effortful processing and significantly more queries typed in the Internet browser occurred when drafting translation in the L2 direction. The study by the PACTE group showed similar patterns, with most consultations in the drafting for the students and professional translators alike (Kuznik and Olalla-Soler 2018, 36). Finally, there are no significant effects of translation direction or text type in the revision stage. In this way, our results differ from the PACTE study which showed more use of OR in end revision in the L1 direction (Kuznik and Olalla-Soler 2018, 37). The results discussed so far are

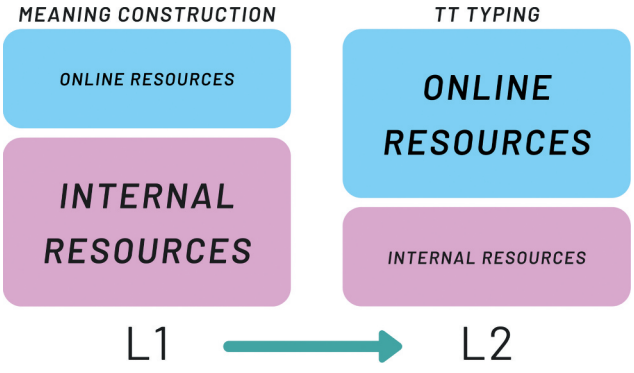

Figure 4. Information behaviour in bidirectional translation – the IBiBT model (L1→L2).

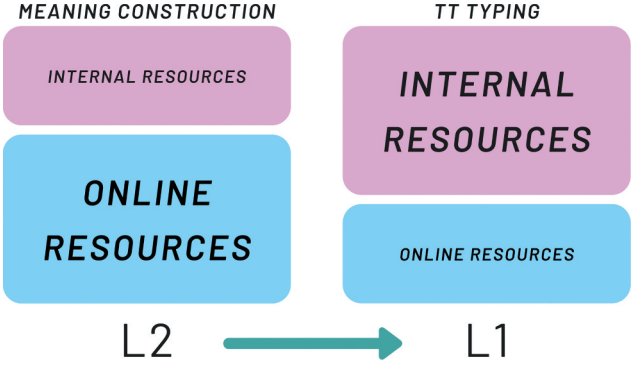

Figure 5. Information behaviour in bidirectional translation – the IBiBT model (L2→L1).

illustrated in Figures 4 and 5 in which the significant differences in IB depending on the direction of translation are visualised in a sketch of a model.

The model shows how the use of ORs in bidirectional translation is driven by cognitive uncertainty experienced at different stages depending on directionality – more support is needed to construct meaning in L1 translation, but when typing the target text, online resources are consulted more in L2 translation. The actual proportion of interaction between the translators' internal resources and online resources is also modulated by the type of text. The impact of both factors, the direction of translation and the text type, on information needs and use should be made more explicit when preparing students to provide services in bidirectional translation.

Finally, the texts produced by the translators who spent more time in OR needed less time to be corrected, pointing to a correlation between IB and the quality of translation and thus confirming the effective use of online resources. This result has to be interpreted with caution as the correlation is moderate to weak. PACTE (Kuznik 2017) found a correlation between the use of OR and the quality of L2 translations for professional translators but not for translation students (also Livbjerg and Mees 2003; Pokorn et al. 2020). The dynamic interaction between the use of OR, translation expertise, directionality and the quality of translated texts needs to be explored in more detail and the results could prove important for the training of translators (Gough 2019), and especially of bidirectional translators.

6. Implications for the training of bidirectional translators

The results of the study highlight the need to prepare future translators who are likely to provide services in bidirectional translation to expect different information needs depending on the direction in which they translate. If they translate between an LLD and, for example English as a *lingua franca*, they might also experience an imbalance in the available resources. Our participants, being experienced translators, used an equal range of resources in both directions, but L2 translation injected a greater measure of uncertainty into the translation process, compared to L1 translation, therefore some awareness raising tasks could be suggested. For example, trainees could make a record of their information searching when translating a similar text into their L1 and L2 to identify their own information needs depending on the translation direction. Sharing their experiences in the classroom could provide opportunities to discuss the range of available resources for each translation direction, as well as to focus on language-specific cross-cultural issues (Pokorn et al. 2020). This is especially important when the students' L1 is a language of low diffusion and low resources and when, at the beginning of their training they lack the knowledge of which OR are trustworthy (Pym 2013).

Avoiding unnecessary risks was demonstrated by the professional translators in our study who, while favouring bilingual dictionaries, performed more cross-language checks when translating into their L2. This shows that, despite their experience in bidirectional translation, they treated the L2 equivalents found in bilingual dictionaries with limited confidence and used them only when the gap between *the uncertain* and *the certain* was bridged by an additional check in L2 OR. The translation students could develop this vigilant procedure by using parallel texts to check the potential equivalents they find in bilingual dictionaries or bilingual concordancers. This could be practised either when translating short texts representing various types, or as pre-translation tasks with the focus on the so-called rich points – words which are likely to require the use of OR. The exercise would involve reading and analysing a specialised text (both in L2 and L1) without drafting the translation at all to lessen the cognitive effort of the entire process. Using authentic texts (like the product description in this study) would further allow students to immerse themselves in the task of researching a new domain, its terminology and phraseology to boost their ST analysis and build up their confidence before they start drafting their translation. An alternative task could involve building task-and-text-specific corpora in the source and target languages – the so-called DIY corpora (Bernardini 2016). This would illustrate the difference in text availability in LLDs as opposed to the abundance of resources in English for various topics and domains, even very narrow ones. Students would then be able to discuss any potential difficulties they had with finding texts suitable for this exercise and work out procedures to arrive at a satisfactory solution being guided by the information they find (Kuusi, Koskinen, and Riionheimo 2019).

Finally, translation students should be encouraged to use information sources wisely in line with their own personal style (Gough 2019) and be aware that the process of searching for information adds up to the temporal and cognitive cost needed for translation (Hvelplund 2017). The very awareness of different information needs depending on the direction and text type may serve as a compelling argument for translation trainees to allot more time to the stages of the translation process which require more time in OR. Such conscious planning might lead to improving their ability to meet client deadlines. Searching for information is

a process with its own physical, cognitive and affective cost (Kuhlthau 2008) but the cost of obtaining information should not exceed the benefits from using it.

7. Conclusions

Translation is knowledge intensive work. Translators search for information when they experience uncertainty in their knowledge construction processes in the hope that OR will facilitate their decision making. The results of the study combining keylogging, eye-tracking, screen recordings and the work of proof-readers who corrected the translated texts show that: (1) searching for information adds more cognitive effort to the already demanding process of translation, and slightly more when the translators work into their L2; (2) professional translators experience more uncertainty when producing translation into their L2; (3) the majority of problems are of a linguistic nature and bilingual resources are most frequently used but significantly more in the L2 direction; (4) translators follow the least effort principle and single searches are most common irrespective of the direction; (5) skilful searching for information might have a positive effect on the quality of translated texts, including L2 translations. We used the empirical evidence to model the information behaviour in bidirectional translation and we suggested how the results can be used to raise awareness of different information needs in translation students. The study presented here is not without limitations – it is based on one language pair and professional translators who, most likely have well-tested searching strategies. More research on how information behaviour evolves into efficient skills is needed, especially to give guidance to bidirectional translators in situations when the desired information is not found – e.g. when one of the languages is of low diffusion and there are limited resources.

Notes

1. Although the use of external resources (printed dictionaries) was reported in some TAP studies, many later TPR studies did not allow the participants to use OR because: (1) the keylogging program in which the translators worked (Translog) would not record the activity anyway; (2) when eye-tracking was added, using OR was believed to complicate the data collection process (Pavlović and Jensen 2009, 95; Lourenço da Silva et al. 2017, 117).
2. Four data sets were incomplete. Out of 26 participants 2 were also excluded from the eye-tracking analysis either because of the missing data set or poor quality of the eye-tracking record.

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Appendix M: Research Article 3

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The proof of the translation process is in the reading of the target text: An eyetracking reception study

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ABSTRACT

This article is an attempt to bridge the divide between translation process research (TPR) which has investigated how translators as specialised bilingual professionals use their expertise to translate texts and translation reception which explores how the texts are read and received by the target language readers. Over the last thirty years, TPR has provided empirically grounded findings to demonstrate the complexity of the cognitive processes in the translator's mind but much less empirical interest has been paid to how translated texts are read and processed by the readers. To redress this imbalance, we hypothesise that the cognitive effort invested in reading a translated text can be taken as proof of how successful the translation process has been. We report on an exploratory study in which two groups of participants read a high-quality and a low-quality translation of the same text while their eye movements were recorded by an eyetracker. We compare the readers' cognitive effort indexed by character-adjusted dwell time, number of runs and re-reading in the second and third run with the translators' character-adjusted cognitive effort invested in producing the target texts. The results show that the relationship between the translation process and the reading experience is not straightforward and depends on the quality of the target text.

1. Introduction

This article is an attempt to bridge the divide between translation process research (TPR) which has investigated how translators as specialised bilingual professionals use their expertise to translate texts and translation reception which explores how the texts are read and received by the target language readers. Although our understanding of the translation process has been enhanced as a result of intensive experimental research within TPR, in the real job market, the translator is paid for the product – not for the process of creating the translation – and the rates are calculated based on the word count or per standard page. In Poland, payment is calculated in standard pages (1 page is 1800 characters with spaces). In other words, the money earned for a translation depends on how many words/letters are in the end product, not on the number of keystrokes in the process of typing the translation (e.g., total user events in *Translog*), or the actual time devoted to produce the target text (total task duration).

The end user, i.e., the reader, reads the target text, so the target text is the key element central to the process of producing and receiving a translation. As defined by Rayner et al. (2016), reading is the processing of textual information to recover the meaning intended by the author for each word, phrase, and sentence. Apart from some literary texts where the author deliberately creates ambiguity, authors want their readers to comprehend all of the words in the text.

It can be assumed that translators produce texts, especially those belonging to functional text types, so that the target readers can understand the intended meaning of each word, phrase, and sentence. In this article, we hypothesise that the cognitive effort invested in reading a translated text and measured by the reader's eye movements can be taken as proof of how successful the translation process has been, i.e. resulted in a well-written target text. To this end, we report on an exploratory eyetracking study in which we look at how translated texts are read and how the reader's reception effort relates to the translator's production effort. Aware of the complexities involved, we call for redressing the imbalance between translation process research and translation reception studies.

2. The need to redress the production reception imbalance

According to Chesterman (1998), translation is done to bring effects

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on individuals and society. The primary effects are cognitive effects referring to the change in the mental or emotional state of the reader who reads a translated text. The secondary effects are behavioural in nature. As a consequence of reading a translation the reader might implement some changes in the behaviour, knowledge, actions, and aesthetic experiences. The tertiary effects reach further and expand to the entire target culture, the intercultural relationship between the source and target culture and affect society at large. These theoretical assumptions, although very appealing, have rarely been empirically validated.

Walker (2021a) in his article, "Investigating How We Read Translations: A Call to Action for Experimental Studies of Translation Reception", points out the imbalance between a robust body of research into how translations are produced using experimental study designs and data collection tools including keylogging and eyetracking, and the lack of empirical investigations into how translated texts are received and experienced by readers.

Over the last thirty years, TPR has provided empirically grounded findings to demonstrate the complexity of the cognitive processes in the translator's mind (Xiao and Muñoz, 2021). Keylogging programmes (Translog, Inputlog) as data collection tools allowed researchers to see how the target text is produced in real time without engaging the translator in an additional task in a way Think Aloud Protocols did (Jakobsen, 2003). Keylogging studies provided evidence for the phases of the translation process – orientation, drafting and revision (Jakobsen, 2003), different translation styles (Dragsted and Carl, 2013), and the impact of translation expertise on the decision-making processes, among others. The deeper understanding of the complexity of the translation process was further expanded thanks to the use of eyetracking and studies looking at how translators interact with the source and target texts as well as with information sources, and how they use the available technology to increase productivity.

Much less effort has been devoted to testing the relationship between the translation process and the quality of the end product or the way it is read and comprehended by the target reader. Kruger and Kruger (2017) review the few studies which explored the effect the translator's choices have on the target audience (Kenesei, 2010; Moran and Perego, 2012; Puurtinen et al., 1994; Rojo et al., 2014; Zasyekin, 2010) and conclude that, "there is clear evidence that the way in which translators choose to translate a text affects the kinds of cognitive representations that readers subsequently construct from the linguistic features …". For example, Zeven and Dorst (2021) argue that the linguistic choices in two Dutch translations of *The Great Gatsby* influence the way the fictional character – Daisy Buchanan is perceived by the reader. With the loss of the author's ambiguity which encourages the readers to form their own opinion, the translators of the two versions which are being compared offer a biased characterisation and encourage potential gender stereotyping by readers. This interesting comparative analysis of three narrative elements (theme, setting, and point of view) and theory-driven conclusions have not been validated empirically but they could be. As pointed out by Kruger and Kruger (2017), "studies of the cognitive dimensions of producing and receiving translated materials have developed largely separately, with few attempts to connect the two processes."

This article is an attempt to bring together the translation process and the reception of the end product – the translated text. The first hurdle in these empirical explorations of the production-reception crossover is that the reader interacts with the product. What we know about the translation process was very often driven by our curiosity about how and why particular decisions are made, and which are cognitively more demanding than others. Much less attention has been paid to the relationship between the translator's cognitive effort and the quality of the final translation version, that is the text which is read by the target readers. Very few studies have included any evaluation of the end product or triangulation of the process and product data (Carl and Buch-Kromann, 2010; Hubscher-Davidson, 2009; Lehka-Paul, 2020).

Translation quality is a complex concept. As argued by Kotze et al. (2021), the individual and social expectations of what constitutes a good translation are shaped by norms defined as "cognitive-evaluative templates". These normative constructs have conceptual, evaluative, and affective dimensions which shape the translator's choices and the reader's expectations when interacting with translated texts. Still, translation quality is relative to the purpose of the target text and remains difficult to measure. One of the ways to operationalise it is to measure the equivalent effect a translated text has on the reader.

3. Eyetracking the reader's experience and methodological challenges

To date, research into eye movements in Translation Studies (TS) and in Cognitive Translation and Interpreting Studies (CTIS) has mainly been reported in translation process research where eyetracking measures (fixation count and duration) were used as correlates of the increased cognitive effort when reading for translation (Alves et al., 2011; Jakobsen and Jensen, 2008), evidence for parallel processing of the source and target language (Schaeffer et al., 2016), coordination of reading and writing (Dragsted, 2010; Hvelplund, 2017), or the use of on-line resources (Whyatt et al., 2021).

Very few studies have used eyetracking to investigate the effect the translator's choices have on the readers outside the research in AVT into how subtitles are read by viewers (Gambier, 2018; Gerber-Morón and Szarkowska, 2018; Hu et al., 2020; Orrego-Carmona, 2016). Kruger (2013) and Walker (2019, 2021b) are known examples of studies which applied eyetracking to explore the effect of the translation strategy on the readers of translated literary texts. Both studies measured the reader's cognitive effort when processing selected phrases in the translations.

Kruger (2013) used eye movements to investigate how Afrikaans children and adult readers processed and responded to foreignised and domesticated textual elements in children's picture books translated from English into Afrikaans. The specific research questions asked whether foreignised elements affect the cognitive effort and comprehension scores of both reader groups. The eyetracking measures included first fixation duration, dwell time, fixation count, and glances count for areas of interest (AOIs) corresponding to domesticated and foreignised textual elements. The effect on comprehension was checked by short questionnaires (adult readers) and interviews (child readers). The author concluded that, "the findings of the experiment demonstrate that while there are perceptible effects on processing and comprehension associated with the use of foreignising strategies, these effects are not straightforward or uniform, with notable differences not only for different AOIs, but also for child and adult readers" (Kruger, 2013).

Walker (2019, 2021b) used eye movements to compare the reading experience of source language (SL) readers who read extracts from a novel *Zazie dans le métro* originally written in French by Raymond Queneau in 1959 with the reading experience of target language (TL) readers who read the same extracts from the English translation – *Zazie in the Metro* translated by Barbara Wright in 1960. Using eye movements as correlates of cognitive effort, Walker focused on the cognitive equivalent effect on the TL readers. This expectation is in line with key concepts from literary reception studies of narrative engagement and the sensations on the reader activated by the reading process (Scott, 2012) – Chesterman's (Chesterman, 1998) primary effects.

Similar to Kruger (2013), the effect on the TL reader is measured with respect to specific stylistic devices which are quasi-phonetic forms ('concertina words'). Processing such stylistic elements required substantial effort from the SL readers. Walker assumed that if the TL readers experienced comparable effort when reading the English translation of these concertina-words then the translator managed to create an equivalent effect. Native French speakers (N17) read four French extracts ranging from 700 to 1500 words and English speakers (N14) read the same extracts translated into English while their eye movements

were recorded. Three parameters were analysed – first fixation duration, gaze duration and total fixation duration in AOIs which included altogether 7 concertina-words in the SL text – 4 of them were rendered "in a stylistically 'equivalent' manner in the TT, and three of which have not". The results showed that the effect on the TL reader was similar to that on the SL reader in terms of comparable eye movement measures only if the translator had applied orthographic manipulation to challenge the reader's imagination.

Both studies show that eye movement data are a valid measure of the effect translator's decisions have on the readers of translated texts. In both studies the reader's reactions are measured in response to the final well-groomed product – a published literary translation.

In the study reported here, we go beyond measuring reactions to selected phrases in the translated texts. We want to show the process in which the translator's decisions are made, the end product of these decisions and the process of receiving the target text by the reader. In particular, we want to explore whether the effort invested by the reader when reading the translated text in any way relates to the cognitive effort invested by the translator.

4. Challenges in operationalising the reader's and the translator's effort

At first glance, the cognitive effort of the translator and the reader seems disproportional, but we really would like to know if the translator's effort pays off when the text is being read – well translated coherent text should read with ease. Taking into consideration the measures of the cognitive effort of the translators and readers, we take the target text as a point of departure – cognitive effort is needed to produce it and to read it.

The first methodological challenge we face is finding a measure of cognitive effort that could reliably capture the effort invested by the translator and the reader of the translation. The concept of cognitive effort defined as the amount of mental resources invested in the task of producing a translated text has been central to TPR (Krings, 2001; Kruger, 2016; O'Brien, 2011; Lacruz, 2017; Vieira, 2014). The cognitive effort of translators has been operationalised depending on the method chosen to collect the data. In keylogging studies, following Jakobsen (2014) assumption that there is a correlation between problem-processing and effort duration, time on task was taken as a proxy for cognitive effort with other measures including number of long pauses, typing speed and the use of online resources, among others (Hvelplund, 2019; Koponen et al., 2012; O'Brien, 2006). In eyetracking studies, the translator's effort was measured mostly by total fixation duration, fixation count, and duration (Jakobsen and Jensen, 2008; Schaeffer et al., 2016; Hvelplund, 2019). There is a substantial body of evidence that the increase in cognitive effort can be related to the features of the source text (lexico-semantic, stylistic, and syntactic complexity) and the level of translation expertise – well-seasoned translators capitalise on their experience. Another factor which is known to contribute to the effort invested in producing a translation is time pressure (Carl and Kay, 2011; Rojo López et al., 2021).

The reader's effort can be indexed by the reading rate – number of words per minute (wpm). Brysbaert (2019) conducted a meta-analysis of 190 studies based on 18,573 participants and estimated that the average silent reading rate for educated adults in English is 238 wpm for non-fiction (the range is 175–300 wpm) and 260 wpm for fiction (range: 200–320 wpm). Fiction is read faster because the words used are usually high in frequency, shorter, and the sentence structures are less complex than in non-fiction texts which are likely to include fewer known words, specialist terminology and more sophisticated syntax. The use of the eyetracking technology has brought more fine-grained measures of the reader's cognitive effort when reading for comprehension. The early reading measures (first-run viewing) reflecting the word recognition processes are indexed by first fixation duration and gaze duration (time spent viewing a word until a saccadic movement is made to fixate on another word) and are related to lexical access (mapping the written word with its meaning stored in the long term memory). Late reading measures refer to comprehension-monitoring processes which kick in when more time is needed for meaning integration and are indexed by regressions to the previously read words and second- and third-run dwell time – re-reading or re-viewing for re-processing (Inhoff et al., 2019; Rayner, 1998). A global measure of cognitive effort can be also indexed by total fixation duration (dwell time) and fixation count.

Numerous studies have shown that more frequent words as well as shorter words are processed faster than less frequent and longer words, and words which are highly predictable from the context need very short fixations or are skipped by the eyes (Ehrlich and Rayner, 1981; Juhasz et al., 2008; Rayner and Duffy, 1986; Staub, 2015). Short words, if not skipped, are fixated once and at the *preferred-viewing locations* (PVL) usually to the left of the word's centre (Rayner, 1978). Longer words, if fixated twice, will receive the first fixation near their beginning and the second near the end. Rayner and Well (1996) found that highly predictable words (86% cloze probability) were read faster than words with a medium level of contextual probability (41%), whereas low-predictable words (4%) were read more slowly. Additionally, factors which slow down the reading process include semantic and syntactic ambiguity (Rayner and Duffy, 1986; Frazier and Rayner, 1982; Wiley and Rayner, 2000) and inconsistency with what has been read or with what the readers know.

The fine-grained knowledge of the reading process comes from studies which focused on single word recognition and sentence reading. In whole-text reading, the reader's effort is modulated by the linguistic features of the text – lexico-semantic, stylistic, and syntactic complexity, information density, and the reader's language skills, cognitive abilities including executive control, working memory, and knowledge of the theme.

It seems that the cognitive effort of both translators and readers of the translated text is dependent on the features of the text and on their own contribution in terms of knowledge and skills derived from their experience with texts. It is tacitly assumed that good translators are aware of their readers' expectations and communicative needs (Apfelthaler, 2014; Shreve, 2009), and therefore they should be able to predict the readability of the translation they consider good enough to be read by the target reader. Translators take much longer to produce a translation which a reader will take a minute to read. Therefore, to find a common denominator for both, we calculate the cognitive effort of the translator as the total time needed to produce the translation divided by the number of characters with spaces in the target text. This has pragmatic relevance – translators are paid for the text they have produced. This simple formula gives us a character-adjusted measure of effort for the translation process to overcome the differences in the length of words and sentences.

In a parallel fashion, we derive a character-adjusted measure of the reader's effort – dwell time per character with spaces to mirror the translator's effort. Although we know that when reading, we do not process every letter, we also know that the length of words is a strong predictor of the cognitive effort needed to process them (Brysbaert, 2019). Character-adjusted measures of effort have been used by Kruger (2013) and Walker (2019) in translation reception studies and by Hyönä and Niemi (1990) in whole text reading research. O'Brien (2010) analysed 14 data sets in an eyetracking study investigating the effect of controlled language rules on the readability of texts and noted that looking at "fixation count as a function of characters per text" was a more accurate measure because the experimental texts differed in the number of words and characters.

5. The study

This exploratory study aims to examine the relationship between the process of producing and receiving a translation, and remains focused on the concept of the cognitive effort invested by the translators to create

the target text and the reader's effort to process the text in order to extract information about the product described in the text.[1] We want to examine whether the outcome of the translation process can be measured by the reader's eye movements which index the reading experience in terms of the cognitive effort that is observable in the fluency of reading. We expect that an efficient translation process where decisions are made with professional diligence should result in a high-quality (HQ) translation which will read better, i.e., with less need for re-reading to integrate meaning than a low quality (LQ) translation. We assume that due diligence requires cognitive effort to tailor the target text to the reader's expectations and ensure its communicative quality. At a more fine-grained level of analysis, we want to see if the sentences which required the least cognitive effort from the translators also required the least cognitive effort from the readers and vice versa – whether the sentences which required the most cognitive effort from the translators were similarly taxing for the readers.

We formulated three research questions (RQ):

RQ1. Is there a systematic relationship between the translator's cognitive effort when producing the translation and the reader's effort when reading the translated text?
RQ2. Are the sentences which required the least character-adjusted cognitive effort from the translator read with ease, that is require little character-adjusted cognitive effort from the reader?
RQ3. Are the sentences which required the most character-adjusted cognitive effort from the translator read with effort, that is require more character-adjusted cognitive effort from the reader?

5.1. Materials

Our materials are two translations of a product description text (ceiling fan) from English (L2) into Polish, the translators' native language (L1). The translations were selected from the set of 26 translations produced by professional bidirectional translators in the EDiT project.[2] One translation was evaluated as a high quality (HQ) translation, because it required very few corrections to be ready for publication; the other one required many corrections to be ready for publication and was classified as a low-quality (LQ) translation (for details on the quality assessment by the proofreaders see Whyatt (2019)). The specific descriptors of the source text (ST) and the two translations together with the readability measures are presented in Table 1.

Looking at the readability measures, all three texts were considered fairly difficult to read but notably the ST had the lowest Fog index, whereas the HQ translation could be assessed as the most difficult to read because of its high Fog index, long sentences and more words than the LQ translation.[3] Both translations were produced by professional translators who participated in the EDiT project. We have a full record of the translation process including the keylogging files in Translog II, the eyetracking data collected by EyeLink 1000 Plus and the screen-capture data showing the interaction with information sources during the entire task. We also have a record of the corrections made by the proofreaders who were asked to make the translated texts publishable. The changes made in the HQ translation included the correction of a punctuation error and a stylistic error (2 minor errors). The changes made in the LQ translation referred to as many as 17 remarks in total: 10 minor corrections to vocabulary, 2 changes related to grammar – wrongly inflected noun and wrong use of the imperfective aspect, 3 typos, and 2 punctuation mistakes. Additionally, one major error affecting logic was found – opposite meaning. The participants in our reading experiment read the selected texts without these corrections, that is as they were produced by the translators. Table 2 provides information about the translators and the translation process of the HQ and LQ translation with the average score for the 26 translators who participated in the EDiT project.

The data in Table 2 show that the two translators differed in terms of years of experience and the LexTALE score which indexes their proficiency in English, the source language. They also differed in the time allocated to the task, especially at the stage of end revision, and the typing speed. The translator who produced the HQ target text was closer to the group average than the translator who produced the LQ translation. If cognitive effort can be taken as a proxy for due diligence expected of professional translators to ensure a high-quality translation, we could argue that the HQ translation was produced by a diligent translator. Table 3 shows the character-adjusted amount of cognitive effort calculated by dividing the time spent translating each sentence by the number of characters with spaces in each sentence of the HQ and LQ translation. We excluded the first sentence because the time spent translating it most likely included time for orientation.

The values in Table 3 show that for the translator of the HQ translation S3 was the least demanding and S2 required the most cognitive effort. The translator of the LQ translation expended the least effort to produce the translation of S7 and the most effort to translate S3. Interestingly, the sentence which required the least cognitive effort from the translator who produced the HQ translation (S3) required the most cognitive effort from the translator who produced the LQ translation. This shows that translation difficulty is subject to individual differences and most likely heavily dependent on the translator's expertise (Jensen, 2009; Sun, 2015).

The values in Table 3 are needed to answer our research questions.

5.2. The participants in the reading experiment

Twenty native speakers of Polish took part in the reading experiment (M_{age} = 20.8 years; SD = 0.834). All of the participants had normal or corrected-to-normal vision and were reimbursed for their time. The participants were also highly proficient in English, which meant that they were in a better position in terms of reliance on the translated text than Polish monolinguals – if dissatisfied with the translation they could read the source text to access information. The LexTALE test score (Lemhöfer and Broersma, 2012) with the mean of 81.2% (N = 20, SD = 6.22) shows that their proficiency in English corresponds to C1/C2 level (CEFR). The participants formed a fairly homogenous group in terms of their reading habits — 73% declared to be passionate readers and 72% read texts in a digital format rather than in print. In terms of their attitude to translations, as many as 85% stated that they sometimes noticed that they were reading a translated text, not an originally written text. 45% of our informants stated that, if given a choice, they would prefer to read a book in the original rather than its translation into Polish, 30% declared that they had no special preference, and 25% would choose a translation. The majority of our participants rarely noticed errors in translated texts with 42% claiming that they sometimes noticed translation errors and 16% claiming that they have never identified errors in translations. All information about the participants was collected after the reading experiment.

5.3. The procedure

The experimental procedure was approved by the Ethics Committee for Research Involving Human Participants at Adam Mickiewicz

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[2] Grant No. UMO-2015/17/B/HS6/03944 from the National Science Centre Poland.
[3] The differences in the number of words in the ST and the two translations are due to the typological differences between the source language (English) – an analytic language and the target language (Polish) – a synthetic (inflectional) language.

Table 1
Readability metrics for the ST, HQ and LQ translations.[a]

Text	No. of characters with spaces	No. of words	No. of sentences	Average sentence length [in words]	Average word length [in characters]	Fog Index – text level
ST	941	162	8	20	4.7	12.57
HQ translation	1138	145	8	18.1	6.8	19.11
LQ translation	1011	136	8	17	6.4	13.86

[a] The Gunning Fog Index was used to calculate readability measures for the ST in English: https://charactercalculator.com/gunning-fog-index/and Jasnopis.pl was used to calculate readability measures for the translation in Polish: https://www.jasnopis.pl/aplikacja#.

Table 2
Information about the translators who produced the HQ and LQ translation.

Translator of	Years of experience	LexTALE score	Task duration [in seconds]	Typing speed [in TUE per min]	Time for orientation [in seconds]	Time for drafting [in seconds]	Time for revision [in seconds]
HQ translation	25	91.25	1366	82.38	57	830	479
LQ translation	3	71.25	648	138.13	50	578	20
Average score for the 26 translations	11.5	92.3	1138	100.00	69	834	235

Table 3
Values for the character-adjusted translator's effort (in milliseconds (*ms*)) in the LQ and HQ translation for sentences (S) 2 to 8.

Translator's effort in *ms*	S2	S3	S4	S5	S6	S7	S8
in HQ translation	1562.25	242.41	847.63	493.45	453.01	485.12	901.76
in LQ translation	435.19	779.39	581.71	530.99	549.39	432.76	496.47

University in Poznan. The experiment was programmed in the Experiment Builder of EyeLink 1000 Plus (SR Research). The data were collected in the EYE-LANG lab (AMU Faculty of English). The participants first read a brief description of the experimental procedure and became familiar with the eyetracking set-up, including the use of the forehead and chin rest to minimise head movement. After giving their written consent, each participant was tested for eye dominance (due to monocular tracking). The research assistants explained the calibration procedure and the sequence of the reading tasks followed by 4 true/false statements to check for comprehension. This comprehension check is often used in reading research to enhance motivation for careful reading without biasing the reader to focus on any specific purpose, which could make them selectively attend only to purpose-relevant information (Kaakinen et al., 2003; Kaakinen and Hyöna, 2005). The fifth question asked the participants about the effect the text could have on their hypothetical future actions (Chesterman's (1998) secondary effects), e.g., whether having read the description of a ceiling fan they felt encouraged to buy the described product.

The experiment started with a baseline text for all participants so that they could become familiar with the procedure. Next, the participants were randomly assigned to the high-quality (HQ) condition (N10) and to the low-quality (LQ) condition (N10). The two product description texts (LQ and HQ), which are analysed for the purpose of this study, were read silently after the baseline text in both conditions. Then, the participants read three more texts which are not analysed in this paper.

The text was displayed on a 24-inch monitor with 1920 x 1080 resolution. The font was Arial 25 pt. with line spacing set to 2.5, which allowed for the entire text – 10 lines – to be presented on one screen. After the participants read the text, they pressed the right ENTER key bar to continue to the next page with 4 true/false questions and a question whether the text encouraged them to buy the described product – a ceiling fan.

The reading task (5 texts in total) together with comprehension check took about 10 min for all of the participants. Then, the participants were briefly asked about their reading experience, and filled in a set of questionnaires.

5.4. Data analysis – the reading experiment

The analysis of the eyetracking data was performed in Data Viewer (SR Research). The texts were divided into sentences so that each sentence became a separate area of interest (AOI). This gave us 8 AOIs in the HQ and LQ translation. The source text also had 8 sentences confirming that the translators seem to be reluctant to change sentence boundaries and prefer to stick to the information structure of the ST (Vandepitte et al., 2013). A manual drift correction where calibration issues caused systemic shifts of fixations was carried out to assign all fixations to the relevant AOIs. The key correlate of the reader's effort was dwell time (total fixation duration) divided by the number of characters with spaces to yield a character-adjusted amount of cognitive effort (see Walker, 2019). In this way, we received a character-adjusted measure of effort for the readers to match the character-adjusted effort invested by the translators – the latter are shown in Table 3 with the values for the character-adjusted translator's effort (in *ms*) in the LQ and HQ translation for sentences 2 to 8. Additionally, we looked at the number of runs when reading each sentence – how many times the eyes returned to the AOI after exiting it, and dwell time during the second and third run as correlates of meaning integration effort. These values were not character-adjusted because re-reading is not systematic and occurs only in response to processing difficulties when alerted by comprehension monitoring (Inhoff et al., 2019; Hessel and Schroeder, 2022; Stafura and Perfetti, 2017). For statistical testing, we used Jamovi software (ver. 2.3.21) to perform linear mixed-effects model analyses. All the remaining statistical analyses were conducted in SPSS (ver. 27).

5.5. Results

5.5.1. Testing a systematic relationship between the translator's cognitive effort when producing the translation and the reader's effort when reading the translated text (RQ1)

Following the assumption that diligent and careful translation requires effort, we conducted a mixed-effects analysis investigating the reader's reception effort relative to the translator's production effort in

the entire dataset irrespective of translation quality. In the first step, we fitted a linear mixed-effects model with the *reader's reception effort* (operationalised as dwell time per character with spaces) as a dependent variable, the *translator's production effort* (operationalised as total time to produce a sentence in milliseconds divided by the number of characters with spaces in the target text) as a fixed factor, and *participants* and *sentences* (sentences 2–8) as random effects. The analysis reveals no significant effect of the translator's effort ($b = -0.001$, $SE = 0.005$, $t = -0.220$, $p = 0.826$) on the reader's reception effort.

Since the two translated texts differed in translation quality, we further explored whether the reader's reception effort differed in the two experimental conditions, i.e. when reading the HQ versus the LQ texts. To achieve this aim, we factored in *translation quality* (HQ and LQ condition) as a fixed factor in the linear mixed-effects model, with the *reader's reception effort* as a dependent variable, and *participants* and *sentences* (sentences 2–8) as random effects. The analysis reveals a significant effect of translation quality ($b = -11.736$, $SE = 4.453$, $t = -2.635$, $p = 0.017$) (see Table 4). The participants show greater reception effort when reading the low-quality translation ($M = 50.21$) as compared to reading the high-quality translation ($M = 38.31$), where the reader's effort is operationalised as character-adjusted dwell time in milliseconds.

To further explore the interplay between the translator's production effort, translation quality and the reader's reception effort, we performed correlation analyses separately for each condition (HQ and LQ translation). We tested whether there was a significant relationship between the *translator's production effort* measured per sentence (S2, S3, S4, S5, S6, S7, S8) in the HQ translation and in the LQ translation and the *reader's reception effort* recorded when reading these sentences.

Spearman's correlation analysis run separately for the HQ translation (S2–S8) shows that there is no statistically significant correlation between the translator's production effort ($Me = 493.45$) and the reader's reception effort ($Me = 34.54$), $r_s = 0.116$, $p = 0.169$ when reading the HQ translation. This shows that when readers read a HQ translation, there is no systematic relationship between their effort and the effort put into producing the text by the translator. Perhaps some sentences require more production effort and some require less production effort but if the outcome of both is a high-quality translation, the readers seem not to notice any difference, because they are reading a clear well-written text. However, Spearman's correlation analysis run for the sentences (S2–S8) in the LQ translation shows that there is a statistically significant weak negative correlation between the translator's effort ($Me = 530.99$) and the reader's effort ($Me = 45.31$), $r_s = -0.214$, $p = 0.037$. It seems that when the translator's production effort is smaller (less time spent to produce a target sentence, measured in *ms* per character with spaces), the reader's effort in the LQ condition is greater (more dwell time per character with spaces). By the same token, when the translator's effort increases (longer time spent to produce a target sentence), the reader's effort decreases, although the strength of the correlation is weak.

Bearing in mind that the reading process is not only about fluency but primarily about comprehension, we also tested whether there is a relationship between the reader's reception effort and the accuracy of their answers to the four comprehension questions. Spearman's correlation analysis shows that there is a moderate positive correlation between the character-adjusted reader's effort and the accuracy of the comprehension task in the HQ translation ($r_s = 0.47$, $p < 0.001$), whereas in the LQ condition the obtained correlation is still positive but weak ($r_s = 0.28$, $p = 0.010$). This outcome was not predicted at the design level and needs to be explored further to uncover how inconsistencies and errors in translated texts affect meaning making processes for the reader.[4]

[4] We would like to thank the anonymous reviewers for their suggestions to expand the data analyses in response to RQ1.

5.5.2. Comparing the reader's effort and the translator's effort in the HQ and the LQ translation (RQ2 and RQ3)

We compared the reader's effort put into reading the sentence which was the least effortful to translate and reading the sentence which was the most effortful to translate. The analyses were performed separately for the HQ and LQ translation. As detailed in Table 3, in the case of the HQ translation, S3 was the least demanding and S2 required the most cognitive effort. In the case of the LQ translation, it was S7 that required the least effort from the translator and S3 that was the most effortful to translate. We operationalised the reader's effort as character-adjusted dwell time (i.e., dwell time per character with spaces) for each sentence, number of second and third time runs (re-reading), and dwell time in the second and third run – all measures capture the meaning-integration effort. We report the results separately for the HQ condition and for the LQ condition.

Since the data for the character-adjusted dwell time in the HQ condition followed a normal distribution, we performed a dependent samples *t*-test that showed no significant difference between reading the most demanding S2 ($M = 37.17$ ms/per character, $SD = 10.71$) and the least demanding S3 ($M = 32.67$ ms/per character, $SD = 6.33$) in the HQ translation, $t = 1.56$, $df = 9$, $p = 0.153$.

Since the number of runs and dwell time in the second and third run (re-reading) were not normally distributed, we performed the Wilcoxon test. We found no statistically significant difference in the number of runs when reading the S2 ($Me = 2$) and S3 ($Me = 1$) in the HQ translation, $Z = -1.265$, $p = 0.206$. There was no statistically significant difference in dwell time in the second run, $Z = -1.68$, $p = 0.093$ when reading S2 ($Me = 293$) and S3 ($Me = 0.0$), nor in the third run, $Z = -1.07$, $p = 0.285$ when reading S2 ($Me = 0.0$) and S3 ($Me = 0.0$). In other words, although the translator put more effort when translating S2 than when translating S3, the reader's reception effort was not significantly different when reading the two sentences.

When comparing the reader's effort and the translator's production effort in the LQ condition, the data for character-adjusted dwell time in the LQ condition did not have a normal distribution, therefore we performed the Mann-Whitney *U* test. Comparing the reader's character-adjusted dwell time in the LQ condition, we found a statistically significant difference ($Z = 2.80$, $p = 0.005$) between reading S3 ($Me = 33.39$) – the most effortful for the translator, and reading S7 ($Me = 59.56$) – the sentence which was the least effortful for the translator. We also found a significant difference in the number of runs, i.e., how many times the reader returned to the sentence after the first reading ($Z = 2.83$, $p = 0.005$). When reading S3, the readers tended to re-view the sentence one more time ($Me = 2$) and when reading S7, the readers showed a tendency to re-inspect the sentence more times ($Me = 4$). The difference between the dwell time needed to re-analyse the two sentences testifying to problems with meaning integration in the second run is non-significant ($Z = -1.89$, $p = 0.059$, $Me = 17.0$ for S3, and $Me = 2721.5$ for S7). However, a statistically significant difference in the reader's effort was found in the third run ($Z = -2.67$, $p = 0.008$) between S3 ($Me = 0.0$) and S7 ($Me = 601.5$). When reading S7 the readers experienced problems with meaning integration, although the translator spent the least amount of effort translating this sentence. This finding further confirms that the relationship between the reader's reception effort and the translator's production effort is not straightforward and the quality of the target text might be a key factor to be considered.

6. Discussion of the results

This study explores uncharted waters trying to bridge the divide between translation production and translation reception. Two complex processes of producing a translation and reading it are analysed to see if the process of reading a translation can be used as a test for the effectiveness of the decisions made by the translator. We assume that a translation of a functional text which describes a product (here a ceiling fan) should read without excessive effort so that the reader knows basic

Table 4
Linear mixed-effects model computed for the reader's reception effort, factoring in translation quality (a two-level factor: HQ vs. LQ).

Fixed effects	*b*	*SE*	*95% CI*	*df*	*t*	*p*
(Intercept)	44.261	3.777	36.859–51.663	9.392	11.720	<0.00001
Translation quality	−11.736	4.453	−20.464– −3.008	18.000	−2.635	0.017
Random effects	*SD*	*Variance*	*ICC*			
Participant (Intercept)	8.044	64.708	0.212			
Sentence number (Intercept)	8.071	65.137	0.213			
Residual	15.528	241.129				

facts, e.g., how high the room needs to be to install the fan, what kind of cooling effect it will have, how it works, and whether it can be used together with AC. It is tacitly assumed that the translator should be able to foresee the reactions of the readers and their meaning construal when reading the target text (Apfelthaler, 2014; Shreve, 2009). The two texts analysed here were deliberately chosen to present the contrasting outcomes of the translators' decisions (HQ and LQ end product). A close analysis of the translation processes which led to the HQ and LQ translation (Tables 2 and 3) shows that there are differences in the amount of cognitive effort invested by the two translators to produce a target text ready for the reader. We explored how the character-adjusted production effort invested by the translator relates to the character-adjusted reader's reception effort when reading the target text.

We found no significant effect of the translator's production effort on the reader's reception effort as shown in the LME analyses performed on the entire dataset, but we found that the reader's reception effort is significantly affected by the quality of the target text. This finding was also to some extent confirmed by the correlation analyses performed separately for the HQ and LQ translation. Interestingly, we found no correlation between the translator's production effort and the reader's reception effort in the HQ translation. Most likely interpretation would be that the translator by investing the amount of effort they considered necessary in the translation process produced a clear reader-friendly text. However, when we tested the relationship between the translator's production effort and the reader's reception effort in the LQ translation, a negative weak correlation was found. Although weak, the correlation shows a tendency that the reader experienced difficulty, i.e., more intensive processing was needed to build a coherent model of the text, where the translator's effort to produce the text had been low. When the translator had invested more effort in producing the translation, the reader's effort to build a coherent model of the text was less pronounced. According to the *coherence assumption* (Graesser et al., 2004), when unable to make connections between textual elements, the readers engage in more intensive processing (Sturt and Kwon, 2018; van den Broek and Helder, 2017). When reading the LQ translation, the comprehension-monitoring processes responded to the higher-order meaning integration failure and made the eyes return to the previously read sentence to re-analyse the wording and extract the information it conveyed (Hessel and Schroeder, 2022). This increased the reader's reception effort that was recorded when reading S7 in the LQ translation.

Looking at the information about the two translators and their translation processes in Table 2, we can surmise that the lack of professional diligence of the translator, i.e., very quick processing and very brief end revision (20 s), might be the cause of producing a LQ target text. Table 2 also shows that the translator of the LQ target text was less experienced and had a lower score on the LexTALE test indexing L2 proficiency than the translator who produced the HQ translation, who was more experienced, had higher L2 proficiency, worked much slower and engaged in intensive end revision (476 s) to assure that the target text reads well. As noted by Shreve (2009), the awareness of the recipients' needs and the ability to tailor the translation output to the recipients' expectations requires higher-order metacognitive skills which develop with experience and are essential for the quality of target texts and the reader's reception effort. When we further explored the relationship between the reader's reception effort and the accuracy of the answers to the four comprehension questions, we found a positive moderate correlation between the two in the HQ condition and a positive weak correlation in the LQ condition. For example, one participant who read the LQ translation had only one correct answer out of four comprehension questions – this did not happen when answering comprehension questions in the HQ condition. This most likely shows that the quality of the translated text may play a key role in the reader's comprehension effort and access to information. Therefore, more insight into the relationship between the translator's production effort and the quality of the translation which is later read by the recipients and users of translated texts in needed. Findings for RQ1 show that while there is no systematic relationship between the reader's reception effort and the translator's production effort in the entire dataset, the quality of the translated text affects the reading experience.

This was also demonstrated at a more fine-grained level (RQ2, RQ3), when we selected the sentence which was produced by the translator with the least effort and the sentence which was produced with the highest character-adjusted effort in the HQ and LQ translation. Drawing on reading research, simple sentences in a source text should be easy to understand by the translator and easier to translate than more complex sentences. We wanted to know if the sentences easy for translators would be also easy to process for readers in line with what is known from reading research. The reader of the HQ translation read the least and the most demanding sentence for the translator with comparable processing effort on all eyetracking measures – character-adjusted dwell time, number of runs and dwell time in the second and third run. This was not the case when reading the least and the most demanding sentences for the translator who produced a low-quality translation. The sentence which was the least effortful to translate in the LQ condition (S7) turned out to be the most demanding to process for the reader. The most likely reason for repeated attempts to re-analyse the sentence is that there is a lack of coherence in the instructions given in S7 in the LQ translation (the ST and the LQ and HQ translations are provided in the Appendix). Namely, the ST sentence, "Turn off ceiling fans when you leave a room; fans cool people, not rooms, by creating a wind chill effect", is translated in literal back translation as: "Keep switching on the fan when leaving the room, because it cools people, not rooms". The wording confused the reader who most likely found the information illogical and made several revisits to re-process the sentence and most likely, having found the mismatch between the sentence and the knowledge of the world in which people do not keep switching on a ceiling fan when they are leaving the room, decided that it is not what is meant. This is in line with the reading studies which show how readers react to inconsistent information (Jensen, 2009; Sun, 2015; Connor et al., 2015; Hessel et al., 2021), namely that readers monitor their comprehension and are likely to "correct mismatches between what they currently read and what they have read before or know to be true" (Hessel and Schroeder, 2022) in their attempt to make sense and extract information.

Overall, the results of this exploratory study show that the relationship between the translator's effort to produce a translation and the reader's effort to process the target text depends largely on the quality of the target text. The HQ translation seemed more demanding because of the readability measures (Table 1) but it turned out to be easier to read

than the LQ translation pointing to the discrepancy between the readability measures (Table 1) and the reading difficulty reflected in the reader's reception effort. The increased effort to read the LQ translation shows that errors and inconsistencies have an arresting effect on the fluency of reading which is responsive to the comprehension-monitoring processes. The nature of translation and language errors and the severity with which they affect the reading experience of the end users of translated texts call for more empirical research. Eyetracking methodology can help to understand how the reader's reception effort is affected by the choices made by translators as highly specialised bilingual professionals.

7. Conclusion

Empirical research has allowed us to understand the complexity of the translation process, but so far, we have rarely weighed it up against the process of receiving its end product by the target reader. The study reported here is modest in size and exploratory in its intentions. Using eyetracking methodology, we compared the process of reading two texts for which we have a full record of the translation process and quality assessment of the translations by proofreaders. The two translations differed in their quality, most likely due to the translators' different levels of expertise and the different decisions that they made during the translation process. The HQ translation was produced with more diligence than the LQ translation in terms of total task time, typing speed and the time for end revision. It was easier to read than the LQ translation, although according to the readability measures it was more complex as a text. The character-adjusted eyetracking measures of the readers' effort needed to process the LQ target text showed that the reading was less fluent with more time for re-processing and re-analysis when the translator's effort was lower. The results reported in this paper should be taken with caution, as they are valid only for the sample of participants who took part in our exploratory study. Bearing in mind this limitation, we plan to repeat the research design with more participants in our next study and increase its statistical power. Nevertheless, our preliminary findings show that there is no straightforward relationship between the translator's production effort and the reader's reception effort. Still, it can be tentatively concluded that the proof of the translation process can be found in the reading experience of the translated text, but it is rather the product of the translation process, especially its quality, which needs to be further explored as a factor affecting the reader's reception effort.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix

The source text in English

Circulating fans include ceiling fans, table fans, floor fans, and fans mounted to poles or walls. These fans create a wind chill effect that will make you more comfortable in your home, even if it's also cooled by natural ventilation or air conditioning. Ceiling fans are considered the most effective of these types of fans, because they effectively circulate the air in a room to create a draft throughout the room. If you use air conditioning, a ceiling fan will allow you to raise the thermostat setting about 4°F with no reduction in comfort. In temperate climates, or during moderately hot weather, ceiling fans may allow you to avoid using your air conditioner altogether. Install a fan in each room that needs to be cooled during hot weather. Turn off ceiling fans when you leave a room; fans cool people, not rooms, by creating a wind chill effect. Ceiling fans are only appropriate in rooms with ceilings at least eight feet high.

The HQ translation into Polish

Do wentylatorów zaliczamy wentylatory sufitowe, stołowe, stojące, oraz wentylatory zamontowane na słupach lub ścianach. Urządzenia te wywołują wrażenie chłodu spowodowanego wiatrem, poprawiając komfort przebywania w domu, nawet jeśli w pomieszczeniu jest wentylacja naturalna, lub jest ono wyposażone w klimatyzację.

Wentylatory sufitowe uznawane są za najbardziej skuteczne urządzenia pod tym względem, ponieważ powodują skuteczny obieg powietrza w całym pomieszczeniu, dając poczucie przeciągu. W przypadku pomieszczeń klimatyzowanych, wentylator sufitowy pozwoli na podniesienie temperatury na termostacie o ok. 2°C, przy zachowaniu takiego samego komfortu cieplnego. W klimacie umiarkowanym lub, gdy nie jest aż tak gorąco, po włączeniu wentylatora sufitowego korzystanie z klimatyzacji często nie będzie potrzebne. Wentylatory sufitowe należy instalować w każdym pomieszczeniu wymagającym chłodzenia w trakcie upałów. Przy wychodzeniu z pokoju wentylator należy wyłączyć, ponieważ wywołując wrażenie wiatru chłodzi on ludzi, a nie pomieszczenie. Wentylatory sufitowe nadają się wyłącznie do pomieszczeń o wysokości co najmniej 240 cm.

The LQ translation into Polish

Wiatraki obrotowe obemują wiatraki sufitowe, stołowe, drzwiowe oraz wiatraki montowane na słupach i ścianach. Wiatraki te tworzą efekt chłodnego wiatru, który zwiększy wrażenie komfortu w twoim domu, nawet jeśli jest on już ochładzany przez naturalną wentylację lub klimatyzację.

Wiatraki sufitowe są uważane za najbardziej skuteczne ze wszystkich wiatraków, ponieważ efektywnie wprawiają w obieg powietrze w pokoju tworząc przewiew. Jeśli używasz klimatyzację, wiatrak sufitowy umożliwi podniesienie termostatu o 4°F bez obniżenie komfortu. W klimatach umiarkowanych lub w trakcie średnio upalnej pogody, wiatrak sufitowy może pozwolić na całkowite wyłączenie klimatyzacji. Zainstaluj wiatrak w każdym pokoju, który powinien być schładzany w trakcie upału. Włączaj wiatrak sufitowy, gdy wychodzisz w pokoju, ponieważ wychładza on osoby a nie pomieszczenie tworząc efekt chłodnego wiatru. Wiatraki sufitowe mogą być instalowane jedynie w pomieszczeniach, w których sufit jest na wysokości co najmniej ośmiu stóp.

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Appendix N: Research Article 4

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Readers have to work harder to understand a badly translated text: an eye-tracking study into the effects of translation errors

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ABSTRACT

Texts are translated to be read and provide access to otherwise inaccessible information or experiences. Scant empirical interest in how translations are read and received by readers is surprising in the context of our knowledge about the features of translations, and the systematic ways in which they differ from originally written texts. In this paper, we explore the impact of translation quality on the reading experience by analysing the cognitive effort involved in reading and text comprehension. Two groups of participants (n = 64) were eye-tracked as they read either a low-quality translation (with errors) or a high-quality translation (without errors) of the same source text. Overall, the errors contributed to longer dwell time when reading the entire text but did not significantly affect the participants' comprehension scores. A more in-depth analysis of the impact of translation errors on the reading experience shows that it depends on the amount of confusion errors cause to the reader when building a coherent model of the entire text.

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1. Introduction

Irrespective of the function they serve, texts are translated to be read and provide access to otherwise inaccessible information or experiences. Although translation quality is an elusive notion and remains difficult to measure in objective ways in professional and educational settings (Koby & Lacruz, 2018; Waddington, 2017), for most practitioners and scholars alike it encompasses accuracy of the rendition and fluency of the target text. In simple terms, good quality translations are comprehensible to the target reader without excessive effort. Translators are assumed to be aware of the target readers' expectations, but the complexity of the translation process and lack of sufficient quality assurance procedures can result in sub-optimal translation products – translations with disfluencies and errors (Araghi et al., 2023; Taibi & Ozolins, 2023).

Although translation quality is of utmost concern in human translation (ISO, 2015; Koby et al., 2014; Mellinger, 2018), the eye movements of readers have not been treated as a measure of quality and studied in the way they were in machine translation (MT) research

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(Colman et al., 2022; Doherty et al., 2010; Kasperavičienė et al., 2020; Kasperė et al., 2023; Stymne et al., 2012). The effect of errors on the readability and comprehensibility of human translation (HT) remains under-researched (Kruger & Kruger, 2017). This scant empirical interest in how translations are read and received by readers (Walker, 2021) is more surprising in the context of our knowledge about the features of translations, and the systematic ways in which they differ from originally written texts (Baker, 1993). To address this research niche, we explore the impact of translation errors on the reading experience.

2. Can what we know about translated language help to predict the reading experience?

When reading functional texts (e.g. product descriptions), readers sometimes do not know that a text is a translation, and the sole purpose of reading is to obtain important information about a product before deciding on a purchase. What we know about the process of reading applies to reading translated texts.

2.1. The process of reading

The natural reading process 'is an elegantly choreographed dance among a number of visual and mental processes' (Rayner et al., 2016, p. 20). The use of eye-tracking has provided ample evidence for the transactional comprehension-driven nature of reading (Dambacher et al., 2013; Engbert et al., 2005). Our eyes move along a text and fixate on words long enough for the mind to retrieve semantic information from memory and update the emerging situational model of the text which is being read (Clifton et al., 2016). The reader's effort to process a text starts with word recognition, based on a familiarity check, and is indexed by early reading measures – first fixation duration and gaze duration, i.e. the sum of all fixation durations in the first-pass (first run) reading. If not clear about the meaning, the reader will invest more cognitive effort, indexed by late reading measures: regressions and re-fixations to re-read and re-analyse what has already been read. Dwell time – sum of all fixation durations is an overall measure of the reader's cognitive effort (Clifton et al., 2016; Rayner & Liversedge, 2011).

Cognitive effort is a construct that has been widely used in experimental Translation and Interpreting Studies. In this reception study, we use the term cognitive effort (or processing effort, reader's effort) to refer to the reader's behavioural response to the task demands (Whyatt et al., 2023), defining it as 'the amount of resources required by a given task' (Piolat et al., 2004). In line with Jakobsen (2014, pp. 75–77), we understand cognitive effort as mental activity that has observable and measurable behavioural correlates (or proxies). In reading research, eye-movements are employed as proxies for cognitive effort (Jian, 2022, pp. 1556–1557). We know that more frequent and shorter words are processed faster (i.e. receive shorter fixations) than less frequent and longer words, and words which are highly predictable from the context need very short fixations or are skipped (Staub, 2015). The predictability of a word or the extent to which its occurrence is unexpected (i.e. its surprisal) is a strong correlate of the time needed to successfully comprehend the contribution it makes to the emerging meaning of the text (Van Berkum et al., 2005; Warren et al., 2008). In other words, 'the less expected a word is in a given context, the higher its surprisal, and hence the greater its processing

difficulty' (Venhuizen et al., 2018, p. 230). Wilcox et al. (2023) tested the relationship between the word's surprisal (the negative log-probability of that word given its preceding context) and reading time in 11 languages, and confirmed that processing words which run against the reader's expectations requires more effort. The reading process also slows down when there is semantic or syntactic ambiguity (Frazier & Rayner, 1982; Levy, 2008) or inconsistency (Stafura & Perfetti, 2017), e.g. due to errors.

Research into whole-text reading is still limited but reading a continuous text or a story is not the same as reading isolated sentences (Radach et al., 2008), and more factors such as the length of sentences, cohesion and information density affect a text's readability (Cop et al., 2015; Hyönä & Niemi, 1990).

To some extent, the difficulty of reading a text can be measured by readability formulas dedicated to a specific language (e.g. *the Gunning FOG formula* for English and *jasnopis.pl* for Polish). These tools calculate the ease with which a text can be read using sentence length, word frequency and word length as measures of readability. However, they are insensitive to other vital aspects when reading texts, e.g. adequate cohesive devices, grammar or vocabulary errors, or inconsistencies with the main theme. Such textual features that do not adhere to the coherence principle (Graesser et al., 2004) occur in badly written texts and, possibly more often, in translations. Below, we discuss some reasons why the experience of reading translations may differ from the experience of reading originally written texts.

2.2. Features of translated language

Corpus Translation Studies has demonstrated that the language of translations differs from originally written language in several respects (Baker, 1993; Laviosa, 2002). Translators tend to make implicit information more explicit (explicitation), they simplify text – lexically and syntactically (simplification), make sure that the translation is in compliance with the target language (TL) standards (normalisation), and they often neutralise stylistically marked language (levelling out). The evidence that translations carry both the source text (ST)-dependent and ST-independent features (Chesterman, 2004) is robust (Baroni & Bernardini, 2005; Corpas Pastor et al., 2008). Koppel and Ordan (2011) found evidence for both in a comparable corpus of original English texts and translations into English from six European languages and Korean.

From the perspective of the reader, the features introduced in the translations could have either a facilitating effect – a text that is lexically less diverse, with explicit meanings and syntactically less complex should read faster – or a hindering effect – a text with odd vocabulary usage and errors, will slow down the reading process (Toury, 2004; Xiao & Hu, 2015). The oddities will be picked up by the reader as surprisal or inconsistent information (Levy, 2008; Rayner et al., 2004), and challenge the ongoing text comprehension (Hessel & Schroeder, 2022).

To sum up, the literature surveyed would suggest that if a translation is well written and does not contain linguistic flaws, it should allow for smooth fluent reading and comprehension (i.e. lower reader's effort). If it is badly written, the reader will most likely need more processing time (i.e. higher reader's effort), because of unpredictable words or unnatural word combinations. In this eye-tracking study, we empirically tested how errors in translations affect the reading experience (cognitive effort and comprehension

defined as an uptake of information the text is meant to provide the reader with) of two groups of readers who read either a low-quality (LQ) translation or a high-quality (HQ) translation of the same ST.

3. The study

The study reported below is a follow-up to an exploratory study reported in Whyatt et al. (2023), in which we investigated the relationship between the process of translating a text and reading it. Using the same study design and method but with more participants, we tested how the quality of translation (presence or absence of errors) affects the reading experience (processing effort and comprehension).[1]

3.1. Our assumptions and research questions

We assume that a translated informative text of high quality (HQ) should read with fairly low cognitive effort usually indexed by short fixation durations, short dwell time and few regressions, and allow for smooth comprehension. Reading a low-quality (LQ) translation with errors will require more cognitive effort (longer fixation durations, longer dwell time, more regressions) reflecting problems with text comprehension, in line with the 're-viewing for reprocessing' hypothesis (Inhoff et al., 2019). Ultimately, errors in a translation may affect the reader's comprehension and willingness to purchase a product which is described (Everard & Galletta, 2005).

To test the above assumptions, we formulated four research questions (RQs) and four corresponding research hypotheses (Hs):

RQ1. Does reading an LQ translation (the entire text) require more cognitive effort than reading an HQ translation?

RQ2. Does reading sentences with errors in an LQ translation require more cognitive effort than reading corresponding sentences without errors in an HQ translation?

RQ3. Do translation errors affect the comprehension (reception) of the target text?

RQ4. Do translation errors affect the willingness to buy the described product?

All dependent measures used in the present study to answer RQ1 and RQ2 are provided in Table 1, alongside their definitions and levels at which they were analysed. The definitions are adapted from the Eyelink Data Viewer software package (SR Research, Ltd., 2024, ver. 4.4.1) unless stated otherwise.

To answer RQ1, we analysed two text-level eye-movement measures: dwell time (character-adjusted) and fixation count (character-adjusted) of the participants reading the entire texts in the LQ and HQ conditions. The same character-adjusted measures of the reader's effort were reported in several eye-tracking studies investigating the impact of MT errors on readers (Doherty et al., 2010; Stymne et al., 2012). Following the findings of our previous study (Whyatt et al., 2023), we hypothesised (H1) longer dwell time and longer fixation count (both character-adjusted) for reading the LQ translation than HQ translation (LQ > HQ, compared at whole-text level).

When answering RQ2, we focused on several sentence-level eye-movement measures which we treated as proxies for cognitive (processing) effort: dwell time (character-

Table 1. Eye-tracking metrics (our dependent variables) used in the present study.

No.	Eye-tracking measure	Definition	Comments	At which level used in the present study?
1.	Dwell time (character-adjusted)	Summation of the duration across all fixations on the current interest area (i.e. AOI) divided by the number of characters in that AOI (excluding spaces).	Another term used in the literature is total fixation duration. Our measure is character-adjusted, following Whyatt et al. (2023, p. 3), 'to overcome the differences in the length of words and sentences'.	Text (H1) and sentence (H2)
2.	Fixation count (character-adjusted)	Total number of fixations falling in the AOI divided by the number of characters in that AOI (excluding spaces).	See comment for measure no. 1.	Text (H1) and sentence (H2)
3.	% of dwell time	Percentage of trial time spent on the AOI.	Dwell time in the AOI (sentence) divided by total dwell time for the entire text.	Sentence (H2)
4.	% of fixation count	Percentage of all fixations in a trial falling in the AOI.	Fixation count in the AOI (sentence) divided by total fixation count for the entire text.	Sentence (H2)
5.	Number of runs	Number of times the AOI was entered and left (runs).	Also referred to as *passes* in the literature.	Sentence (H2)
6.	Re-reading dwell time	First-run dwell time deducted from total dwell time in the AOI.	Measure calculated from two Data Viewer Interest Area report variables. The definition is our own. Measured in *ms*.	Sentence (H2)
7.	Second-run dwell time	Sum of the duration across all fixations of the second-run of fixations within the AOI.	See comment for measure no. 5. Measured in *ms*.	Sentence (H2)
8.	Third-run dwell time	Sum of the duration across all fixations in the third-run of fixations within the AOI.	See comment for measure no. 5. Measured in *ms*.	Sentence (H2)

adjusted), fixation count (character-adjusted), percentage of dwell time, percentage of fixation count, number of runs[2], re-reading dwell time, second-run dwell time and third-run dwell time. We selected three sentences – sentence 4 (S4), sentence 7 (S7) and sentence 8 (S8) – all with errors in the LQ translation which could hinder the comprehension process by creating surprisal – and compared the inferred cognitive effort involved in reading them with the effort of readers who read translations of the same ST sentences without errors in the HQ condition. Again, in line with our earlier results, we hypothesised (H2) longer values of the above-listed eye-movement measures for reading sentences with errors in the LQ translation than reading corresponding sentences without errors in the HQ translation (LQ > HQ, compared at sentence level).

To answer RQ3, we compared text comprehension scores (the number of correct answers) of the readers between the LQ and HQ conditions, and the time taken to respond (RTs). Each reader responded to four *true/false* comprehension questions (correct answer: 1, incorrect answer: 0; the max. total score was 4, the min. total score was 0). We assumed that there would be a difference between the LQ and HQ translation condition (H3a) in the number of correct answers given by the readers to text comprehension questions (LQ≠HQ), and (H3b) in the readers' response times (RTs) to these questions (LQ≠HQ).

For RQ4, we compared how frequently the readers in the LQ condition and in the HQ condition reported that they felt encouraged to buy the product described in the text they have read (positive answer: 1, negative answer: 0), and the time taken to indicate their

(*yes/no*) response. We assumed that there would be a difference between the LQ and HQ translation condition (H4a) in the readers' responses regarding their willingness to buy the described product (LQ≠HQ), and in (H4b) in the time taken by readers to respond (LQ≠HQ).

3.2. Materials

We selected two English-to-Polish translations of a product description text (of a ceiling fan) from the set of 26 translations produced by professional translators in the EDiT project.[3] The criteria for the selection were based on the number of corrections introduced by proofreaders. The low-quality translation required many corrections from the proofreaders, whereas the high-quality translation required very few corrections to be ready for publication (for details, see Whyatt, 2019; Tomczak & Whyatt, 2022). We also selected a text of similar type which was originally written in Polish (the target language) to serve as a baseline for all of the participants. Tables 2 and 3 present the descriptors and the readability metrics for the baseline text and the two translations.

Judging by the measures obtained from the readability formula (*jasnopis.pl*), the HQ translation is a more complex text – higher complexity score, more difficult and long words. We could therefore expect that reading the HQ text should be more demanding (Inhoff et al., 2019; Stafura & Perfetti, 2017). Yet, the readability formula does not check whether or not the texts contain errors or inconsistencies – the factor differentiating the two translations.

3.3. Participants

We recruited 67 participants who were randomly assigned to read the low-quality translation (LQ condition) or the high-quality translation (HQ condition). All the participants were native speakers of Polish and university students of English. They did not participate in the translation training programme. They had normal or corrected-to-normal vision and received remuneration (course credits or vouchers). Datasets from 64 participants (M_{age} = 20.52 years old, *sd* = 1.37; 48 women, 9 men, 7 other)[4] were selected as fit for data analysis – see section 3.5.

Table 2. Readability metrics for the baseline text and the LQ and HQ translation.

Text	Complexity score	No. of words	No. of sentences	Average sentence length [in words]	Average word length [in syllables]	FOG: text level
Baseline text	5/7	163	9	18.1	2.24	13.62
LQ translation	5/7	136	8	17.0	2.35	13.86
HQ translation	6/7	145	8	18.1	2.64	19.11

Table 3. Readability metrics for the baseline text and the LQ and HQ translation (%, ratio).

Text	% of difficult words	% of nouns	% of verbs	% of adjectives	Noun-to-verb ratio	% of long words
Baseline text	7%	38%	13%	17%	2.95	13.70%
LQ translation	10%	34%	14%	21%	2.42	13.30%
HQ translation	15%	36%	10%	18%	3.40	25.20%

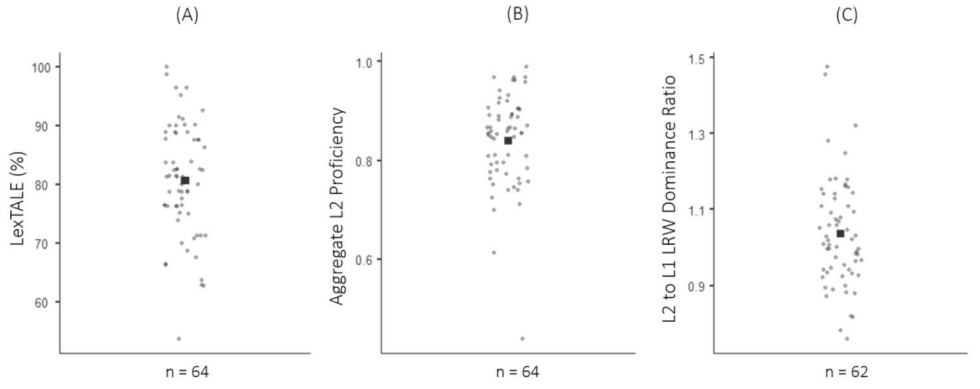

Figure 1. (A) LexTALE (%) test scores, (B) aggregate L2 proficiency scores and (C) L2 to L1 listening, reading and writing (LRW) dominance ratio scores (the black square represents the mean).

Figure 1 shows the language profile of the participants for which we used the LexTALE test (scatterplot A; Lemhöfer & Broersma, 2012) and the Language History Questionnaire (scatterplot B and C; LHQ, version 3.0; Li et al., 2020) – the tools used to assess language proficiency, as well as language background, exposure and use. The LHQ3 gauged their L2 proficiency (scatterplot B; aggregate weighted and normalised score based on self-ratings on a scale 1–7 for each language component; $M = 0.84$, $sd = 0.09$)[5] and their L2 to L1 listening, reading and writing dominance ratio (scatterplot C; LRWDR; $M = 1.04$, $sd = 0.14$).[6] This measure of dominance for both languages is based on self-reported proficiency and how much time is spent daily with respect to each assessed component, i.e. listening, reading and writing. The reported time is an estimation provided by the participants. The closer the score to 1, the more balanced the use of the two languages. The LexTALE test score ($M = 80.64\%$, $sd = 9.56$) shows that they are proficient users of English at C1/C2 level according to the Common European Framework of Reference for Languages (CEFR).

Regarding our participants' reading habits and their attitude to reading translations, 81% declared to be avid readers most often reading texts in a digital format (58.8%) rather than in print. Most of them (54.7%) stated that they sometimes noticed that they were reading a translation, not an originally written text, 39.1% claimed that they always did, and 6.3% said that they did not pay attention at all to whether they were reading a translated text. Interestingly, 46.9% of our informants claimed that they sometimes noticed errors in translations, 18.8% rarely and 17.2% very rarely noticed them, 12.5% admitted to noticing translation errors often, and only 3.1% never noticed errors when reading translations. All the information about the participants was collected after the reading experiment.

3.4. Procedure and apparatus

The experiment was programmed in the Experiment Builder (SR Research) and data were collected using the EyeLink 1000 Plus tracking the participant's dominant eye.[7] The participants became familiar with the procedure and the eye-tracking set-up, including a forehead and chin rest. After giving their written consent and a 9-point calibration

procedure, all the participants read silently the baseline text to become familiar with the task (reading for comprehension). Then, they read either the LQ or HQ translation, depending on the condition to which they were randomly assigned.[8]

The entire text was displayed in Arial 25 pt. with 2.5 line spacing and presented on a 24-inch monitor (53.3 × 30 cm) with 1920 × 1080 resolution. After the participants read the text, they pressed the spacebar to continue to the page with four *true/false* statements (text comprehension task) and a question asking whether they felt encouraged to buy the described product. Then, the participants were briefly asked about their reading experience and filled in a set of questionnaires.

As the design was between-participants, we used the baseline text to check the reading rate (number of words read per minute – wpm) of the participants. No statistically significant differences were found in wpm (baseline) between the participants who were (randomly) assigned to the LQ condition ($M = 169.91$, $sd = 47.32$) and the HQ condition ($M = 185.44$, $sd = 47.93$), $t(62) = 1.30$, $p = 0.198$, $d = 0.326$, 95% CI [−0.174, 0.821].

3.5. Data analysis

To extract eye-tracking data from the Data Viewer, the texts were divided into sentences – 8 areas of interest (AOIs) in the LQ translation and, likewise, in the HQ translation. After a manual drift correction, we excluded 3 out of 67 datasets from the analysis (4.48%). This gave us 30 datasets from reading the LQ translation and 34 datasets from reading the HQ translation (in total $n = 64$). In all statistical analyses, translation quality (two levels: LQ, HQ) was our independent variable. Because the two texts and the sentences differed in length, we calculated dwell time (total fixation duration) and fixation count per character (excluding spaces).[9] However, such correlates of the processing effort as the number of runs, i.e. how many times a sentence was viewed, re-reading dwell time, and second-run and third-run dwell time remained not character-adjusted because re-reading is not systematic and occurs only in response to processing difficulties (Inhoff et al., 2019).

Number of runs, re-reading dwell time, and dwell time in the second – and third run were intended to show processing effort, which – when high – could be taken as evidence for increased difficulty to integrate meaning when reading selected sentences. Additionally, such measures as percentage of dwell time on the sentence in the two conditions and percentage of fixation count show how taxing the processing of the sentence was in the context of the entire text. Following studies on whole-text reading (e.g. Cop et al., 2015; Hyönä & Niemi, 1990), we decided to look at the eye-movement measures separately as dependent variables.

To test our hypothesis 1 and 2, with translation quality as our independent variable and eye-movement measures as the dependent variables, we computed one-tailed right-sided (LQ > HQ) independent samples t-tests or right-sided Mann–Whitney U tests (where the distributions of the variables deviated from normality). The two-sided Mann–Whitney U tests were used to test the H3 for the significance of the difference between the two conditions in the readers' text comprehension scores (text-level) and in their RTs (both text – and sentence-level). Additionally, to verify whether there is a statistically significant difference between the translation conditions (LQ, HQ) in the readers' comprehension accuracy analysed at sentence level (1,0), we conducted the

chi-square test (H3a). We also performed the chi-square test to test for the effect of translation errors on the readers' willingness to buy the product described in the translations, and the two-tailed Mann–Whitney U test to compare the readers' time to respond between the two conditions (H4). Data analyses were performed using Jamovi (2022, ver. 2.3). Effect sizes and their 95% confidence intervals (95% CI) were computed using JASP (2023, ver. 0.17.3).

3.6. Results

The results are reported in the order the four research questions were asked.

3.6.1. Reading the LQ translation requires more cognitive effort than reading the HQ translation

The right-sided independent samples t-test conducted to verify the H1 shows a statistically significant difference (at whole-text level) in the character-adjusted dwell time between the readers of the LQ translation ($M = 55.74$, $sd = 13.10$) and the HQ translation ($M = 49.43$, $sd = 12.02$), $t(62) = 2.01$, $p = 0.024$, with an effect size of medium strength: $d = 0.504$, 95% CI [0.083, ∞]. The difference between the two translations in the mean and median character-adjusted dwell time is illustrated in Figure 2.

The data for the character-adjusted fixation count did not follow a normal distribution and required non-parametric statistics. The right-sided Mann–Whitney U test shows that there is no statistically significant difference in fixation count for reading the LQ ($Me = 0.25$, $IQR = 0.07$) compared to HQ translation ($Me = 0.21$, $IQR = 0.07$), $U = 393$, $p = 0.059$, $r = 0.229$ (weak strength), 95% CI [−0.006, ∞].

The results show that reading the LQ translation as an entire text required significantly more dwell time but not more fixations, yet we obtained a weak effect size for the difference in the latter.

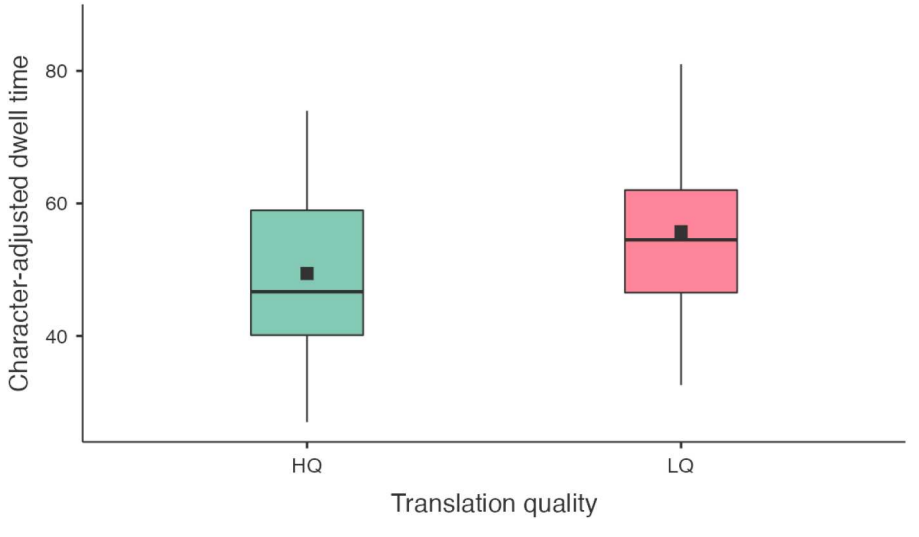

Figure 2. Significant difference in the character-adjusted dwell time between the HQ and LQ translation (the black square illustrates the mean, the line – the median).

3.6.2. Reading sentences with errors in the LQ translation requires more cognitive effort than reading corresponding sentences without errors in the HQ translation

To answer RQ2, we focused on three sentences (S4, S7 and S8) because errors in these sentences may create a kind of surprisal for the reader. When translating S4, the translator did not convert Fahrenheit into Celsius – therefore failing to adapt the content to the readers' expectations. In S7, the LQ translation included a problem with logic due to the imperfective instead of perfective aspect of the verb. The sentence was very confusing as the reader was told *to keep switching on* the fan when leaving the room, while in the source text the user was advised *to switch off* the fan when leaving the room. In S8, similar to S4, the height of the room was given in feet, and Poland uses the metric system.

We compared the cognitive (processing) effort when S4, S7 and S8 were read in both conditions. Apart from the character-adjusted dwell time and character-adjusted fixation count, we compared the percentage of dwell time and of fixation count, number of runs, dwell time in re-reading, second-run dwell time and third-run dwell time. Table 4 shows the median value and the interquartile range for each eye-tracking measure for the LQ and HQ translation condition.

To show the magnitude of each tested difference between the LQ and HQ translation in reading S4, S7 and S8, we computed the values of effect size (rank biserial correlation) with 95% confidence intervals (95% CI) – see Table A1 in the Appendix.

The comparison showed that when reading S4 in the LQ translation, the readers needed overall more processing time ($Me = 67.17$, $IQR = 27.42$), as shown by the character-adjusted dwell time, than the HQ translation readers ($Me = 46.57$, $IQR = 22.65$), $U = 226$, $p < 0.001$, $r = 0.557$ (strong effect size). The same effect of increased effort to read the sentence which was not adapted to the reader's expectations (thus LQ) was recorded in the character-adjusted fixation count with $Me = 0.28$ ($IQR = 0.10$), as compared to $Me = 0.23$ ($IQR = 0.10$) for reading the HQ translation adapted to the reader's expectations, $U = 252$, $p < 0.001$, $r = 0.506$ (strong effect size). There were no significant differences found in the percentage of dwell time ($U = 362$, $p = 0.977$, $r = -0.290$), percentage of fixation count ($U = 312$, $p = 0.996$, $r = -0.388$), number of runs ($U = 412.5$, $p = 0.917$, $r = -0.191$), dwell time in re-reading ($U = 467$, $p = 0.726$, $r = -0.084$), second-run dwell time ($U = 487.5$, $p = 0.624$, $r = -0.044$) and third-run dwell time ($U = 426$, $p = 0.920$, $r = -0.165$).

When reading S7, with the error causing confusion, significant differences were obtained for the percentage of dwell time ($U = 353$, $p = 0.018$, $r = 0.308$ – an effect size of medium strength), percentage of fixation count ($U = 308.5$, $p = 0.003$, $r = 0.395$ – medium effect size) and number of runs ($U = 386.5$, $p = 0.043$, $r = 0.242$ – weak strength), with higher measure values found for the LQ translation readers. These results indicate that S7 was more challenging for the readers in the context of reading the entire text in the LQ translation than for the readers in the HQ translation condition. More runs in the LQ translation point to the need for a re-analysis. This was not the case for the readers of the error-free sentence in the HQ translation. No statistically significant differences (and in most cases showing weak effect sizes) were observed for the remaining investigated variables: character-adjusted dwell time ($U = 420$, $p = 0.115$, $r = 0.177$), character-adjusted fixation count ($U = 401$, $p = 0.072$, $r = 0.214$), re-reading dwell time ($U = 406.5$, $p = 0.077$, $r = 0.203$), second-run dwell time ($U = 467.5$, $p = 0.281$, $r = 0.083$) and third-run dwell time ($U = 411$, $p = 0.061$, $r = 0.194$).

Table 4. Descriptive statistics (median: *Me,* interquartile range: *IQR*) for eye-tracking measures of effort for reading the three sentences (S4, S7, S8) in the low-quality (LQ) vs. high-quality (HQ) translation.

Sentences in **LQ/HQ** translation		Dwell time (character-adjusted)	Fixation count (character-adjusted)	% of dwell time	% of fixation count	No. of runs	Re-reading dwell time	Second-run dwell time	Third-run dwell time
S4 in **LQ**	*Me*	67.17*** (27.42)	0.28*** (0.10)	0.13 (0.04)	0.13 (0.03)	2 (1)	393.5 (1768.50)	254 (825.75)	0 (0)
	(IQR)								
S4 in **HQ**	*Me*	46.57*** (22.65)	0.23*** (0.10)	0.15 (0.04)	0.16 (0.05)	2 (2)	539 (3135.25)	169 (860.50)	0 (285)
	(IQR)								
S7 in **LQ**	*Me*	57.89 (25.13)	0.27 (0.13)	0.14* (0.04)	0.14** (0.04)	2* (3)	620.5 (5517.00)	258.5 (1193.75)	0 (509.75)
	(IQR)								
S7 in **HQ**	*Me*	54.94 (22.68)	0.24 (0.10)	0.13* (0.05)	0.12** (0.04)	2* (1.75)	344.5 (2586)	337.5 (1343.75)	0 (161.25)
	(IQR)								
S8 in **LQ**	*Me*	40.67 (15.50)	0.20 (0.08)	0.09** (0.02)	0.09*** (0.03)	2 (2)	3295* (5020.50)	643.5 (3643.50)	0 (178.25)
	(IQR)								
S8 in **HQ**	*Me*	45.64 (14.50)	0.22 (0.08)	0.07** (0.02)	0.08*** (0.02)	2 (1)	185* (2630.50)	73 (796.50)	0 (0)
	(IQR)								

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Sentence 8 in the LQ translation contained the lack of adaptation to the target readers' expectations, similar to S4. Significant differences were found in the percentage of dwell time ($U = 283.5$, $p = 0.001$, $r = 0.444$ – an effect size of moderate strength) and percentage of fixation count ($U = 234$, $p < 0.001$, $r = 0.541$ – a strong effect), showing that it was more taxing to read in the LQ condition than the corresponding S8 in the HQ translation. It also required significantly more re-reading dwell time ($U = 371.5$, $p = 0.027$, $r = 0.272$ – a weak effect). There were no statistically significant differences found for the remaining variables: character-adjusted dwell time ($U = 409$, $p = 0.914$, $r = -0.198$), character-adjusted fixation count ($U = 428$, $p = 0.867$, $r = -0.161$), number of runs ($U = 460.5$, $p = 0.241$, $r = 0.097$), second-run dwell time ($U = 398$, $p = 0.059$, $r = 0.220$) and third-run dwell time ($U = 441$, $p = 0.107$, $r = 0.135$).

3.6.3. Translation errors and text comprehension

To answer RQ3, in the first step we compared the number of correct answers to four *true/false* (0,1) questions of the readers in the LQ translation and in the HQ translation. The statistical analysis conducted with the two-tailed Mann–Whitney U test shows no statistically significant differences in the number of correct answers to all four questions per participant between the LQ translation ($Me = 3$, $IQR = 1$) and HQ translation condition ($Me = 3$, $IQR = 1$), $U = 434.5$, $p = 0.289$, $r = 0.148$, 95% CI [−0.136, 0.409]. In the second step, we compared the average time taken in each condition to respond to all four comprehension questions. Average response time (RT) was calculated for each participant. The differences in average RTs recorded for the comprehension questions in the LQ condition ($Me = 4993.5$ ms, $IQR = 1928.1$) and HQ condition ($Me = 4343.1$ ms, $IQR = 1684.8$) were not statistically significant, $U = 447$, $p = 0.403$, $r = 0.124$, 95% CI [−0.160, 0.388].

To investigate further, in the third step, we conducted a series of analyses to capture the correspondence between reading a sentence with a specific translation error and comprehension of that sentence. Two comprehension questions checked the understanding of sentence 7 (problems with logic in LQ) and two tested the comprehension of sentences with a lack of adaptation (in LQ) to the Polish reader (sentence 4 and 8). Table 5 shows that the results reached statistical significance only in two cases, yet different measures in each case: sentence comprehension response times for S7 and sentence comprehension accuracy for S8 (the details are provided in the next paragraph).

When responding to Q1 checking the comprehension of S7, the participants took significantly more time (longer RTs) in the LQ condition ($Me = 3952$ ms) than in the HQ condition ($Me = 3039$ ms), $U = 363$, $p = 0.048$, $r = 0.288$, 95% CI [0.011, 0.524] – yet the effect was weak. The analysis of comprehension scores obtained for S8 (lack of adaptation from feet to centimetres) yielded a statistically significant difference between the translation conditions in sentence comprehension accuracy, $\chi^2(1) = 11.46$, $p < 0.001$, $\Phi = -0.423$, 95% CI [−0.540, – 0.152]. This shows that readers of S8 in the LQ condition were more frequently correct (93.33% of correct answers) on the question checking the understanding of that sentence, relative to the readers in the HQ condition (with 55.88% accuracy).

3.6.4. Translation errors and willingness to buy the described product

To answer RQ4, we checked whether there was a difference between the translation conditions (LQ or HQ) in terms of the given response ('Yes' or 'No'). No significant

Table 5. Statistics for the analyses of sentence comprehension (accuracy scores and response times) in the LQ condition (containing translation errors) and the HQ condition (error-free).

Comprehension questions and their correspondence to sentences with errors	Test statistic, *p*-value, effect size with 95% CI for the comparison of comprehension scores	% of correct responses in the two conditions	Test statistic, *p*-value, effect size with 95% CI for the comparison of response times (RTs)	Median value *(Me)* and interquartile range *(IQR)* of time taken to respond (RTs in *ms*) to the comprehension questions in the two conditions
Q1 – **Sentence 7** (problems with logic)	$\chi^2(1) = 2.09$ $p = 0.148$ $\Phi = 0.181$ [−0.096, 0.413]	LQ: 66.67% HQ: 82.35%	$U = 363$* $p = 0.048$ $r = 0.288$ [0.011, 0.524]	LQ: *Me* = 3952 *IQR* = 3344 HQ: *Me* = 3039 *IQR* = 1795
Q2 – **Sentence 7** (problems with logic)	$\chi^2(1) = 2.09$ $p = 0.148$ $\Phi = -0.181$ [−0.394, 0.099]	LQ: 83.33% HQ: 67.65%	$U = 467$ $p = 0.570$ $r = -0.084$ [−0.354, 0.198]	LQ: *Me* = 4149 *IQR* = 1905.5 HQ: *Me* = 4403 *IQR* = 1812
Q3 – **Sentence 4** (lack of adaptation: F to C)	$\chi^2(1) = 0.48$ $p = 0.489$ $\Phi = 0.087$ [−0.187, 0.338]	LQ: 30% HQ: 38.24%	$U = 498$ $p = 0.878$ $r = -0.024$ [−0.300, 0.256]	LQ: *Me* = 3848.5 *IQR* = 1872.5 HQ: *Me* = 4180 *IQR* = 1867.8
Q4 – **Sentence 8** (lack of adaptation: feet to centimetres)	$\chi^2(1) = 11.46$*** $p < 0.001$ $\Phi = -0.423$ [−0.540, − 0.152]	LQ: 93.33% HQ: 55.88%	$U = 546$ $p = 0.633$ $r = 0.071$ [−0.212, 0.342]	LQ: *Me* = 5506 *IQR* = 1612 HQ: *Me* = 5008.5 *IQR* = 2729.8

*$p < 0.05$, ***$p < 0.001$.

difference was revealed ($\chi^2(1) = 0.87$, $p = 0.352$, $\Phi = 0.116$, 95% CI [−0.159, 0.365]), with 30% of positive responses (i.e. willing to buy the described product) from the LQ translation readers, and 41.18% of positive responses from the HQ translation readers. The time taken by the readers to respond if they are willing to buy the described product did not differ significantly between the LQ (*Me* = 2246 ms, *IQR* = 1119.3) and HQ (*Me* = 2396 ms, *IQR* = 1380.5) condition, $U = 500$, $p = 0.899$, $r = -0.020$, 95% CI [−0.296, 0.260].

4. Discussion

In this between-participants study, we compared character-adjusted dwell time, character-adjusted fixation count, percentage of dwell time, percentage of fixation count, number of runs, dwell time in re-reading, second-run dwell time and third-run dwell time of the readers who read either the LQ translation or the HQ translation of the same source text. All of the measures are taken as proxies for cognitive effort, and including several of them allowed us to capture the processing difficulty at various levels when the readers try to integrate the meaning of the emerging text (see section 2.1). The two renditions of the same ST also differed in the number of words and some readability measures, so that the HQ translation should have been in fact more difficult to read. The results show that reading the translation with errors (LQ) required significantly more cognitive effort than reading the HQ translation as indexed by the character-adjusted dwell time (total fixation duration) but not in terms of the character-adjusted fixation count (yet, the effect size obtained for the tested difference in the latter was weak). As dwell time is widely considered to be a measure of cognitive effort, the readers in the LQ translation had to work harder to process and comprehend the entire text, confirming our assumptions.

To obtain a more detailed insight into how errors in the LQ translation affected the reader, we selected three sentences with errors of different nature that could hinder the process of reading. Sentence 4, in which the translator failed to convert Fahrenheit to Celsius for the target readership, required more processing in the LQ condition as evidenced by the character-adjusted dwell time and character-adjusted fixation count. But for all remaining measures no significant differences were found between the two conditions, although S4 was also much shorter in the LQ translation (13 words, 95 characters excluding spaces) than in the HQ translation (21 words, 153 characters excluding spaces). This could possibly explain the lack of significant differences in the remaining measures. Sentence 7, which caused a problem with logic, attracted proportionally more visual attention from the readers in the LQ condition than in the HQ condition – both in terms of dwell time (%) and fixation count (%). Additionally, the sentence was revisited more than the corresponding sentence in the HQ condition, although both sentences were very similar in the number of characters and words (18 words, 113 characters vs. 17 words, 111 characters, respectively). The most likely interpretation is that the problem with logic – telling the reader to keep switching the ceiling fan on when leaving the room – caused confusion in the reader's coherence building, and the comprehension monitoring processes made the readers' eyes regress (Inhoff et al., 2019; Stafura & Perfetti, 2017) to check the mismatches with what they know to be true (Hessel & Schroeder, 2022). A similar effect was found when reading sentence 8, which had an adaptation error (the height of the room was given in feet instead of centimetres) – it also attracted proportionally more visual attention (dwell time % and fixation count %), and yielded significantly longer re-reading dwell time, but the sentence was also longer (18 words, 106 characters) than S8 in the HQ translation (13 words, 76 characters). The length of the sentence might have amplified the reader's processing effort (Cop et al., 2015). The fact that there were no significant differences in the second – and third-run dwell time when the sentences were read in the two conditions shows that the readers fairly quickly resolved the problems caused by errors at sentence level. It seems that errors had a more global rather than local effect on the readers as they contributed to the LQ translation being more demanding to read as the entire text than the HQ translation, although the latter was in fact a more complex text.

When interpreting the results, it needs to be pointed out that our participants were university students of English and therefore more likely to accept lack of adaptation to the metric system (Fahrenheit instead of Celsius, feet instead of centimetres) than people not familiar with the imperial system of measurements. In other words, when our participants came across imperial measures, they might have experienced lower surprisal – and thus lower processing effort (Venhuizen et al., 2018) – than readers without extensive knowledge of the English language and culture.

Interestingly, although the readers had to work harder to understand the LQ translation than the readers of the HQ translation, their responses on the comprehension questions were comparable in terms of accuracy and response time. We can infer that hard work paid off. This is in line with Frazier & Rayner's (1982) finding that skilled readers, in a way, bypass the visual uptake of information and after re-viewing for reprocessing (Inhoff et al., 2019), they will recognise an error, ignore it and ascribe the most predictable meaning to the sentences they read (Frazier & Rayner, 1982; Stafura & Perfetti, 2017; Staub, 2015). Longer response time to answer the comprehension question

related to S7 in the LQ condition seems to suggest that such operations require more processing time.

Significantly more correct responses to the question (Q4) checking the comprehension of S8 in the LQ condition show that the effect of surprisal (Wilcox et al., 2023) – providing height in feet rather than centimetres – in fact might have improved the retention and recognition of the information when compared to the HQ condition. However, it could also be the result of proportionally more time spent on re-reading and re-processing in the LQ condition. Additionally, S8 was more complex in the HQ translation than the corresponding sentence in the LQ translation (see Appendix) and this might have lowered the comprehension scores.

Comparably low willingness to buy the described product in both groups of participants may be driven by a range of factors. Possibly, the young age of our participants made the purchase of a ceiling fan low on their list of priorities. Another likely reason is the season when the question was asked (data collection stretched from spring to late autumn), relevance prompting the response.

5. Conclusions

The effects of errors in the human translations analysed here were not as spectacular as in studies of reading MT outputs, but our focus was also slightly different. We analysed eye movements at sentence and whole-text level, and included more late reading measures capturing the meaning integration processes when reading a translation of sentences with or without errors. Overall, we conclude that our readers had to work harder to understand a badly translated text. Although the effect of errors may not be significantly present at the local (sentence) level, it nevertheless contributes to demanding more effort to build a coherent model of the entire text. In our study, the first error appeared in S4, that is when the reader became familiar with the theme. In future studies more attention should be paid to how the position of the error (e.g. at the beginning or at the end of the text) impacts the reader. The results of our study need to be interpreted with caution, mostly because our participants were language students and most likely more skilled in processing texts of various quality and complexity, and therefore experienced with overcoming comprehension difficulties. The results could have been different if the participants had no knowledge of the English language – the source language of the translation that they read. Therefore, not only text-related factors, but also reader-related factors need to be taken into consideration in future studies investigating the process of reading and reception of translated texts.

Notes

1. The study is a part of the Read Me project (Reading and Reception of Mediated/translated Text) financed by a grant from the National Science Centre Poland (2021–2025, UMO – 2020/39/B/HS2/00697).
2. Our eye-tracking data processing software Data Viewer uses the term *run* for each reading pass for the text. Another term used in the literature is *number of passes,* as specified in Table 1. We will use the term *run* for the sake of consistency with SR Research terminology and our previous publications.

3. The participants read unedited translations. The source text and the LQ and HQ translations aligned at sentence level are in the Appendix (Table A2). The EDiT project was financed by the National Science Centre Poland (2016–2019, UMO – 2015/17/B/HS6/03944).
4. Analyses were done in Jamovi (The jamovi project, 2022).
5. Proficiency was calculated based on equal weights (0.25) for listening, speaking, reading, and writing self-rating scores. For more details, see LHQ3 Documentation online (https://lhq-blclab.org/static/docs/aggregate-scores.html#language-proficiency) (date of access 17 July 2024).
6. Sixty-two participants provided complete data for the LRW dominance ratio. To compute the LRWDR, we assumed weights of 0.25, 0.5 and 0.25 only for listening, reading and writing respectively. For details, see LHQ3 Documentation (https://lhq-blclab.org/static/docs/aggregate-scores.html#ratio-of-dominance) (date of access 17 July 2024).
7. The experimental procedure was approved by the Ethics Committee for Research Involving Human Participants at Adam Mickiewicz University, Poznań (no. 21/2021/2022).
8. After the experimental text, the participants read three other texts not analysed in this study.
9. In Whyatt et al. (2023), we included spaces when calculating the character-adjusted measures of the reader's effort to make it comparable to the effort of the translator who produced the target text.

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Disclosure statement

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Appendix

Table A1. Effect sizes (rank biserial correlation) with 95% confidence intervals (95% CI) provided for the differences tested in H2 (section 3.6.2 – RQ2).

Effect size (rank biserial correlation r) with 95% CI		Character-adjusted dwell time	Character-adjusted fixation count	% of dwell time	% of fixation count	No. of runs	Re-reading dwell time	Dwell time in 2nd run	Dwell time in 3rd run
S4	*r*	0.557	0.506	−0.290	−0.388	−0.191	−0.084	−0.044	−0.165
	95% CI	[0.370, ∞]	[0.307, ∞]	[−0.492, ∞]	[−0.571, ∞]	[−0.408, ∞]	[−0.313, ∞]	[−0.276, ∞]	[−0.385, ∞]
S7	*r*	0.176	0.214	0.308	0.395	0.242	0.203	0.083	0.194
	95% CI	[−0.061, ∞]	[−0.023, ∞]	[0.078, ∞]	[0.176, ∞]	[0.007, ∞]	[−0.034, ∞]	[−0.155, ∞]	[−0.043, ∞]
S8	*r*	−0.198#	−0.161	0.444	0.541	0.097	0.272	0.220	0.135
	95% CI	[−0.414, ∞]	[−0.382, ∞]	[0.233, ∞]	[0.351, ∞]	[−0.141, ∞]	[0.039, ∞]	[−0.016, ∞]	[−0.103, ∞]

a negative value of *r* means that higher values of the measure are found for reading the LQ translation (entered into the analyses as first) than for the HQ translation.

The source text in English

Circulating fans include ceiling fans, table fans, floor fans, and fans mounted to poles or walls. These fans create a wind chill effect that will make you more comfortable in your home, even if it's also cooled by natural ventilation or air conditioning. Ceiling fans are considered the most effective of these types of fans, because they effectively circulate the air in a room to create a draft throughout the room. If you use air conditioning, a ceiling fan will allow you to raise the thermostat setting about 4°F with no reduction in comfort. In temperate climates, or during moderately hot weather, ceiling fans may allow you to avoid using your air conditioner altogether. Install a fan in each room that needs to be cooled during hot weather. Turn off ceiling fans when you leave a room; fans cool people, not rooms, by creating a wind chill effect. Ceiling fans are only appropriate in rooms with ceilings at least eight feet high.

Table A2. The LQ and HQ translations aligned at sentence level showing the differing number of words and characters in the corresponding sentences.

LQ translation	HQ translation
(1) Wiatraki obrotowe obemują wiatraki sufitowe, stołowe, drzwiowe oraz wiatraki montowane na słupach i ścianach.	(1) Do wentylatorów zaliczamy wentylatory sufitowe, stołowe, stojące, oraz wentylatory zamontowane na słupach lub ścianach.
(2) Wiatraki te tworzą efekt chłodnego wiatru, który zwiększy wrażenie komfortu w twoim domu, nawet jeśli jest on już ochładzany przez naturalną wentylację lub klimatyzację.	(2) Urządzenia te wywołują wrażenie chłodu spowodowanego wiatrem, poprawiając komfort przebywania w domu, nawet jeśli w pomieszczeniu jest wentylacja naturalna, lub jest ono wyposażone w klimatyzację.
(3) Wiatraki sufitowe są uważane za najbardziej skuteczne ze wszystkich wiatraków, ponieważ efektywnie wprawiają w obieg powietrze w pokoju tworząc przewiew.	(3) Wentylatory sufitowe uznawane są za najbardziej skuteczne urządzenia pod tym względem, ponieważ powodują skuteczny obieg powietrza w całym pomieszczeniu, dając poczucie przeciągu.
(4) Jeśli używasz klimatyzację, wiatrak sufitowy umożliwi podniesienie termostatu o 4°F bez obniżenie komfortu.	(4) W przypadku pomieszczeń klimatyzowanych, wentylator sufitowy pozwoli na podniesienie temperatury na termostacie o ok. 2°C, przy zachowaniu takiego samego komfortu cieplnego.
(5) W klimatach umiarkowanych lub w trakcie średnio upalnej pogody, wiatrak sufitowy może pozwolić na całkowite wyłączenie klimatyzacji.	(5) W klimacie umiarkowanym lub, gdy nie jest aż tak gorąco, po włączeniu wentylatora sufitowego korzystanie z klimatyzacji często nie będzie potrzebne.
(6) Zainstaluj wiatrak w każdym pokoju, który powinien być schładzany w trakcie upału.	(6) Wentylatory sufitowe należy instalować w każdym pomieszczeniu wymagającym chłodzenia w trakcie upałów.
(7) Włączaj wiatrak sufitowy, gdy wychodzisz w pokoju, ponieważ wychładza on osoby a nie pomieszczenie tworząc efekt chłodnego wiatru.	(7) Przy wychodzeniu z pokoju wentylator należy wyłączyć, ponieważ wywołując wrażenie wiatru chłodzi on ludzi, a nie pomieszczenie.
(8) Wiatraki sufitowe mogą być instalowane jedynie w pomieszczeniach, w których sufit jest na wysokości co najmniej ośmiu stóp.	(8) Wentylatory sufitowe nadają się wyłącznie do pomieszczeń o wysokości co najmniej 240 cm.

Appendix O: Research Article 5

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Spotlight on the reader: methodological challenges in combining translation process, product, and translation reception

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Abstract: This contribution addresses methodological challenges in integrating translation process, product, and reception data, and explores intricate relationships between translator's cognitive effort, translation quality, and the readers' cognitive effort. The interplay is examined with an eyetracking experiment in which participants read professional L2→L1 translations (whole texts) of varying quality (high vs. low). The analysis focuses on meaning integration and re-processing during L1 reading, operationalised through three eyetracking measures: dwell time, number of runs, and re-reading dwell time. The texts read are either high-quality translations (an end-product of a translator with many years of professional experience) or low-quality translations (delivered by a less experienced professional translator). Each L2→L1 translation consists of eight sentences. Each sentence in the text thus has a record of each reader's cognitive effort (eyetracking measures), and a record of translator's cognitive effort operationalised as the time taken by the translator to deliver a translation of a target sentence. Results reveal a significant interaction effect: readers exert more cognitive effort when reading low-quality translations, particularly when the translator's effort is lower, whereas high-quality translations elicit increased reader's effort when the translator's effort is higher. Moderated mediation analyses further show that readers' proficiency in the source text language (L2) mediates the relationship between the number of years they use their L2 and cognitive effort invested in reading L1 translations, but only in the case of low-quality translations. These findings underscore the complex dynamics between translation production and reception, highlighting the role of individual differences in shaping cognitive processing. The study contributes to the growing body of research in Cognitive Translation and Interpreting Studies by bridging process- and reception-oriented approaches, and by offering insights into how translator's effort and decisions impact reading processes.

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Keywords: translation reception; cognitive effort; translation quality; L2 proficiency and exposure; eyetracking; methodological challenges

1 Introduction

The intersection of *Translation Studies* and *Reception Studies* has ushered in lines of research which brought the reader, viewer, and listener from backstage into the dazzling spotlight. This shift from the periphery to centre is particularly evident in latest research trends in Cognitive Translation and Interpreting Studies (CTIS), both in terms of the scale of empirical interest and the diversity of research methods used to examine the recipient's experience (Walker 2019, 2021; Whyatt et al. 2023). Even though the turn towards reception in Translation Studies (TS) may seem strikingly contemporary and fresh, as Muñoz Martín (2024) points out, reception-oriented research has long been part of the scholarly tradition in CTIS, albeit encountered in diverse forms also from the perspective of the translator.

Within an act of translation, the translator assumes more than one role: the reader of the source text (ST), the writer of the target text (TT), often the first reviewer, reviser, and proofreader of the initial TT draft. This multi-layered engagement with the text further foregrounds the intricate relationship between TT production, its quality and reception, and – since we deal with human translation and human reception – we need to consider individual differences brought to the process of translation and reading.

Reading research and reception-oriented translation studies rest on the assumption that there is a link between visual attention and information processing (Just and Carpenter 1980). A word (phrase or sentence) that is more difficult to process, garners more visual attention. The reading process, defined as "the processing of textual information so as to recover the intended meaning of each word, phrase, and sentence" (Rayner et al. 2016: 5), serves as a mirror that may reflect the purpose of reading task (e.g., scanning, reading-for-comprehension; see Ho & Tsai, this volume), text type (e.g., functional, expressive), text complexity, and quality.

The eyes lingering on text segments containing errors or inaccuracies may manifest as an increased number of fixations or regressions to the words, longer fixation durations, taken to reflect higher *cognitive effort* required to access the mental lexicon to construe and integrate the underlying meaning of the text (see Clifton et al. 2016; Rayner 1998). In this way, higher reading effort – as expressed in more or longer fixations, regressions, and, as a result, longer dwell time (i.e., total fixation duration) – can indicate low quality of the text (text containing many errors that disturb the reading process).

All the same, low-quality features of the text (e.g., errors, problems with logic) may become more (or less) salient depending on the reading task and levels of text processing it entails (Rayner et al. 2016). Textual features are also filtered through the reader's profile (e.g., their language proficiency, background, reading habits), potentially modulating cognitive effort exerted in reading. In this way, the reading effort may reflect the interaction of the (bottom-up) text quality and the reader's (top-down) individual differences.

Translations offer yet another layer of features that may impact the reading process, and thus provide even more angles for exploration. The very possibility of testing the effectiveness of the translator's keystrokes and pauses (recorded during the translation process) with the readers' eye movements opens up another door to translation quality evaluation. Moreover, the potential effects of the translator's effort and translation quality on the process of reading TTs may not 'shine through' in the reading process in the same way for all the readers, who enter into the reading process with their individual linguistic backgrounds.

The present contribution examines the correspondence between the *translator's effort* exerted to translate a text (operationalised as the total time taken by the translator to produce a target sentence in a text, see Table 1 in §3.1) and the *reader's effort* exerted to read the final outcome of the translation process. Since research at the interface of *translation process – product – reception* is still scarce, initial sections of this contribution discuss the selected methodological challenges that may emerge in attempts to integrate the translation process and product with translation reception. Part of the challenges stem from the difficulties associated with defining the underlying key constructs in this equation: *cognitive effort, translation quality, translation expertise,* and *language proficiency and use*. The second part of this article tests the interaction of these constructs and reports on the experimental investigation of how the professional translator's effort, translation quality, as well as readers' ST-language proficiency and exposure (L2 proficiency and L2 use) shape the reception of the TT captured with eyetracking during reading.

2 Methodological challenges in combining translation process, product, and reception

Shifting the concept of *reception* from the periphery to the forefront of the scholarly focus in CTIS has opened new research avenues elucidating the effects of the translator's decisions on the reader. Meanwhile, the key concepts aimed at capturing the granularity of the link between translation process, product, and reception – cognitive effort, translation quality, the role of translation experience,

and the background and traits of the reader (here, the focus on linguistic background) – have remained relatively elusive. Below they are closely examined as they pose challenges for translation reception studies.

2.1 The many shades of the reader's and translator's cognitive effort

The construct of *cognitive effort* has been addressed across many disciplines studying the mind and the brain. The broad research scope and proliferation of terms often used interchangeably (e.g., mental effort, processing effort, mental workload, cognitive load) reflect its relevance in understanding mental processes and their associated costs. In his influential theory on attention and effort, Kahneman (1973) understands cognitive (mental) effort as the amount of attention allocated during task performance, thereby disambiguating it from physical effort. This understanding of cognitive effort resonates across Reading Studies (RS) and CTIS today.

2.1.1 The choice of proxies for cognitive effort

At the heart of methodological challenges in combining cognitive effort studies in translation and reception lies identifying valid and reliable measures capable of gauging cognitive effort invested in a translation task by the translator and in a reading task by the TT reader. The selection of appropriate measures is based on how cognitive effort is defined and operationalised.

Across RS, *cognitive effort* is often understood as attention or mental-resource allocation, cognitive load, processing difficulty, fluency disruption, and engagement in higher-order processing (e.g., Alter and Oppenheimer 2009; Kahnemann 1973; Sweller 2011). In CTIS, it remains a central construct, often conceptualised as the amount of mental resources exerted to produce a translation (e.g., Hvelplund 2011; Krings 2001; Vieira 2014). Using a broader understanding, the cognitive effort of the translator may be defined as "[t]he total effort that the translator expends during the translation task [and] the target text (TT) is then the product of this translator effort" (Hunziker Heeb 2020: 48), and researched analysing its different representations as indicators of the same cognitive effort, rather than technical, temporal, or cognitive efforts (see Hunziker Heeb 2020; Pietryga 2025).

Cognitive effort invested in performing a task by the translator and the reader lends itself to indirect measurement with 'online' *verbal descriptions of thoughts* (TAPs), *retrospective rating scales* (evaluating the subjective feelings of effort), *comprehension accuracy* (more inaccurate answers on text comprehension

questions indexing high cognitive effort), *brain waves* (changes in the selected alpha or theta waves indexing changes in cognitive effort), *physiological signals*, *reading times* (longer time indexing higher effort), and *eye movements* – higher values of measures such as a number of fixations, regressions, and dwell time indexing higher effort (Gile and Lei 2020: 269–273). Its distribution across translation tasks is also investigated with *hesitation pauses* (Lacruz and Shreve 2014; O'Brien 2006) and *eye-key span* (Dragsted and Hansen 2008; Pietryga 2025), with longer pauses and longer time lags taken to reflect enhanced cognitive effort. Within CTIS, data registered with keystroke logging, screen-capture techniques, and eyetracking – today often used in triangulated and mixed-methods designs – are further interpreted within frameworks mainly developed for post-editing such as Krings's (2001) temporal, technical, and cognitive indicators.

Eye-movement control models in reading (e.g., the E-Z Reader model) implicitly assume that "the link between eye movements and cognition is quite tight" (Reichle et al. 2003: 511), and that the distribution of visual attention aligns with information processing (the *eye-mind hypothesis*, Just and Carpenter 1980). To analyse this distribution across the tasks involving reading, researchers readily apply Rayner's (2009) framework, where specific eye-movement measures are assumed to reflect specific stages of processing during reading. Early-stage eye-movement measures are taken to reflect initial lexical access (low-order visual encoding and initial lexical processing) and primarily include *first-pass fixation duration, gaze duration* (sum of all first-pass fixation durations), and *saccade length*. Late-stage eye-movement measures, assumed to reflect post-lexical access (higher-order processes thereof: semantic integration, comprehension), include *regressions* and *re-reading time,* and *number of passes (runs)*.

Dwell time (total fixation duration) – a more global measure – reflects the total cognitive effort exerted over a specific AOI (Walker 2021). Although the exact labels for eyetracking measures vary, a prevailing view emerges: their higher values recorded to AOIs (a word, phrase, sentence, excerpt, or whole text) are taken as proxies for the increased cognitive effort invested in processing the AOIs. The research hypothesis will guide the choice of measure (early, late, or global) that is relevant to addressing the research question.

2.1.2 The choice of experimental stimuli to gauge cognitive effort

Another challenge of integrating translation process, product, and reception scopes lies in the choice of experimental stimuli. When the same experimental material (e.g., a text) is utilised in a translation-process-and-product study and the subsequent reading study, many decisions are mutually dependent and thus become more complex. Cognitive effort is sensitive to the lexico-semantic, syntactic, and stylistic

features of the text (Frazier and Rayner 1982; Rayner and Duffy 1986). More cognitively taxing are infrequent, abstract, or ambiguous words; unconventional metaphors; long, syntactically complex, unpredictable sentences; texts lacking in coherence (Staub and Rayner 2007). Since cognitive effort is tied to specific features of the text, a ST will to some extent affect the outcome of translation process (the TT), and the TT – when used as an experimental text in a reading study – will modulate readers' cognitive effort.

Insights into the reading process, advanced by studies on single-word and sentence processing, show cognitive effort to be affected by word- and text length (e.g., Cop et al. 2015). In empirical attempts to tie cognitive effort in translation production with translation reception, measures independent of text length may be more accurate to consider, as they allow for between-studies comparisons of the invested processing effort (see O'Brien 2010). Character-adjusted eye-movement measures have already been employed to quantify cognitive effort in entire-text reading experiments: to examine repeated exposure effects (Hyönä and Niemi 1990), text readability (O'Brien 2010), processing of foreignised elements (Kruger 2013), and translation reception (Walker 2019; Whyatt et al. 2025).

This solution makes comparisons possible between the amounts of cognitive effort invested in reading texts, despite variability in text length. In an exploratory proof-of-concept experiment marrying the translation process to reception, Whyatt et al. (2023) use character-adjusted dwell time and fixation count as proxies for cognitive effort. In studies that tie the reading process to translator's effort, including spaces as additional characters in calculations seems justified – effortless as pressing the spacebar may appear, it contributes to the translator's technical effort (Krings 2001). Yet, across CTIS and RS, the decision to include or exclude spaces in such adjustments varies depending on the research problem and methodological design. As a case in point, research questions that address language processing in a single language tend to exclude spaces from the total count of characters in a sentence or in a text. In such cases, there is no need to adjust for the word length that may typologically vary across the explored languages (e.g., Polish, as an inflected language, has richer morphology than English).

Another factor reported to modulate cognitive effort is text complexity. That may be assessed within the methodological framework of grammatical intricacy and lexical density (Yu and Wu 2019). Complex syntactic patterns (e.g., object relative clauses) and dense information integration in a text (e.g., many content words, uncommon lexical items) increase readers' reaction times and gaze durations (Singh et al. 2016). While readability formulas have been reported to successfully predict the processing effort involved in translating and reading (e.g., Vieira 2014), it appears that high-complexity-but-high-quality translations might still be less cognitively taxing to read than low-complexity-but-low-quality translations (Whyatt et al. 2023,

2025). Readability metrics should therefore be employed with caution as predictors of cognitive effort in reading TTs of varying quality.

What tends to be associated with specific levels of text complexity are text types. In CTIS, some studies found text type to predict the translator's time and processing effort invested in translation: different text types were associated with different processing efforts (e.g., Wang and Daghigh 2024; Whyatt et al. 2021). The choice of text type (e.g., descriptive, functional, literary, a news story) as experimental stimuli seems then pivotal. Expressive literary texts appear to allow for more emotional and cognitive engagement and hence might be more taxing to process, translate or read than descriptive texts. When translating literary texts, the translators may use more creative translation strategies (e.g., less frequent vocabulary or unusual grammar structures to convey the intended tone), which overall may increase cognitive effort involved in reading, yet it does not necessarily reflect the translation quality. Functional descriptive texts are assumed to be more standardised in terms of lexis than more creative texts (Tomczak and Whyatt 2022: 126) and thus potentially limited as to their effects on readers.

On the other hand, texts with language for special purposes can be rich in low frequent terms which would increase cognitive demands. In a reading experiment with excerpts that could pass as both news or literary stories, Zwaan (1994: 930) established that, when the participants believed to be reading a news story, they allocated "more resources to the construction of a causal-situation model," and exhibited shorter reading times. Readers who believed to be reading literary stories allocated "more resources to surface-level and textbase-level processes," which manifested in longer reading times. Minimising unwanted variability and potential confounds stemming from the choice of text allows for a more controlled exploration of the reading process, and thus raises confidence in ascribing the captured cognitive effort to the investigated factor rather than other factors.

2.1.3 The choice of experimental task to gauge cognitive effort

Task effects serve as a considerable source of variability in the processing effort (Horiba 2000). Shreve et al. (1993) found that anticipation of translation problems involved in reading-for-translation somewhat slowed down the reading process, as compared to careful reading-for-comprehension. An eyetracking study by Schaeffer et al. (2017) revealed that the total reading time, and the number of fixations and regressions approximately doubled while reading for translation, when compared to reading for comprehension. The authors argue that this lends support to the assumption that the reading purpose and task instructions have effects both on lexical access and meaning integration processes. Hvelplund (2017) examined the distribution of cognitive effort across four types of reading during translation: ST

reading, ST reading while typing, TT reading while it is emerging, and then when it is complete. Reading of the emerging TT was found to be most cognitively demanding (longer fixations), followed by reading the existing TT, ST reading (without typing), and ST reading while typing which attracted shortest fixations.

Ingrained in the translation task, translation directionality has often been shown to modulate cognitive effort of translators. Translating into L2 tends to be more demanding than translating into L1 (Buchweitz and Alves 2006; Ferreira et al. 2016) and invites more extensive use of online resources (Kuznik and Olalla-Soler 2018; Whyatt et al. 2021). In reading studies, a considerable portion of variability in data can be attributed to the choice of language (here, readers' L1 or L2) for the reading task and the purpose of reading. As evidenced by psycho- and neurolinguistic research, reading in L2 is more cognitively taxing than reading in L1. It typically involves longer reading times than L1 reading (e.g., Cop et al. 2015; Nahatame 2023).

Studying the effects of task on cognitive effort presents challenges, as it remains difficult to isolate them from other cognitive processes that become co-activated during task performance. To tease apart entangled cognitive processes involved in the translation task or reading task, and limit the extraneous factors to ensure valid and reliable measurement of cognitive effort, methodological rigour remains a priority (Fleming et al. 2023: 290). On the other hand, highly controlled studies carried out in experimental settings are, by definition, often limited in their ecological validity. Thus, reconciling high control of potential confounding variables and high ecological validity remains an ever-green challenge in itself.

2.2 The curious case of translation quality

As noted by Gile and Lei (2020: 265), examining translator's effort warrants attention because of its nuanced relationship with the quality of the TT. While the link is not strictly linear, a TT where the translator is assumed to have exerted low cognitive effort most probably exhibits inaccuracies, errors, and other language imperfections that compromise translation quality. With a greater amount of invested cognitive effort (e.g., more thorough information collection and ST analysis, more self-revision) visible in the amount of time spent to produce each target sentence in the text, the overall quality of the translation has been found to improve, affecting text comprehension and reception experience of the readers.

Tracing the correspondence between translator's effort and translation quality depends on the definitions and assessment metrics of both. As discussed by Koby et al. (2014), definitions of translation quality can be located with respect to the two axes: the axis of *scope* (narrow-to-broad) and the axis of *specifications* (absolute-to-

relative). A broad view of translation quality includes accuracy, fluency required for the purpose and the audience; it acknowledges the end-user and complies with specifications negotiated between the requester and provider. A narrow definition of translation quality, on the other hand, focuses on the complete transfer of the ST message (including its connotation, denotation, nuance, and style) into a culturally appropriate TT, often with the expectation that it reads as an original. A vast array of translation quality assessment methods proposed to date include intuitive assessment, error analysis, corpus-based evaluation, rubrics-referenced and scale-based scoring, item-based assessment, comparative (expert) judgement (review in Han 2020).

While unveiling the power of the reading process to bring insights about the quality of TTs has not been extensively applied, recent studies suggest that text comprehension accuracy, feedback about engagement in reading, and – most interestingly – reading fluency tested with eye movements, may all reflect translation quality. In their exploratory study Whyatt et al. (2023) found no straightforward effect of the translator's effort but rather a visible effect of translation quality on the process of reading a product description text: the low-quality translation (involved text type: descriptive) required more cognitive effort to read than the high-quality translation, as evidenced by readers' longer character-adjusted dwell time. The experiment was conducted with a modest sample size and was exploratory in its nature. Treating readers' eye movements as indirect accurate measures of translation quality acknowledges the reading stage as an integral part of the quality assessment of the translation process and product. This wide-angle view looks beyond the edges of the translation process and product, and perceives the reading of the TT as the proof of the translation process in itself.

2.3 The unbearable lightness of language proficiency and translation expertise

This last section brings forward the role of the translator and the reader in experimental studies of the translation process and in reception studies. Alongside task- and stimuli-specific effects, differences in participant characteristics are one of the major sources of variability in information processing data produced by human beings. Where translators and readers are involved, their performance differences (including cognitive effort) are shaped by their language proficiency and exposure, domain expertise, specific cognitive abilities, age, and years of experience, to name but a few. Language proficiency and exposure are factors contributing to both the reader and translator profile. While for translators L2 proficiency is tacitly assumed

to be a part of their translation expertise, in reading studies the language background of the reader has often been overlooked.

CTIS have mostly tested their research hypotheses with participants of varying levels of translation expertise. What is meant by translation expertise and how it affects translation task performance in terms of cognitive processing are questions that have fuelled a substantial area of scholarly enquiry and thought (e.g., Massey 2017; Muñoz Martín 2014; Shreve 2006; Shreve et al. 2018; Tiselius and Hild 2017). As a multifaceted concept, translation expertise has witnessed "almost as many definitions (…) as the number of researchers studying the subject" (Muñoz Martín 2014). As "a unique combination of experience, knowledge and skills" (Whyatt 2018a: 65), it evolves through sustained efforts and practice over the timespan of professional experience (Massey 2017; Shreve et al. 2018) to ensure high-quality work performance.

From a methodological standpoint, in CTIS translation expertise is thus often linked to years of professional experience (Tiselius and Hild 2017: 430), and thus the labels *professional, expert, experienced* are equally often used interchangeably to refer to participants. The lines of consistent empirical enquiry in CTIS using eye-tracking and keylogging have found professional translators to exhibit fewer but longer fixations, fewer regressions, shorter pauses during translation than the less experienced translators (Hvelplund 2011), and more efficient coordination of the reading and writing processes during translation (Dragsted 2010).

While CTIS often examine professional, experienced, and expert translators, psycholinguistic bilingual reading studies often engage highly proficient users of their languages (L1, L2) as participants to investigate cross-language dynamics. With more than one definition of language proficiency and language exposure, visual-world eyetracking experiments have revealed activation of the L1 during L2 processing (e.g., Duyck et al. 2007), and – more intriguingly – activation of the L2 during L1 processing (e.g., Spivey and Marian 1999). Crucially, L2 proficiency has been reported to significantly modulate these cross-language activation (CLA) patterns.

Yet, research findings pointing to L2 proficiency affecting L2→L1 CLA remain somewhat contradictory and inconclusive: higher L2 proficiency leads to stronger and earlier L2→L1 CLA reflected as interference effects (e.g., Mishra and Singh 2016) or higher L2 proficiency has been found to reduce L2→L1 CLA, yet with higher L2 exposure observed to strengthen L2→L1 CLA (e.g., Berghoff and Bylund 2024). The L2 proficiency effects are inherently intertwined with age of L2 acquisition and L2 exposure. The complexity of this relationship becomes particularly salient when examining L2 activation during reading of texts in L1 and – most interestingly – texts translated into one's L1 where the ST language is one's L2. The major question is then whether the levels of L2 proficiency and L2 exposure modulate the strength of CLA

when reading translations from L2 into L1. The study reported below embraces the above challenges to combining the translator and the reader, the translation process, its product, and its reception.

3 The study

3.1 Main objectives, research questions, and variables

The main objective of this study is to further our understanding of (1) how the translator's cognitive effort and translation quality affect the cognitive effort that the reader invests in reading a TT, and (2) how the quality of the TT – coupled with the reader's background (*L2 proficiency* and *the number of years of L2 use*) may be related to translation reception, indexed by the reader's cognitive effort at reading the translation. This contribution draws on eyetracking attempts to combine the translation process and product with translation reception process (Whyatt et al. 2023, 2025), and further investigates this interface with a larger sample size. To this aim, the following research questions are addressed:

RQ 1: Is there a relationship between the *translator's cognitive effort* when producing the translation, *translation quality*, and the *reader's cognitive effort* invested in meaning integration? More specifically, do the *translator's cognitive effort* invested in producing the translation and *translation quality* affect the *reader's cognitive effort* involved in re-reading the translation (dwell time, re-reading dwell time, and the number of runs)?

Bearing in mind the importance of individual differences that readers bring into the reading process, in the second step, the aim is to explore the intricate interplay between *translator's cognitive effort*, *translation quality*, and the *reader's cognitive effort* involved in reading the TT, and the selected individual differences regarding the use and proficiency in the ST language (i.e., years of L2 use, L2 proficiency) of the readers. To this aim, the following research question is addressed:

RQ 2: Is the mediation relationship between *L2 years of use – L2 proficiency – reader's cognitive effort* (indexed by a late-stage-of-processing eye-movement measures: number of runs, re-reading dwell time, as well as total reading dwell time) different for the low-quality (LQ) translation and high-quality (HQ) translation?

The operationalisation of the investigated variables is presented in Table 1.

Table 1: The investigated variables operationalised.

Proxy for	Measure	Comments	Data collection or assessment method
Translator's cognitive effort	*Total time* taken by the translator to produce a TT (each sentence in the TT is a separate value). Following Hunziker Heeb (2020: 48), the translator's cognitive effort is understood as "[t]he total effort the translator expends during the translation task [and] the target text (TT) is then the product of this translator effort."	Character-adjusted (i.e., divided by the number of characters in a given sentence in the TT, including spaces)	Keylogging (Translog II)
Translation quality	The translation quality of the TT. Categorised as low quality (LQ) and high quality (HQ).	All corrections made by proofeaders and accuracy evaluator were classified into the following categories: vocabulary, grammar, orthography, style, cohesion, spelling, punctuation, vocabulary, sense-nonsense error, cultural adaptation, and accuracy. The lower the number of points, the better the translation quality. See Whyatt (2019) and Whyatt et al. (2023) for details about types of corrected errors and criteria of translation quality evaluation.	Evaluated by two proofreaders who did not have access to the ST and focused on scoring language and cultural adaptation Additionally, evaluated by one experienced professional translator who focused on evaluating only accuracy of the translations (who had access to the ST) The proofreaders and the accuracy evaluator were instructed to correct the TT to make them publishable (to correct the TTs when they felt it was necessary).
Reader's cognitive effort invested in meaning integration	*Dwell time (total fixation duration)* – the sum of the duration of all fixations in the area of interest (AOI). Character-adjusted (the sum divided by the number of characters in the AOI, including spaces).	Each sentence in the text serves as a separate AOI. Hence, 8 AOIs in each text. Dwell time is a more global measure exerting the total cognitive effort exerted over a specific AOI (Walker 2021).	Eyetracking (EyeLink 1000 Plus)

Table 1: (continued)

Proxy for	Measure	Comments	Data collection or assessment method
	Re-reading dwell time – first-run dwell time deducted from total dwell time in the AOI. *Number of runs (passes)* – the number of times each AOI (each sentence) was entered and left.	Re-reading dwell time and number of runs are taken as late-stage cognitive effort measures, linked to re-processing and meaning integration (Inhoff et al. 2019; Rayner 1998). Not character-adjusted.	
Reader's L2 proficiency (English)	The average score computed out of four language skills (reading, listening, speaking, writing). Since each skill was self-rated using a 7-point Likert scale, the total score (the mean value) for each participant's L2 proficiency is the average score calculated out of the four skills divided by 7. This mean value ranges from 0 (minimum) to 1 (maximum).	Self-rated L2 stands for English, which is the language of the source text (ST) of the translation into Polish (L1).	Questionnaire LHQ ver. 3.0
Reader's number of years of L2 use (English)	The reported total number of years spent using English (following the instructions after Li et al. 2020, "you may have learned a language, stopped using it, and then started using it again. Please give the total number of years.")		

3.2 Participants

The readers (n = 67) who took part in the eyetracking study (the applied pre-screening inclusion criteria) were speakers of Polish as L1, highly proficient in English as their L2 (and the ST language), with normal or corrected-to-normal vision. All participants

Table 2: Descriptive statistics for the group of readers (Polish users of English).

Profile	Unit	Mean	Median	SD	Min.	Max.
Years of L2 use (L2 exposure)[a]	years	14	14	2.31	7	19
English L2 proficiency[a]	score	0.84	0.86	0.09	0.43	1.00
English L1 proficiency[a]	score	0.94[c]	1	0.09	0.61	1.00
English L2 proficiency[b]	score	81.07[d]	81.25	9.00	62.5	100
Age[b]	years	20.52	20.00	1.38	18	25

[a]LHQ, self-reported; used to profile the group of participants and in the subsequent data analyses. [b]LexTALE test; used only to provide a more detailed profile of the participants. [c]Based on 61 participants (incomplete datasets). [d]CEFR= C1/C2.

(47 women, 9 men, 5 non-binary, 2 non-relevant) were university students of English and were remunerated for their time (app. 1 h; vouchers or course credits). Four datasets had to be discarded because they were either incomplete or of very low quality of eye-tracking records. As a results, the 63 datasets were suitable for statistical analysis involving data collected with an eyetracker and participant profiling instruments (see §3.3.1). The participants were relatively homogenous regarding their reading habits (self-declared avid readers, 81 %; read most often in digital format, 58.5 %; more details on their reading habits in Whyatt et al. 2025). Table 2 shows a more detailed group profile.

3.3 Instruments, materials, and experimental tasks

3.3.1 Instruments used to profile the participants

The participants completed the *Language History Questionnaire* (LHQ 3.0, Li et al. 2020), used to gauge their self-reported language proficiency in L1 (Polish) and L2 (English – the language of the source text in the translation-process-and-product study), the number of years of L2 (English) use, age of L2 acquisition, language dominance, language background, exposure and use. They also took the LexTALE test (Lemhöfer and Broersma 2012) that provided more information about their L2 (English) vocabulary knowledge and filled out a survey about their reading habits, which both helped to provide more information about their profiles.

3.3.2 Experimental texts

The data recorded for two texts of different translation quality (high vs. low) were submitted to statistical analyses to answer the two primary research questions. Both

texts were Polish translations of English product descriptions (L2→L1) by professional bidirectional translators in the EDiT project (see Tomczak and Whyatt 2022; Whyatt 2018b). A descriptive text type (describing a ceiling fan) was selected for further analysis for its lower potential to evoke emotional engagement in reading, which could otherwise bias the investigated relationship between the translator's effort, translation quality, and reader's cognitive effort.

The TT requiring extensive correction by proofreaders (17 corrections in total) was classified as low-quality (LQ); the counterpart TT requiring minimal correction for publication (only 2 minor errors) was classified as high-quality (HQ) – details on proofreader corrections and quality assessment in Whyatt (2019: 86) and Whyatt et al. (2023). Two uncorrected TTs were used in the reading experiment. They differed in terms of word- and character length (including spaces): LQ TT (1011 characters, 136 words, 8 sentences), HQ TT (1138 characters, 145 words, 8 sentences), as compared to the ST (941 characters, 162 words, 8 sentences). The readability measures (*jasnopis.pl*) reveal that both translations are difficult to read, with a higher index of difficulty for the HQ TT (*the text-level FOG index* = 19.11) than for the LQ TT (*the text-level FOG index* = 13.86), both more difficult to read than the ST in English (*the text-level FOG index* = 12.57).

The two TTs (English→Polish) of different quality were end products by two professional bidirectional translators. Demographics and data records of the translation process collected in our previous project (EDiT using keylogging, eye-tracking, screen capture) show that the LQ translator had fewer years of professional experience than the HQ translator (3 years vs. 25 years), lower proficiency in English (LexTALE score = 71.25 vs. 91.25), allocated considerably less time to revision (20 s vs. 479 s) and drafting (578 s vs. 830 s), but comparable time as the HQ translator to orientation (50 s vs. 57 s). Each translator produced one TT, in the next stage evaluated by the two proofreaders and one professional translator (see Table 1 in §3.1) as a TT of LQ or HQ. Each TT contained 8 sentences, reflecting the structure of the 8-sentence ST. The translator's effort was recorded using keylogging (Translog II) and factored in and analysed at sentence level, with varying amounts of effort put into translating each sentence. As a result, the LQ TT contained 8 sentences into which the less experienced translator put varied effort (including low and high). In the same vein, the HQ TT contained 8 sentences into which the more experienced translator put varied effort (including low and high).

3.4 Apparatus, task, and procedure

Participants were familiarised with the procedure and study set-up, tested for eye dominance (due to monocular tracking), entered calibration, and completed reading-

for-comprehension tasks. They read five texts, each on a separate screen, each followed by comprehension checks (four true/false statements) to ensure careful reading (Kaakinen et al. 2003). The reading experiment (approx. 10 min) began with a baseline text (a product description of a mop cleaning set), followed by four texts, with a product description text (the experimental text – description of a ceiling fan) shown as first.

In this contribution, we analyse the data collected to a product description translation in its two variants: LQ and HQ. The between-subjects design was used with random condition assignment: reading the HQ versus LQ TT. Each text was displayed on a single screen (a 24-inch monitor, 1920 × 1080 resolution, 10 lines per text, 2.5 line spacing, Arial 25 pt.) in a self-paced mode. After the reading experiment, the participants provided feedback on their reception experience of the texts, and completed a battery of questionnaires.

The experiment was programmed and conducted using the EyeLink 1000 Plus eyetracker (SR Research) in the eyetracking Laboratory for Research in Language (EYE-LANG) at AMU Faculty of English, Poznań. The experimental protocol was approved by the Ethics Committee for Research Involving Human Participants at AMU, Poznań. Prior to the experiment, all participants provided written informed consent.

3.5 Statistical analyses

The drift-corrected eyetracking data collected in the reading experiment were submitted to statistical analyses (at sentence level), alongside both translators' total time taken to produce each target sentence in the translations (analysed at sentence level). The translation process data come from two translators recorded in a separate translation experiment (part of the EDiT project, described in Tomczak and Whyatt 2022). Data Viewer software (SR Research) was used for drift correction, and Jamovi software (ver. 2.3.28) for statistical analyses.

To answer RQ1, a linear mixed-effects (LME) analysis was conducted with five fixed effects: *translator's cognitive effort*, *translation quality*, and *the interaction of translator's effort and translation quality*, *reader's L2 proficiency*, and *their number of years of L2 use* (henceforth, *years of L2 use*), and with *participant* as a random effect. Following Whyatt et al. (2023), translation quality had two levels (low vs. high) and the translator's cognitive effort was character-adjusted and entered into the analyses at sentence level: to produce a TT each translator (the more experienced, the less experienced) translated 8 sentences. In the case of L2 proficiency and years of L2 use, L2 stands for English, which is the language of the ST of the translation into Polish. The reader's cognitive effort (reception effort) is assumed to be reflected in three

dependent variables (eyetracking measures): *dwell time*, *number of runs* and *re-reading dwell time*. The latter two are late-stage processing measures taken as proxies for cognitive effort involved in re-processing and meaning integration (Inhoff et al. 2019; Rayner 1998). As re-reading and regressing to the part of text is less systematic and occurs as a response to processing difficulties (e.g., Inhoff et al. 2019), these two measures are not character-adjusted. All the same, dwell time – a more global measure of reading – is character-adjusted (including spaces) to match the character-adjusted translator's effort and to make the variable independent of text length.

To answer RQ2, a moderated mediation analysis was performed, where translation quality was tested as a moderator of the mediation relationship between *years of L2 use – L2 proficiency – dwell time,* with character-adjusted dwell time indexing reader's cognitive effort at a more global level. The readers' L2 proficiency was tested as a mediator in this relationship. The same model was tested for the late-stage processing eye-movement measures (not character-adjusted): the *number of runs* and *re-reading dwell time.*

3.6 Results

The following sections provide a detailed presentation of the results of the statistical analyses performed to address the two investigated research questions (RQ1, RQ2). To ease the reading of the detailed results, what follows is a brief overview of the key findings. Both LQ and HQ TTs comprised 8 target sentences produced by each translator with varying effort recorded at sentence level (e.g., there were sentences in both LQ and HQ TTs where the translator's effort was lower or higher). The analyses reveal statistically significant interaction effects: readers' dwell time, number of runs, and re-reading dwell time is higher for reading the low-quality than the high-quality translation (LQ > HQ) but only when reading sentences into which the translators put low effort. When the translator's effort is high, readers show longer dwell time and re-reading dwell time for reading HQ versus LQ TT (HQ > LQ).

The effect of the number of years of L2 use was significant for re-reading dwell time and number of runs, with more years of L2 associated with lower reader's cognitive effort. Translation quality was found to moderate the relationship between readers' L2 proficiency and their dwell time, re-reading dwell time, and the number of runs. Readers' L2 proficiency mediates the relationship between readers' years of

L2 use and their cognitive effort but only for the LQ TT. Their number of years of L2 use is positively related to their L2 proficiency, and their L2 proficiency is negatively related to the investigated proxies for readers' cognitive effort.

3.6.1 Significant interaction effect of translator's effort and translation quality on TT readers' dwell time

Linear mixed-effects (LME) analyses tested the statistical significance of the investigated effects on *dwell time* and yielded no significant effect of *translator's effort* nor of *translation quality* (b = –0.006, SE = 0.005, t = –1.199, p = 0.231; b = –3.837, SE = 2.782, t = –1.379, p = 0.172, respectively). However, a significant interaction effect of *translator's effort* and *translation quality* on the reader's *dwell time* (b = 0.022, SE = 0.010, t = 2.261, p = 0.024) was revealed, indicating that the way translator's effort and translation quality affect reader's dwell time is more complex. Interestingly, the examined simple effect of translator's effort on the reader's dwell time reached significance only for reading the high-quality translation (b = 0.005, SE = 0.002, t = 2.147, p = 0.032), and not for reading the LQ TT (p = 0.075). What follows, in the TT which was evaluated by proofreaders as high-quality, those sentences into which translator put more effort, showed higher reading dwell time among the readers (b = 0.005, SE = 0.002, t = 2.147, p = 0.032). Moreover, the readers' dwell time was higher for reading the LQ than HQ TT (LQ > HQ) only for those sentences in the TTs into which the translators put low effort (b = –10.863, SE = 3.555, t = –3.056, p = 0.003). Neither L2 proficiency (p = 0.825) nor years of L2 use (p = 0.109) reached significance in the tested LME model (see Figure 1).

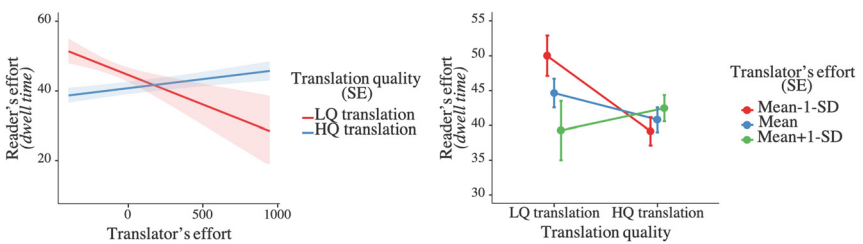

Figure 1: Plots for the simple slope analyses for the significant interaction effect of the translator's effort and translation quality on the reader's effort (indexed by *eye-movement dwell time*).

3.6.2 Significant interaction effect of translator's effort and translation quality on TT readers' number of runs and re-reading dwell time

Two eye-movement measures taken to reflect late-stage cognitive processing (meaning integration) were examined: *number of runs in the text* and *re-reading dwell time.* The LME analyses performed for the *number of runs* are reported first. Significant effects were found for the invested *translator's effort* (b = –0.001, SE = 0.0001, t = –2.423, p = 0.016), and for its interaction with *translation quality* (b = 0.002, SE = 0.001, t = 2.563, p = 0.011). In general, when the translator's effort invested in translation was low, the readers re-visited the TT more frequently (i.e., showed a higher number of runs). However, this general finding is driven mainly by one level of the independent variable: LQ TT (b = –0.002, SE = 0.001, t = –2.573, p = 0.010), not HQ (p = 0.797). The difference in the readers' number of runs to sentences (AOIs) in the HQ and LQ text was significant only where the translators put less effort to translate the corresponding sentences (b = –0.523, SE = 0.256, t = –2.041, p = 0.043), with more runs in the LQ TT (LQ > HQ).

The tested effect of *L2 proficiency* on the *number of runs* did not reach statistical significance (p = 0.508). However, the effect of *years of L2 use* was significant (b = –0.093, SE = 0.045, t = –2.055, p = 0.044). The higher number of years that the readers had been using English turned out to be linked to the lower cognitive effort they exerted to read the text that was a translation from English into Polish (see Figure 2).

Next, *re-reading dwell time* was examined. The LME analyses yielded a significant effect of *translator's effort* on re-reading dwell time (b = –1.979, SE = 0.774, t = –2.557, p = 0.011), as well as a significant effect of the *number of years of L2 use* (b = –226.459, SE = 81.092, t = –2.793, p = 0.007). Overall, when translator's effort increases, the reader's effort decreases. Likewise, when the number of years of L2 use increases, re-reading dwell time decreases. The tested interaction effect of translator's effort and translation quality reached statistical significance (b = 5.117,

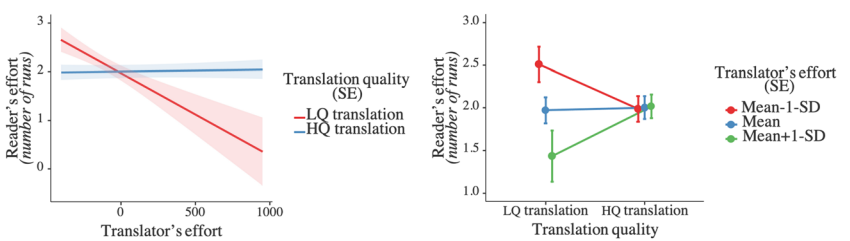

Figure 2: Plots for the simple slope analyses for the significant interaction effect of the translator's effort and translation quality on the reader's effort (indexed by *number of runs*).

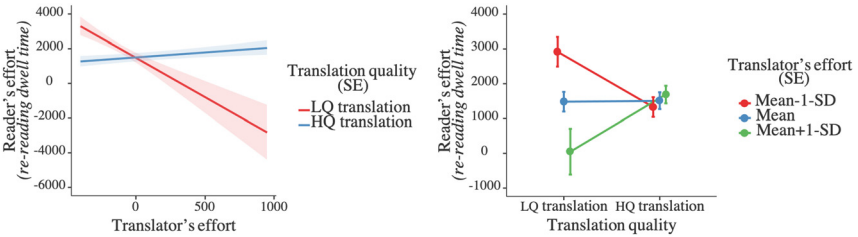

Figure 3: Plots for the simple slope analyses for the significant interaction effect of the translator's effort and translation quality on the reader's effort (indexed by *re-reading dwell time*).

SE = 1.548, *t* = 3.306, *p* = 0.001). As in the case of the number of runs, the simple effect of translator's effort is only significant for re-reading LQ TT (*b* = –4.537, *SE* = 1.500, *t* = –3.026, *p* = 0.003), not HQ TT (*p* = 0.131). When the LQ translator put more effort into translating sentences into L1, the readers spent less time re-reading those sentences.

Moreover, in the case of low effort invested by the translator into rendering sentences, the readers found it more cognitively taxing to read those in the LQ TT than in the HQ TT (LQ > HQ; *b* = –1593.927, *SE* = 512.086, *t* = –3.113, *p* = 0.002). When the translator's effort was high, readers showed lower re-reading dwell time (indexing lower cognitive effort) in the LQ than HQ TT (LQ < HQ) (*b* = 1643.926, *SE* = 706.102, *t* = 2.328, *p* = 0.020). Neither translation quality (*p* = 0.947) nor L2 proficiency (*p* = 0.697) reached significance in the tested LME model, indicating no significant impact of the two on participants' re-reading dwell time (see Figure 3).

3.6.3 Testing the moderated mediation model

We further investigated whether there was a relationship between *the number of years of L2 use, L2 proficiency,* and *dwell time* (more global eyetracking measure), and two late-stage processing eyetracking measures taken as proxies for cognitive effort involved in re-processing, re-analysis, and meaning integration: the *number of runs (passes),* and *re-reading dwell time*.

The moderated mediation analysis reveals that, in the tested mediation model *(years of L2 use – L2 proficiency – dwell time),* translation quality moderates the relationship between *L2 proficiency* and *dwell time* (*b* = 67.796, 95 % CI [10.039; 125.553], *β* = 2.585, *p* = 0.021). The indirect effect for the mediation model is significant for the LQ TT (*b* = –0.736, 95 % CI [–1.367; –0.106], *β* = –0.139, *p* = 0.022), but not for the HQ TT (*p* = 0.227).

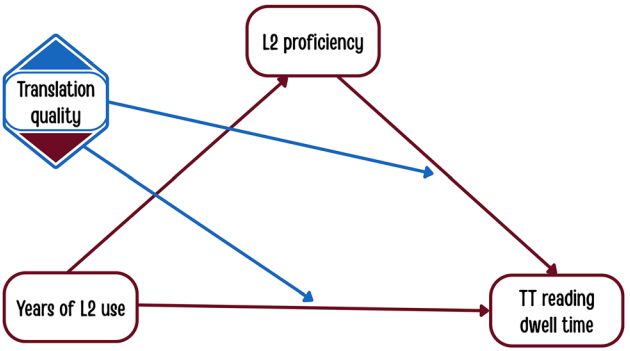

Figure 4: *L2 proficiency* as a mediator in the relationship between *years of L2 use* and (*total*) *dwell time* for reading the *low-quality* and *high-quality translation (TT)* – a moderated mediation model.

When the participants read the LQ TT, their *L2 proficiency* served as a mediator in the relationship between their *years of L2 use* and their *dwell time* invested in reading the text. In this relationship, their number of *years of L2 use* was positively related to their L2 proficiency (b = 0.015, 95 % CI [0.006; 0.025], β = 0.371, p = 0.002), whereas their L2 proficiency was negatively related to their *dwell time* (b = –48.864, 95 % CI [–77.137; –20.591], β = –0.376, p < 0.001). See Figure 4.

The moderated mediation analysis reveals that in the mediation model *(years of L2 use – L2 proficiency – number of runs)* translation quality moderates the relationship between *years of L2 use* and *number of runs* (b = –1.552, 95 % CI [–2.796; –0.308], β = –0.296, p = 0.015). Again, the indirect effect for the tested mediation model emerges as significant only for the LQ TT (b = –0.301, 95 % CI [–0.596; –0.006], β = –0.112, p = 0.046). When the participants read the LQ TT, their *L2 proficiency* mediates the relationship between their *number of years they use L2* and their *number of runs* they produced when reading the text. Moreover, *the number of years of L2 use* is positively related to L2 proficiency (b = 0.015, 95 % CI [0.006; 0.025], β = 0.371, p = 0.002), whereas their L2 proficiency is negatively related to the *number of runs* (b = –19.963, 95 % CI [–34.949; –4.976], β = –0.301, p = 0.009). In the case of the HQ TT, the investigated indirect effect was not statistically significant (p = 0.912). See Figure 5.

To further corroborate the answer to the research question.

Does the mediation relationship *L2 years of use – L2 proficiency – late-stage processing measures* differ depending on translation quality?

In the third step, the moderated mediation analysis for *re-reading dwell time* was performed. In line with the findings for the *number of runs,* the analysis reveals that in the mediation model *(years of L2 use – L2 proficiency – re-reading dwell time),*

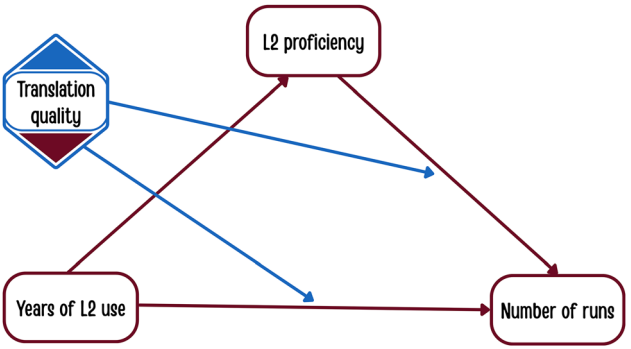

Figure 5: *L2 proficiency* as a mediator in the relationship between *years of L2 use* and *numbers of runs* for reading the *low-quality* and *high-quality translation (TT)* – a moderated mediation model.

translation quality moderates the relationship between *the number of years of L2 use* and *re-reading dwell time* (b = –2.553, 95% CI [–4.822; –0.284], β = –0.259, p = 0.027). Likewise, the observed indirect effect for the mediation relationship is significant for reading the LQ TT only (b = –0.647, 95% CI [–1.227; –0.067], β = –0.126, p = 0.029), not for the HQ TT (p = 0.983). In this model, the number of participants' *years of L2 use* was positively related to their *L2 proficiency* (b = 0.015, 95% CI [0.006; 0.025], β = 0.371, p = 0.002). Their L2 proficiency, on the other hand, was negatively related to their dwell time they invested in re-reading the text (b = –42.943, 95% CI [–70.270; –15.615], β = –0.340, p = 0.002).

4 Discussion

Moving from "translator-centredness" to "reader-centredness" (Gengshen 2004) in CTIS underscores that the translation process, or the mediated communication process (Halverson and Muñoz Martín 2020) does not end with the revision phase. It rather extends into *the translation reception phase,* in which the spotlight is shifted to the reader. The very possibility of testing the effectiveness of the translator's keystrokes and pauses with the readers' eye movements opens up another door to translation quality evaluation. Tracing the potential effects of the translated work on the reading process and readers entails examining their text comprehension, emotional response to text content, narrative engagement, or their cognitive effort involved in text processing. In this contribution, the focus is on the latter, with an assumption that cognitive effort of the translator, translation quality, and individual reader's background may 'shine through' in the reading process.

The LME analyses performed on eye-movement data recorded for reading a TT revealed a more complex interplay of the investigated factors. A significant interaction effect of translator's effort and translation quality was found for all three eyetracking measures taken to reflect cognitive effort. On the whole, readers' *dwell time, number of runs,* and *re-reading dwell time* were higher for reading the low-quality than high-quality translation (LQ > HQ) but only for the sentences into which the translators put low effort.

These results extend Whyatt et al.'s (2023) preliminary findings. With a smaller sample size allowing for a less robust statistical model, they observed that translation quality (and not necessarily translator's effort) affects readers' cognitive effort captured at a text level. Yet, their additional correlation analyses confirmed that translator's effort is negatively related (weak effect size) to the reader's effort only in the LQ TT condition. Whyatt et al.'s (2023) conclude that the relationship between the translator's production effort and reader's reception effort is not straightforward, and point to a more complex interplay between the examined variables that needs to be further investigated.

As reported here, this complex interplay emerges in the form of significant interaction effects between translator's effort and translation quality. Tested with more participants and alongside reader-related factors, *translator's cognitive effort* emerges as a significant factor when analysed through the prism of *translation quality:* the readers of LQ TT dwelled more on the text and revisited it more frequently when the translator's effort was low. Altogether, it seems that when reading the text of low quality, the readers show more processing difficulty when parsing sentences to which the translator devoted little time – the sentences translated with low time and therefore potentially low diligence were most effortful to process for the readers of the LQ text (evidenced by all three eyetracking measures).

Interestingly, when the participants read high-quality translation, they spent more time dwelling on sentences into which the translator invested high effort. At the same time, the sentences into which both translators put more effort, turned out to be more effortful to read when they were part of the HQ than LQ TT (as indexed by *re-reading dwell time*). Perhaps high-quality sentences translated with extra cognitive effort by the experienced professional translator were processed with more difficulty by the readers, because – compared to the corresponding target sentences in the LQ TT – their syntactic structure in Polish was denser and more complex (which holds especially for the second sentence in the TT). It may appear that the HQ translator refined some of the sentences too much, which overall lead to higher reader effort. In the case of these sentences, the invested higher translator's effort does not facilitate parsing for the readers, which also points to the importance of text-specific features.

The present contribution also tested whether reader-related factors, alongside the translator- and quality-related factors, are related to cognitive effort invested by the readers into reading the whole-text translation. Translation quality was observed to be a significant moderator of the mediation relationship *(L2 years of use – L2 proficiency – cognitive effort proxies)* for all three tested variables *(dwell time, number of runs, re-reading dwell time).* The investigated mediation relationship changes relative to translation quality. L2 proficiency (the proficiency in the language of the source text: English) was also found to mediate the relationship between the number of years of L2 use and the reader's effort (reflected in *dwell time*) depending on the translation quality. In fact, it emerged as a significant mediator only when the participants were reading the low-quality translation.

It therefore seems that *proficiency in the language of the ST* (readers' L2) has a facilitating effect on reading texts that contain errors and inaccuracies – it lowers readers' processing effort. With more years of L2 use, L2 proficiency increases, and higher L2 proficiency lowers the participants dwell time spent on reading the LQ TT. Its higher levels are related to lower cognitive effort involved only in reading texts riddled with errors, inaccuracies and other features of low-quality translation. The mediating effect of L2 proficiency on the readers' cognitive effort is corroborated in the analyses of the two late-stage measures: *number of runs* and *re-reading time*. Participants with higher proficiency in the language of the ST read the low-quality text with less effort. Higher L2 proficiency is also linked to more years of L2 use.

The readers participating in the eye-movement experiment were highly proficient users of English (their L2 and the ST language), with only nuanced differences in L2 proficiency. L2 proficiency effects, however, came to surface when they were challenged with a more strenuous task: reading a low-quality translation as if their proficiency in the source language helped them to see the intended meaning due to cross-language activation.

Just as stories can be mediated by narrators, the process of reading a TT will proceed with a ghostly presence of the translator. High degrees of translation expertise, developed over years of practice, help to navigate the translation challenges without compromising the quality of the end product. In this study, the experienced professional translator (25 years of professional practice) produced a high-quality translation. The considerably less experienced professional translator (3 years in the professional market) produced a text that required 17 corrections in total to make it publishable. Studies exploring the intersection of *translation expertise* and *cognitive effort* show that levels of translation expertise modulate the amount of cognitive resources allocated during a translation task (see Muñoz Martín 2014). However, as evidenced by shorter time devoted to translation and poor translation quality, the English→Polish translation task was most probably beyond the capacity of the less experienced translator, who seems not to have put due

diligence into the task, and – consequently – the TT reading task became more of a battleground for the readers.

The process of reading a translation (TT) appears to be constantly shaped by an intricate bidirectional interaction between the TT (produced by the translator) and the reader. It is a top-down process, which readers enter with their language proficiencies, reading skills and habits, and expectations, to name but a few. At the same time, it is a bottom-up process in which the readers receive the translation and respond to it (e.g., behaviourally, physiologically). The features of the translation may all affect the reading process, text comprehension, and interpretation. On this view, the reader's cognitive effort (modulated in a top-down manner through the prism of their individual differences) is modulated by the translator's bottom-up (affected by the features of the ST) and top-down processing during the TT production (shaped by their own expertise, professional experience, and other individual differences).

Insofar as the textual flaws in the translation that impact the reading process result from less optimal linguistic choices made by the translator, the interaction of the top-down and bottom-up processes appears even more inter-dependent and convoluted. Though a challenging task, integrating translation process, product, and reception of the translated text may thus afford a more comprehensive understanding of how the translator's cognitive effort and the quality of translation interact to shape the reader's cognitive effort involved in reading the translated text. Recognising that individual contributions of the factors discussed in the introductory part, which oftentimes remain challenging to isolate and control in the complex interplay, is an important step in CTIS research.

While this study offers a combined approach to looking at translation process, product, and reception data, several limitations must be acknowledged to guide future research. Firstly, the conscious reading-for-comprehension task, while ensuring careful reading, may not fully capture the natural reading behaviours that occur in real-world settings where translated texts are encountered and read (e.g., skimming for information, reading for pleasure; see Ho & Tsai, this volume). Additionally, participants were aware that their eye movements were being tracked. As a result, the generalisability of the findings reported in the present study to all reading scenarios is limited.

Secondly, the design of the reported study relied on the translations produced by only two professional (bidirectional) translators. Their translations represented the high-quality and low-quality conditions. While this allowed for a more detailed (sentence-level) analysis of the interplay between a translator's effort invested into producing a specific target sentence and the resulting reception of that target

sentence, it inherently conflates translation quality with individual translator profiles. Therefore, it is challenging to disentangle whether the effects observed as the reader's cognitive effort were driven by the textual features defining translation quality, translator's cognitive effort, reader's individual background, or by idiosyncratic aspects of the individual translator's style or profile (including experience, L2 proficiency).

Thirdly, it also remains an open question whether the same effects as found in the current study would be observed in a more general population of readers – for instance, with different reading habits, with a wider range of L2 proficiency. The pool of participants in the present study consisted exclusively of university students of English, who were highly proficient L2 users and avid readers in general. Keeping the participant pool homogenous was beneficial for controlling unwanted variability but – at the same time – limited the scope of conclusions and generalisations. The finding that L2 proficiency acted as a mediator between the number of L2 years and readers' cognitive effort but only for the low-quality translation might be specific to this particular demographic of skilled language users. In future studies, it is worth investigating whether the intricate interactions (found with highly proficient L2 users, avid readers) also hold for less specialised readerships.

By combining translation process, translation product, and reception of translated texts, the present contribution highlights a vital constant in an era of automation and rigorous experimental control: the human element. Beyond the advanced technologies, well-controlled experimental settings, and meticulous methodologies, it is the human translator who creates and the human reader who receives. This holistic approach weaving together three essential scopes on translation (process, product, and reception) helps to spotlight the irreplaceable role of the reader.

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