

**Easy Language under test: Effects of graphic and linguistic features
on comprehension, processing, and perception in primary users**

Mariona González Sordé

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Easy Language under test:

Effects of graphic and linguistic features on comprehension, processing, and perception in primary users.

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“Soon I'll find the right words,

they'll be **very simple.**”

Jack Kerouac

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I als que possiblement em deixo.

Despite the constraints and formal requirements of thesis submission, the author has made a conscious effort to ensure that both the format and structure of this dissertation are as clear, accessible, and easy to follow as possible.

The author also aimed to present the content in a clear and direct way.

An **Easy Language** summary of the results of our studies is available in Annex 1.

For any questions you can contact the author: marionagsorde@gmail.com

Trobareu un resum dels resultats dels nostres estudis en **Lectura Fàcil** a l'Annex 1.

Si teniu qualsevol pregunta, podeu contactar l'autora: marionagsorde@gmail.com

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Acronyms and abbreviations glossary

A1, A2, A3 – Aim 1, aim 2, aim 3

ANOVA – Analysis of variance

AOI – Area of interest / **AOIs** – Areas of interest

EL – Easy Language

fMRI – Functional magnetic resonance imaging

H1, H2, H3 – Hypothesis 1, hypothesis 2, hypothesis 3

HSD – Tukey's Honest Significant Difference test

ID – Intellectual disability

IDDs – Intellectual and developmental disabilities

IFLA – International Federation of Library Associations and Institutions

ILSMH – International League of Societies for Persons with Mental Handicaps

IQR – Interquartile range

ISO – International Organization for Standardization

PL – Plain Language

Q1, Q2 – Research question 1, research question 2

RPM – Raven's Progressive Matrices

TLC – Test de lectura comprensiva

UNE – Spanish Association for Standardization

CHAPTER 1

1. Introduction

Communication today takes place through an ever-growing number of channels and reaches farther than ever in our globalised world. Thanks to translation, content can cross linguistic borders and connect people around the world. Imagine that the usual ways of communicating around you feel out of reach, even in your own language. Most of us have struggled to make sense of dense laws or official documents. True inclusive communication goes beyond translation and requires content to be designed and expressed in a way that everyone can understand it.

Although translation was initially understood as the transfer of a text from one language to another, what Jakobson (1959) termed interlingual translation, there is now broad consensus that the discipline extends beyond this narrow definition to encompass a wide range of practices (Díaz Cintas et al., 2010; Köksal and Zorlu Kale, 2023). Within this expanded framework, Audiovisual Translation involves adapting multimedia content across languages, cultures, and modalities to provide access not only for speakers of different languages but also for individuals with sensory, cognitive, or learning disabilities (Díaz Cintas et al., 2007). Accessibility is therefore central to Audiovisual Translation, even though persistent challenges, such as inconsistent standardisation, remain (Rica Peromingo, 2025). As a result, Media Accessibility has emerged as a dynamic subfield within Audiovisual Translation, gaining recognition through legislation and standardisation initiatives (Matamala & Orero, 2018). Within Media Accessibility, additional emerging areas have also gained prominence, such as Web Accessibility (Orero et al., 2021) and Game Accessibility (Larreina & Mangirón, 2025; Oliva-Zamora & Mangirón, 2025).

Within this context, Easy Language, the main focus of this dissertation, is firmly situated in Audiovisual Translation Studies. Maaß and Hernández Garrido (2020) define Easy Language and Plain Language as varieties designed for enhanced comprehensibility, explicitly locating them within Audiovisual Translation, which encompasses all forms of translation and interpreting across modalities in

tertiary media, such as subtitles, audio descriptions, or sign language interpretation. While Easy Language can be applied across modalities, this dissertation focuses specifically on its written form, with awareness of broader multimodal applications and emerging research in audiovisual contexts (e.g., Arias-Badia & Matamala, 2020; Taylor & Perego, 2020; Machuca & Matamala, 2025; Pujadas-Farreras & Matamala, 2026).

These varieties fall under the umbrella term “easy-to-understand languages” (Maaß, 2020). Plain Language aims to communicate information clearly to the public, often in legal or institutional contexts (ISO, 2023a; Generalitat de Catalunya, 2025). Easy Language, the focus of this dissertation, is a more specialised variety: it applies explicit recommendations on wording, structure, design, and evaluation to ensure accessibility for people who have difficulties with reading comprehension (ISO, 2023b) (see § 1.2.3). Thus, Easy Language can be understood as a targeted subset of the broader easy-to-understand language spectrum, situated at the intersection of language simplification and written audiovisual translation.

Empirical research on Easy Language (EL) is generally scarce (see § 1.2.3.1. and Chapter 2), except for the German variant. Mandated by German law (Federal Ministry of Justice and Consumer Protection, 2011) as the standard for accessible written communication, German EL has been extensively studied since 2010, notably by the research groups Simply Complex – Easy Language (Johannes Gutenberg University Mainz), and the Research Centre for Easy Language (*Forschungsstelle Leichte Sprache*, University of Hildesheim). Outside of Germany, there is a lack of alignment between the empirical research conducted in this area (which often lacks conclusive results) and the development and application of EL guidelines (Lindholm & Vanhatalo, 2021, p. 15; Sutherland & Isherwood, 2016, pp. 297-298). Several literature reviews and studies (Sutherland & Isherwood, 2016; Rivero-Contreras & Saldaña, 2020; González-Sordé & Matamala, 2023; Rastelli, 2024) have emphasised the need for further empirical research to support existing EL guidelines, refine current practices, and enhance the comprehensibility of EL texts. This dissertation contributes to these ongoing efforts by addressing this research gap. Importantly, rather than seeking to identify shortcomings in EL in order to challenge its validity, this study aims to

explore evidence-based ways of rethinking current practices and strengthening their effectiveness, ultimately contributing to more accessible communication through empirically grounded approaches.

This present dissertation is part of the PhD programme in Translation and Intercultural Studies at the Department of Translation, Interpreting, and East Asian Studies at the Universitat Autònoma de Barcelona. It was partially carried out within the framework of the H2020 Mediaverse project (Grant Agreement 957252) and received funding from the Catalan Government (2021SGR00077). Additionally, the researcher received partial funding to perform the empirical studies from the Leading Platform for European Citizens, Industries, Academia, and Policymakers in Media Accessibility (LEAD-ME) (Cost Action CA19142).

1.1. Aims and hypotheses

The main objective of this dissertation is to examine whether selected key features of EL facilitate written text processing and improve text comprehension among one of its primary target groups, people with intellectual disabilities. To determine which aspects of EL to analyse in this research, we first conducted a literature review to understand the current state of research and identify previous studies to build upon. As Sutherland and Isherwood (2016) noted in their review, and as will be discussed in Chapter 2, very few studies examine the effects of the recommendations provided in EL guidelines, and the use of online, objective measures is not widely generalised¹.

The findings of this review led us to explore how EL recommendations influence comprehension, perceived difficulty, preference, and the cognitive effort involved in text processing, measured through eye movements, and by means of focusing on two main areas of EL guidelines: the use of images to support textual information and two linguistic features characteristic of standard Catalan, namely subordinate clauses, and the use of null and overt pronouns. As previously explained, EL differs from standard language not only in wording but also in

¹ Online measures assess language processing in real time while participants are reading or listening, such as eye-tracking or self-paced reading. Offline measures, like questionnaires, are carried out after the task is completed and capture only the final interpretation rather than the processing itself (Marinis, 2010).

structure and design. Therefore, we aimed to assess both graphic aspects (in the first empirical study, presented in Chapter 3) and linguistic aspects (in the second empirical study, presented in Chapter 4). These aspects were assessed among two participant groups: one consisting of people with intellectual disability (ID), and another consisting of neurotypical participants (also referred to throughout the dissertation as “participants without ID”).

These are the aims (A) of our dissertation:

A1: To review the existing empirical studies in Catalan, English and Spanish on the recommendations in EL guidelines

Before designing our empirical studies and defining their focus, we needed to conduct a thorough review of the existing literature on previous research that aimed to empirically evaluate aspects of EL guidelines in Catalan, English and Spanish, the languages the researchers were fluent in. This review helped us identify gaps in the literature and highlight areas in need of further investigation and shaped the direction of our empirical tests.

The literature review is available in Chapter 2, which corresponds to the article *Empirical evaluation of Easy Language recommendations: a systematic literature review from journal research in Catalan, English, and Spanish* (González-Sordé & Matamala, 2023).

A2: To assess the effects of visual support and image type in EL texts on comprehension and perception, and on text processing as measured through eye movements, on people with and without ID

The graphic aspect analysed in Chapter 3, which corresponds to the article *Visual support in Easy Language: The impact of images on comprehension, perceived difficulty, and eye movements* (González-Sordé et al., 2025), concerns the use of visual support in EL texts. The guidelines state that “to illustrate your text, you can use photographs, drawings, or symbols” (Inclusion Europe, 2009, p. 20), and further advise to “check with the audience whether they prefer drawings, photographs, or other types of illustration, and maintain the same style throughout the text” (García-Muñoz, 2012, p. 74). Following these recommendations, we examined whether the type of visual support included in a

document (photograph, illustration, or no visual support) influenced literal comprehension, perceived difficulty, and eye movements, which provide insights into the cognitive effort involved in text processing. We also investigated which visual style each participant group preferred.

These are the hypotheses (H) and research questions (Q) of this empirical study:

- *H1*. Visual support of any type has significant effects on text comprehension for readers with ID.
- *H2*. People with and without ID explore the page differently.
- *Q1*. How does the presence and type of visual support influence perceived level of text difficulty?
- *Q2*. How does the presence and type of visual support influence the way readers explore the page?

A3: To assess the effects of the exclusion of subordinate clauses, null and overt pronouns in EL texts on comprehension and perception, and on text processing as measured through eye movements, on people with and without ID

The linguistic aspects analysed in Chapter 4 are (1) subordinate clauses and (2) null and overt pronouns. These are highly prevalent elements in standard Catalan; however, according to EL guidelines, they should be avoided or, at least, minimised in favour of (1) simple sentences (UNE, 2018, p. 22) and (2) the repetition of the same word to guarantee referential identification (UNE, 2018, p. 23). The second empirical study of the dissertation examines literal and inferential comprehension, preference, and perceived difficulty through offline methods, as well as the cognitive effort involved in text processing through eye-movement data, that is, online methods.

These are the hypotheses proposed in this study:

- *H1*. The presence of null and overt pronouns makes the text harder to understand for people with ID.
- *H2a*. People with ID perceive texts with null and overt pronouns as more difficult to understand and prefer texts without those elements.

- *H2b.* People with ID perceive texts with subordinate clauses as more difficult to understand and prefer texts without those elements.
- *H3a.* The presence of null and overt pronouns affects the cognitive effort required for text processing.
- *H3b.* The presence of subordinate clauses affects the cognitive effort required for text processing.

The methodology followed in each empirical study can be overseen in § 1.3 and is explained in detail in Chapters 2-4 and correspond to the article *Visual support in Easy Language: The impact of images on comprehension, perceived difficulty, and eye movements* (González-Sordé et al., 2026).

1.2. Theoretical framework

In the following subsections, several concepts that are relevant to this dissertation will be explored, including cognitive accessibility, comprehension, and EL.

1.2.1. Cognitive accessibility

In recent years, the discourse on accessibility and disability has evolved significantly. It has shifted from a narrow focus on individuals with permanent impairments to a broader understanding that everyone, at different times and under varying circumstances, may encounter barriers in their environment and require accessibility measures or support services (Oliver & Sapey, 2006; Larraz, 2015). Within this evolving perspective, the social model of disability, as opposed to the traditional medical model, conceives “disability” not as an intrinsic condition of the individual, but as a situation that arises from the interaction between people and the barriers present in society (Oliver & Sapey, 2006; AccessibleEU, 2025).

As a result, the concept of accessibility has expanded to encompass various dimensions that together contribute to the notion of “universal accessibility,” in which physical, sensory, and cognitive barriers are eliminated (Maaß, 2015). Within this broader framework, cognitive accessibility refers to the design of

information that is easy to understand, process and read (ISO, 2020; Ley 6/2022, 2022; Moreno et al., 2023). The use of EL represents one of the most widely adopted strategies to achieve accessible communication, complemented by other approaches such as augmentative and alternative communication systems, including the use of pictograms.

Accessible communication uses simple or clear language to prevent people from being excluded, and goes beyond users with disabilities (Perego, 2020, Maaß, 2020). Expert or complex content can be hard to understand, especially when information is new, unexpected, or abundant (Maaß, 2020). Using easy-to-understand languages makes content precise, direct, and easy to understand (Perego, 2020).

The recognition, regulation, and standardisation of cognitive accessibility have advanced notably in recent years (Matamala & Orero, 2018). In the case of EL, one of the first major acknowledgments was its classification as an assistive product under *ISO 9999:2016 - Assistive Products for Persons with Disabilities: Classification and Terminology* (ISO, 2016), later adapted into a Spanish UNE standard (UNE, 2017). Within this framework, EL appears under categories 051506 (assistive products for encoding and decoding written language) and 050306 (training materials for developing reading skills) (Larraz, 2015). Digital accessibility requirements at a European level are defined in EN 301 549 (European Accessibility Act), including provisions on EL, while the Web Content Accessibility Guidelines (WCAG) 2.1 include success criteria relevant to people with cognitive disabilities (Oncins & Orero, 2021).

In terms of legislation, the Catalan Accessibility Code (Codi d'accessibilitat de Catalunya) (Generalitat de Catalunya, 2023) requires that signage and information in public spaces, such as ports, stations, airports, and cultural facilities, is provided in EL in Catalonia. Additionally, all public documents must be made available in EL. Moreover, it requires a mandatory public document detailing each establishment's specific accessibility features. This sheet facilitates inspections, ensures compliance, and informs customers about the available adaptations (Generalitat de Catalunya, 2023).

At the national level, an amendment to Spanish law (Ley 6/2022, de 31 de marzo) introduced cognitive accessibility as a legal requirement and emphasised the promotion of EL. To implement mandates set out in this Law, the Spanish government is drafting a Royal Decree establishing the basic conditions for cognitive accessibility (Ministerio de Derechos Sociales, Consumo y Agenda 2030, 2024). The Spanish draft regulation aims to unify nationwide directives for cognitive accessibility within a single regulatory framework, explicitly incorporating provisions to promote EL. These provisions include ensuring that complaints forms, public administration documents, electoral programmes, and vocational training materials are available as EL versions.

In the Spanish context, UNE 153101:2018 EX, *Easy to read. Guidelines and recommendations for the elaboration of documents* (UNE, 2018), serves as the main standard and reference for the use and practice of EL. This standard also informed the development of the international standard ISO/IEC 23859:2023, *Information technology, User interfaces, Requirements and recommendations on making written text easy to read and understand* (ISO, 2023b). However, as will be discussed in Chapter 2, these standards, like most EL guidelines, lack a strong scientific foundation, with the exception of certain German publications (Maaß, 2015; Bredel and Maaß, 2016).

It is important to note that the progress in EL standardisation presented here has been achieved primarily in its written form, whereas spoken EL remains comparatively understudied (Perego, 2023). Initiatives such as the SELSI project have begun to empirically investigate the linguistic support needs and methods in spoken EL (Perego, 2023; Trevisan & Brumen, 2023). The focus of this thesis and its empirical analysis are specifically centred on written EL. Accordingly, the next section will address the concepts of processing and comprehension of written information.

1.2.2. Processing and comprehension of written information

Written communication is a fundamental aspect of daily life, shaping how we interact and function as social beings (Buell, 2017). In the context of reading processes, a distinction must be drawn between text processing and

comprehension. Van Gompel (2013) describes comprehension as the goal or endpoint, while processing refers to the mechanisms through which words are analysed and elaborated upon. Processing can lead to varying levels of understanding, ranging from partial comprehension to persistent ambiguity, whether unintended or deliberate (Van Gompel, 2013). Unlike comprehension, which refers to the outcome, processing involves the active mental mechanisms which are used to decode, organise, and interpret written or spoken language to construct meaning.

The comprehension process, or rather its interconnected components, forms a coordinated system that relies on diverse types of information to produce intricate mental representations (Kintsch & Rawson, 2005; Kintsch, 2018). Numerous frameworks have been proposed by researchers to explain this system. One such approach to describing the distinct levels of text comprehension is outlined below (Kintsch, 1998; Kintsch & Rawson, 2005):

- First, words and phrases are processed at the **linguistic level**.

The reader must decode the graphic symbols on the page through a process that involves perception, word recognition and parsing.

- Then, through **semantic analysis**, the meaning of the text is determined.

Word meanings are combined, forming units of ideas. These units are interrelated and form the microstructure of the text. Coreference, for example, is one element that relates these units. And inferences, on the other hand, are often needed to form coherent microstructures.

Microstructures are, in turn, organised into higher units that form the global structure of the text, called the macrostructure. Microstructure and macrostructure together are called the textbase.

- Finally, the **textbase** represents the explicit meaning of the text.

To achieve deeper understanding, the reader needs to use the meaning of the text to construct a mental model of the situation described by the text. Generally, this requires the integration of information in the text with relevant prior knowledge and the goals of the reader. This involves imagery, emotions, and



personal experiences (Schmalhofer et al., 2002; Louwerse, 2004; Kintsch & Rawson, 2005).

Reading comprehension develops in a progressive way. Apart from this top-down perspective on reading, we can also distinguish different types of comprehension that contribute to the construction of meaning. Readers first master literal comprehension before moving to inferential and evaluative comprehension (Herber, 1970). Literal comprehension involves retrieving explicitly stated information (Carnine et al., 2010; Basaraba et al., 2013, p. 353), whereas inferential comprehension requires identifying implicit relationships, such as connections between events or characters' motivations (Basaraba et al., 2013, p. 353). Evaluative comprehension entails critically analysing the text based on prior knowledge (Basaraba et al., 2013, p. 353).

As outlined in the aims, the studies in this dissertation primarily assess literal comprehension, since most questions target explicit textual information. The null and overt pronouns test also includes a basic inferential component, as it examines inferences related to null pronouns. For simplicity, the term "comprehension" will generally be used throughout the dissertation. They also assess text processing through eye tracking (see § 1.3.1).

One of the key barriers that cognitive accessibility seeks to address involves difficulties in information processing and communication (AccessibleEU, 2025). To overcome these challenges, solutions focus on making messages easier to understand in both content and form. One such approach is EL, which aims to simplify texts for individuals who struggle with standard written language. People with ID are a primary target group for EL (Buell, 2017; ISO, 2023b) and form one of the experimental groups in our research. Individuals with ID often experience challenges such as reduced language comprehension (Nash & Heath, 2011), limited vocabulary (Henderson et al., 2013), and shorter memory spans (van der Schuit et al., 2011), all of which make reading and understanding text more difficult (Buell, 2017). EL texts respond to these needs through structural and content adaptations designed to facilitate text processing and improve overall comprehension (ISO, 2023b).

1.2.2.1. Adult readers with intellectual disabilities

Reading proficiency is a fundamental skill closely linked to educational achievement, financial stability, and independent living (Chhabra & McCardle, 2004; Alwell & Cobb, 2009). As seen in § 1.2.2, good language and cognitive skills are fundamental to making connections between reading words on a page, understanding them and linking them to everyday life experience, past and present (Buell, 2017). Therefore, written information is likely to present challenges to anyone who faces difficulties with cognitive functions (Channel et al., 2013; van Tilborg et al., 2014; Riffo et al., 2025) and might be hard to understand for those who do not have a high level of reading ability (Riffo et al., 2025). These include a big part of the population of adults with ID, who often show poor decoding and reading comprehension skills (van der Bos et al., 2007; Leon & León-López, 2019).

In Catalonia, literacy levels are generally high. In 2018, 85.5% of people over the age of 15 were able to read Catalan, and 98.5% could read standard Spanish (Idescat, 2018). When focusing specifically on individuals with ID, a particularly enlightening study in the Spanish context is that of León and León-López (2019). The authors examined the reading competence of adults with intellectual and developmental disabilities (IDDs) and compared their performance with that of neurotypical university students using Spanish texts of varying levels of difficulty. When reading simple texts comparable to EL materials, 70% of participants with IDD achieved an adequate level of reading competence. This percentage dropped to 53% for intermediate texts, which contained fewer images and more written content. For the most complex texts, with minimal visual support and dense text, only 20% of the IDDs group achieved sufficient comprehension.

Despite this overall decline as text difficulty increased, the authors reported substantial variability within the IDDs group across all levels of complexity. In fact, individuals with similar degrees of ID could perceive the same text as either very easy or very challenging. When comparing both groups, university students generally showed higher reading competence, as expected. However, a notable overlap was observed: some adults with IDDs performed as well as, or even better than, university students, including on the most demanding tasks (León & León-

López, 2019). One key factor explaining this overlap was the time allowed to complete the tests. While university students finished in an average of 36 minutes, participants with IDD required about 109 minutes. The authors suggest that, given adequate time and support, some adults with IDDs can reach high levels of reading performance.

Although there is currently no comparable data on the reading abilities of people with ID in Catalonia, evidence from other contexts can also provide useful insights. For example, Ratz and Lenhard (2013) examined the reading development of 1,629 school-aged students with ID in Germany, assessing their reading stages using Frith's (1985) model of reading development. According to this model, reading progresses through three stages: the logographic stage, where words are recognised visually and memorised like logos; the alphabetic stage, where children analyse words phoneme by phoneme to decode them; and the orthographic stage, where readers process larger word units and letter patterns for more fluent reading. These stages reflect a progression from visual recognition to analytical decoding, and finally to automatic, structured word recognition (Frith, 1985; Ratz & Lenhard, 2013). The study found that 29.3% of participants did not read at all, 6.8% were at the logographic stage, 31.9% at the alphabetic stage, and 32% at the orthographic stage.

Connors (2003) reviewed the empirical literature on children with IDDs and found no consistent evidence of specific difficulties in sight word learning or letter knowledge. Instead, two main areas of weakness emerged: phonological decoding and reading comprehension. The latter includes challenges such as making inferences from expository texts, effectively using contextual cues when these are limited, and monitoring one's own understanding while reading. Findings on word identification, however, have been inconsistent across studies (Cupples & Lacono, 2002; Sevcik et al., 2019).

Importantly, these reading difficulties often persist into adulthood, significantly limiting independence, educational attainment, and daily functioning for individuals with IDDs (Sevcik et al., 2019). Nonetheless, as seen in León and León-López (2019), many adults with IDDs demonstrate higher than expected reading skills, and a considerable proportion were able to understand texts of

medium or even high complexity in their study. Thus, it is suggested that reading abilities in this population are not fixed and can be enhanced by tailoring materials to their cognitive and motivational profiles; for instance, by adjusting text difficulty, making content more engaging, and implementing targeted reading workshops (Leon & León-López, 2019). In this regard, EL is often promoted as a way to improve communication accessibility, but evidence of its effectiveness is mixed, with some studies indicating that certain adaptations in use do not consistently enhance comprehension (Hurtado et al., 2014; Sutherland & Isherwood, 2016; Chinn & Homeyard, 2017).

1.2.3. Easy Language

As defined in § 1.2.1, cognitive accessibility refers to the design of information that is easy to understand and process (ISO, 2020; Ley 6/2022, 2022; Moreno et al., 2023). Achieving this goal involves the use of various tools and strategies. Within what is known as easy-to-understand languages, there is a spectrum of language varieties that differ in their levels of comprehensibility enhancement (Maaß, 2020), their degree of adaptation compared to standard language, and ultimately in their goals and target audiences. This umbrella term spans a continuum of language varieties, including Plain Language and Easy Language (EL). As mentioned before, our focus throughout the dissertation will be on the written forms of these communication strategies.

Plain Language texts are close to standard language and are often not easily perceived as distinct from it. They are intended for the general public, particularly for readers who find certain texts, often written in specialised or technical language such as official or legal documents, too difficult to understand (Leskelä et al., 2022). Therefore, Plain Language texts are not primarily designed for people with communication impairments, as they may still be insufficiently accessible for this group (Maaß, 2020; Leskelä et al., 2022). At the other end of the easy-to-understand language spectrum lies EL, which strives for maximum comprehensibility and simplification. EL is specifically designed for people with communication impairments of any kind or origin (Maaß, 2015; Borghardt et al.,

2021; Leskelä et al., 2022) (see Fig. 1, created by the author based on Maaß, 2015, p. 51; Maaß, 2020, p. 14).

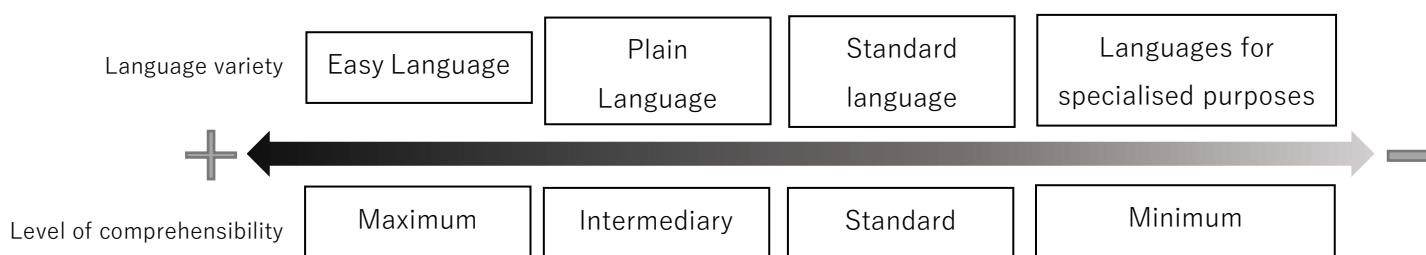


Figure 1 *Continuum of the level of comprehensibility of different languages*

EL aims to reduce difficulty in the following areas (Belinchón et al., 2014):

1. Recognising and understanding the meanings of individual words in the text.
2. Grasping syntactic relationships between linguistic units (e.g., identifying the subject and predicate in a sentence).
3. Integrating the meanings of sentences and paragraphs into a cohesive overall understanding of the text.
4. Connecting the linguistic content of the text with the reader's prior knowledge of the topic.
5. Interpreting and evaluating the text in a pragmatic way, including recognising its overall communicative intent, contextual appropriateness, and other nuances.

To achieve this, EL simplifies content, vocabulary, and structure (Lindholm & Vanhatalo, 2021). Specifically, it adapts lexical choices by prioritizing high-frequency and concrete words, reduces sentence complexity through shorter and more linear syntactic constructions, and ensures textual cohesion with clear thematic organisation and explicit logical connectors. In addition, EL often includes paratextual and multimodal supports (such as images, icons, or summaries) to reinforce comprehension and retention (Inclusion Europe, 2009; Nomura et al., 2010; ISO, 2023b). See a sample extract from a document in EL:







Cortex will have videos and podcasts on the internet.

A podcast is an interview that you can listen to on-line.

These video and podcast will talk about:

- **Health**
- **People with intellectual disabilities**
- **Being independent**

Source: Inclusion Europe, 2023

Most EL standards and guidelines have emerged from practical experience. Linguists and translation scholars did not play a significant role in the development of some of the first EL rulesets (i.e., ILSMH, 1997; Inclusion Europe, 2009) (Bredel & Maaß, 2016, p. 82). The notions of simplicity reflected in EL guidelines are largely based on linguistic intuition. Gerd Antos (2017) argues that simplicity is often confused with comprehensibility, which tends to be associated with what is linguistically or communicatively familiar, emotionally appealing, subjectively plausible, concise, immediately coherent, and easy to remember.

The first systematic attempts to define EL principles began to appear around 30 years ago. In 1997, the European association “International League of Societies for the Mentally Handicapped – European Association” (currently named “Inclusion Europe”) developed the first guidelines for creating content in EL (ILSMH, 1997) (Associació Lectura Fàcil, n.d.). These guidelines were translated into fifteen languages, including Catalan (ILSMH, 1998a) and Spanish (ILSMH, 1998b). Additionally, they designed the blue logo, still in use today, which features a book and a closed hand with a thumbs-up, introduced in 2002 to certify that a document is in EL and has been reviewed by at least one person with intellectual disability (Associació Lectura Fàcil, n.d.). Building on these foundations and the key role of validation in ensuring quality and accessibility, the European project TRAIN2VALIDATE focuses on strengthening the training



Source: Inclusion Europe.

and certification of EL validators and facilitators, with online trainings available since 2024 (Plena Inclusión Madrid, n.d.).

In Catalonia, the Associació Lectura Fàcil were pioneers in promoting EL. The origins of EL practice in the region can be traced back to 1999, with a study commissioned by the Fundació Jaume Bofill on “the possibilities of EL books in Catalonia” (Salvador, 1999), as well as the translation into Catalan of the ILSMH guidelines (ILSMH, 1998a). Since then, numerous guidelines have been developed, some of which are discussed in Chapter 2, and many associations and foundations now work to promote EL and cognitive accessibility, such as Dincat and SOM Fundació.

EL texts can be either original creations or adaptations of texts written in standard or specialised language. The latter practice is commonly referred to as the adaptation method (Nomura et al., 2010; UNE, 2018). However, some scholars in Translation Studies argue that this process should instead be understood as a form of intralingual and intersemiotic translation. It is considered intralingual insofar as the source text is reworked to make it easier to read and understand in EL, and intersemiotic because EL texts are inherently multimodal, typically combining written language with illustrations and other paratextual elements that support comprehension (Medina & Balaguer, 2021; González, 2022). Some studies on EL conceptualise it as a form of intralingual translation and explore its combination with interlingual translation practices, suggesting that such an integrated approach may be beneficial. For instance, Vanhatalo and Lindholm (2023) demonstrate the advantages of language simplification in healthcare interpretation contexts.

As mentioned, the target audience is involved in the validation process when creating or adapting EL texts. The Spanish Standard for EL (UNE, 2018) provides a methodological framework for the adaptation, creation, and validation of EL documents, organised into two phases: the adaptation or creation phase and the validation phase. See Table 1 (based on UNE, 2018; Rivero-Contreras, 2022).

Table 1 *Phases of the process of creating or adapting content in Easy Language*

Adaptation phase		Creation phase
Who takes part in it? Adapter, designer, layout editor		Who takes part in it? Creator, designer, layout editor
1	Take instructions from the promoter and agree on an adaptation project	Plan the creation process
2a	Gather information about the original document to be adapted	Decide on the structure of the document, taking the content into account
2b	Analyze the content and structure of the original document	
2c	Make decisions taking into account the document's purpose and the previous analysis	
3a	Draft the EL document, following guidelines for writing and designing EL documents	
3b	Consult with experts, if necessary	
4	Provide the draft in EL to the dynamizer	



Validation phase	
Who takes part in it? Validators, facilitator(s)	
1	(Dynamizer) Plan the validation sessions, considering the number of validators (min. 3), the duration of the sessions and the available resources
2	(Dynamizer) Select the activities to assess the comprehension of the material
3a	(Validators) Read the material and provide feedback
3b	(Dynamizer) Collect the validator's feedback and prepare a report with the revisions that need to be made, if any
Steps 3a and 3b are repeated as many times as necessary, up until there is a validated, comprehensible version	

Step 3a of the adaptation phase calls for “following guidelines and recommendations for writing and designing EL documents” when drafting the EL document (UNE, 2018; Rivero-Contreras, 2022). Chapter 2 provides an overview of various international guidelines, including those employed in Catalan EL, within the context of a literature review on empirical research related to EL. Our review reinforces and extends the conclusions of previous studies (Hurtado et al., 2014; Sutherland & Isherwood, 2016; Chinn & Homeyard, 2017; Rivero-Contreras & Saldaña, 2020), highlighting that current adaptations often lack robust empirical support, which makes it uncertain whether they reliably enhance comprehension.

Given that these guidelines constitute the starting point for the adaptation procedure adopted in this study, their internal structure and emphasis, in addition to their effectiveness, also needed to be examined. In our literature review (Chapter 2), the recommendations extracted from the eight analysed guidelines were categorised to identify those that were shared across guidelines and to determine which aspects were most predominant. Each recommendation was assigned a keyword corresponding to the aspect it addressed or advised on (see § 2.2.1). Of the 158 keywords identified in total, the 15 most frequently occurring are listed below.

1. Page (119)	6. Font (62)	11. Sentence structure (42)
2. Image (98)	7. Complex / difficult vocabulary (52)	12. Layout (35)
3. Vocabulary (79)	8. Sentence (52)	13. Relevance (34)
4. Page layout (73)	9. Semantics / meaning (52)	14. Word frequency (30)
5. Paratextual element / paratext (69)	10. Explanation (44)	15. Line (30)

Notably, linguistic aspects do not dominate the top of the keyword list. The only recurrent (>50 occurrences) linguistic terms were “vocabulary” (including “complex or difficult vocabulary”), “sentence”, and “semantics/meaning”. Beyond these, keywords appearing more than 50 times are predominantly related to graphic or design elements, such as “page”, “image”, “page layout”, “paratextual element”, and “font”. These findings confirm that EL concerns not only the written content but also the way a document is structured and designed, which directly affects how readers comprehend the information (see Subiela-Hernández & Gómez-Company, 2018). They also highlight the need to evaluate visual and structural elements alongside linguistic features.

In the literature review in Chapter 2, we only found empirical studies examining the following EL recommendations: (1) 2.3.1. Visual support, (2) linguistic simplification, (3) word frequency, (4) literacy mediation, (5) connectives, (6) co-references, and (7) number of sentences, text length, and word length (§ 2.3.1—2.3.7). Interestingly, most of the results from these studies were either mixed (e.g., Fajardo et al., 2013 & 2014; Rivero-Contreras et al., 2021) or contradicted current recommendations in EL guidelines (e.g., Schatz et al., 2017; Schmutz et al., 2019; Buell et al., 2020). German EL is the only variety that has some scientifically-based guidelines (Maaß et al., 2021), which were developed at the

University of Hildesheim, where there is a Research Centre for Easy Language (Forschungsstelle Leichte Sprache). The first scientific guidelines, *Leichte Sprache. Das Regelbuch* (“Easy Language. The Rulebook”) were published in 2015 (Maaß, 2015), a systematic scientific rulebook that combines a critical evaluation of earlier practical guidelines with linguistically grounded rules developed at the Research Centre for Easy Language. A second set of guidelines was published the next year (*Duden Leichte Sprache* or “Duden Easy Language”) (Bredel & Maaß, 2016), which established a scientific and practical framework for EL and includes a theoretical foundation, a guide for broader audiences, and a practical workbook.

1.2.3.1. Research on Easy Language

Research on EL has grown steadily in recent years. To understand the current state of EL research, this section provides a global and succinct overview, highlighting key projects and studies, methodological approaches, and gaps in empirical testing. A systematic review of studies in Catalan, Spanish, and English that specifically evaluate aspects recommended in EL guidelines is presented in Chapter 2.

Interest in promoting accessible communication has led to a gradual increase in research on EL in Spain, as demonstrated by several notable projects. Among them is the project EASIT, Easy Access for Social Inclusion Training (2018–2021), coordinated by the Transmedia Catalonia group at the Universitat Autònoma de Barcelona (Perego, 2020; Matamala et al., 2021). This project developed materials aimed at training professionals to write in a clear and accessible way. Other Spanish research groups working on EL include Atypical (University of Valencia), which studies language and reading development in populations with various types of disabilities; TRACCE (University of Granada), focused on universal accessibility and, in particular, on EL; and COMINTRAD (Pablo de Olavide University), which addresses EL within a broader framework of translation and accessibility. Despite these efforts, there remains a significant lack of empirical studies assessing the effectiveness of the guidelines commonly used by practitioners (Chinn & Homeyard, 2017; Sutherland & Isherwood, 2016; Hurtado et al., 2014; Rivero-Contreras & Saldaña, 2020; González-Sordé &

Matamala, 2023), as reviewed and argued in Chapter 2. Moreover, most existing studies only rely on offline or subjective methods (González-Sordé & Matamala, 2023).

Research on Plain Language and EL from a psycholinguistic perspective requires online methods and data (Rastelli, 2024, p. 97). These methods, such as eye tracking, electroencephalography and functional magnetic resonance imaging (fMRI), capture comprehension in real time and show how language is processed step by step (Marinis, 2010; Gillioz & Zufferey, 2020, p. 17; Hansen-Schirra & Gutermuth, 2024). Offline methods like questionnaires, grammaticality judgments, or recall tasks only measure the final interpretation after processing is complete (Marinis, 2010; Rastelli, 2024, p. 97), and can be affected by memory or other external factors. For this reason, online methods are key to understanding the processes behind comprehension and reducing the influence of non-linguistic variables (Marinis, 2010).

Simplified languages assume that less linguistic complexity means easier cognitive processing, but this still needs more empirical research using both online and offline methods (Borghardt et al., 2021). Sutherland and Isherwood (2016, p. 297) performed a literature review and reported that, at that time, scientific evidence supporting the practice of EL was largely absent. Of the 3,000 papers they screened, only six publications met their inclusion criteria, and just one of these six measured the effectiveness of EL resources using both online and offline methods. Our review (see Chapter 2), conducted in 2022, found six studies that empirically assessed EL recommendations in English (i.e., Fajardo et al., 2013; Fajardo et al., 2014; Schatz et al., 2017; Schmutz et al., 2019; Buell et al., 2020; Rivero-Contreras et al., 2021), out of 600 eligible papers; and only one (i.e., Rivero-Contreras et al., 2021) used an online method in its testing (eye tracking). As discussed, online methods remain relatively rare in EL research, though they are becoming increasingly common (e.g. Rivero-Contreras et al., 2023; Frondén & Kaakinen, 2023), particularly in studies on German EL (e.g., Borghardt, 2022; Deilen et al., 2022). For this reason, our experiments employ both online and offline methods to assess text comprehension and processing.

In Germany, EL has evolved within a robust legal and institutional framework, notably supported by the 2011 BITV 2.0 accessibility regulation, which fostered a professional market for Easy Language translation in the country (Maaß et al., 2021), and the creation of the Bundesfachstelle Barrierefreiheit (Federal Accessibility Office), which provides accessibility advice to both private and public entities (Medina & Balaguer, 2021). Extensive empirical research is led by the Simply Complex – Easy Language group and the Research Centre for Easy Language at the University of Hildesheim and has positioned German EL at the forefront of evidence-based accessibility studies in Europe. Using advanced online methods such as electroencephalography, eye tracking, and functional magnetic resonance imaging, researchers can analyse reading and comprehension processes in real time. Informed by this line of research, the scientifically grounded German EL rulebooks mentioned earlier (Maaß, 2015; Bredel & Maaß, 2016) integrate insights from linguistics, cognitive science, and research on comprehensibility.

Building on this foundation, Pappert and Bock (2020) showed that segmenting German compound nouns improved reading performance among adults with ID, supporting a practice often debated within German EL guidelines. Borghardt (2022) tested the EL rule discouraging subordinate clauses by comparing causal sentences with and without connectors, similar to one of our studies in Chapter 4, although they used fMRI as an online method, and found no significant advantage for the simplified forms, in line with our results. Deilen (2020, 2021, 2023) and Deilen et al. (2022) examined how visual segmentation, complexity, and context affect the processing of compounds in EL among unimpaired adults and hearing-impaired pupils using eye tracking. Results showed that subtle visual segmentation aids pupils with low literacy skills but not those with high literacy or unimpaired adults. While hyphenation initially speeds recognition of the first morpheme, it ultimately slows overall compound processing by preventing direct whole-word access.

Beyond the German variety, research on EL has pursued similar goals, though the field remains comparatively less extensive and methodologically diverse. Nonetheless, evidence from various European EL contexts highlights consistent patterns. Research in Spain (Fajardo et al., 2014; León & León-López, 2019)

shows that sentence length, complexity of vocabulary, and word familiarity strongly influence comprehension in EL texts. León and León-López (2019) also found that reading comprehension declines as text complexity increases, is predicted by educational level, and relies on a top-down processing model, while reading enjoyment does not necessarily correlate with understanding. Fajardo et al. (2014) found that students with mild ID performed better on literal than inferential questions when reading Spanish EL news articles, and that higher sentence density hindered comprehension. Rivero-Contreras (2022) examined both visual and linguistic dimensions of Spanish EL using online and offline methods, reporting that textual simplification benefits adults with lower literacy levels and that viewing visual aids prior to reading can facilitate processing of difficult words. Fajardo et al. (2022), however, found that linguistic simplification did not benefit students with lower comprehension skills within the group of students with ID. In a previous study (Fajardo et al., 2013), they also found that neither word frequency nor word length improve inferential comprehension.

Outside the Spanish context, Buell et al. (2020, 2024) found that adults with learning disabilities struggled most with inferential reasoning in English EL texts and that EL health materials often use less inclusive and empowering language compared with standard versions. Rastelli (2025) challenges strict prohibitions on the passive voice in EL, arguing that its use may be limited in instructional and warning texts for weaker readers, but remains appropriate in other communicative contexts. In Swedish EL, Frondén and Kaakinen (2023) observed that longer and less frequent words increased fixations and regressions among readers with learning disabilities, consistent with patterns documented in cognitive impairments (Schiffl, 2020). Chinn and Homeyard (2017) further demonstrated that EL materials can significantly improve health information comprehension and participation in decision-making for people with ID, particularly when texts are accompanied by images or diagrams, and produced with professional training. Similar findings are reported in studies on wordless books (Hollins et al., 2016), immigrant populations (Becker, 2020), and co-created public service documents (Callus & Cauchi, 2020), emphasising the importance of involving the target audience to ensure relevance and clarity.

Despite these advances, the effectiveness of specific EL rules remains uncertain. Hurtado et al. (2014) found that simplifying text or adding images does not consistently enhance comprehension, while Borghardt (2022), as discussed earlier, similarly questioned the recommendations of EL guidelines. Moreover, the majority of the studies identified in our literature review yielded either inconsistent results (e.g., Fajardo et al., 2013, 2014; Rivero-Contreras et al., 2021) or findings that diverge from current EL guideline recommendations (e.g., Schatz et al., 2017; Schmutz et al., 2019; Buell et al., 2020). Due in part to this lack of consistent evidence, some scholars challenge the prescriptive, rule-based approach. Bettina Bock (2018) suggests that strict rules alone do not guarantee text quality. She proposes treating guidelines as flexible principles and defining EL by its goal: making communication clear and accessible for people with communication difficulties (Bock, 2018; Hennig & Jacob, 2022). The five factors of adequacy they propose involve considering the reader, the text's function, content, context, and the emissary.

We can see a picture that highlights both the promise and the current limitations of EL research, particularly regarding the empirical validation of specific strategies and aspects recommended in the guidelines (for a full literature review, see Chapter 2) and the use of online methods. In the following section, we describe how our experiments address these gaps through a mixed-method design, combining eye tracking and behavioural tasks to evaluate the effectiveness of underexplored EL aspects for users with ID.

1.3. Methodology

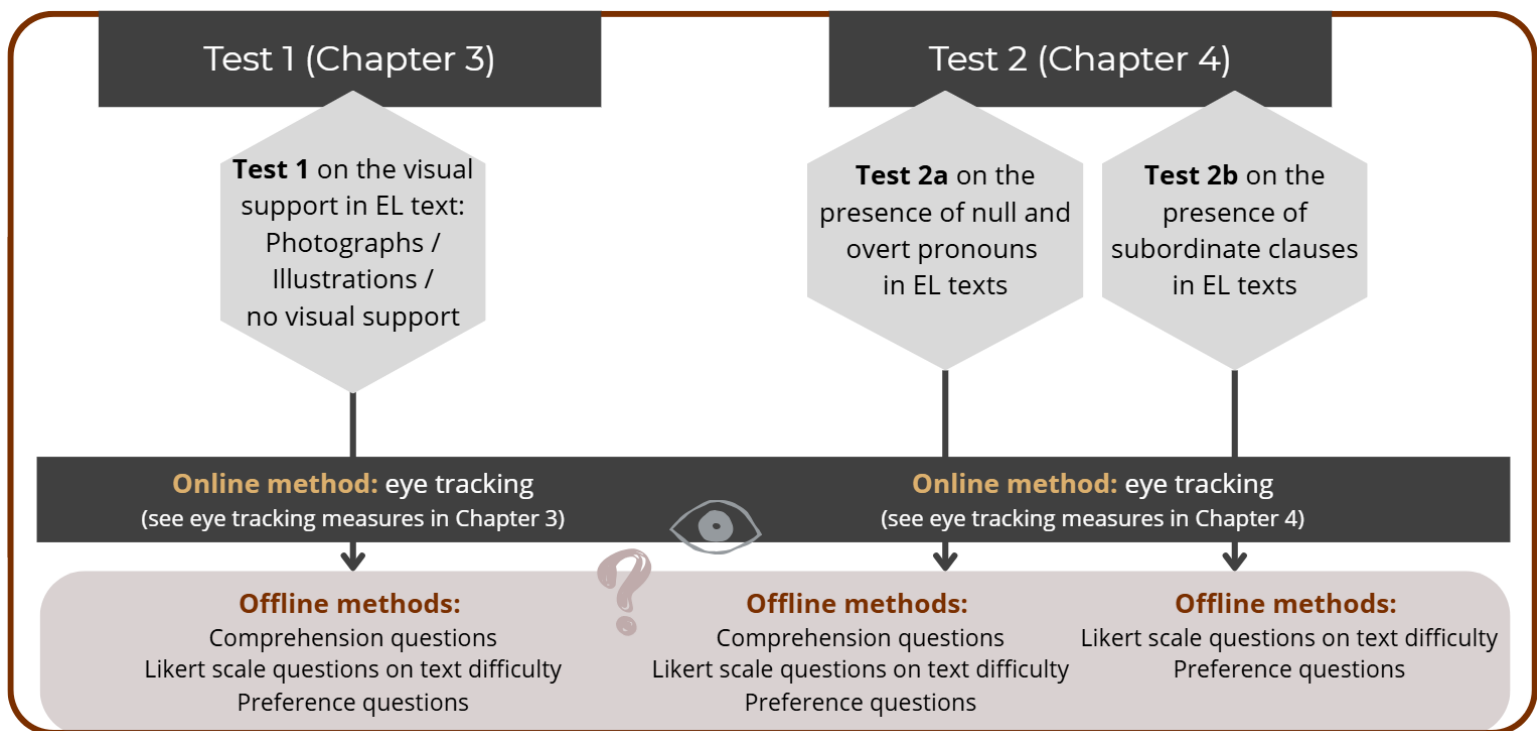
The present dissertation encompasses three studies, including a literature review and two empirical investigations, designed to address the hypotheses and research questions outlined in § 1.1 and achieve the corresponding aims. While the methodology for each study is described in detail in their respective chapters (2-4), an overview is provided here, along with the rationale for the methodological choices. The experimental design and study protocol (CEEAH CA40) were approved by the Research Ethics Committee of the Universitat Autònoma de Barcelona in February 2022 (Annex 6).

The first study, presented in Chapter 2, is a systematic literature review aimed at identifying and evaluating empirical evidence supporting EL recommendations. The methodology involved systematic searches across multiple academic databases using keyword combinations related to EL guidelines and their empirical evaluation. Results were screened using predefined inclusion and exclusion criteria, and the selected studies were analysed with a quality appraisal checklist. This study establishes an overview of the current state of research and provides justification for the specific elements that the subsequent empirical tests would focus on.

The first empirical study, presented in Chapter 3, examines the impact of visual support, comparing illustration, photographs, or no visual support, using a mixed-methods design. The online method, specifically eye-tracking, captured readers' gaze patterns to assess real-time text processing, while offline methods included comprehension questions targeting content supported by the visuals, Likert-scale questions on perceived difficulty, and open-ended preference questions.

The second empirical study, set out in Chapter 4, investigates the influence of two linguistic aspects of EL texts, namely the use of null pronouns and the presence of subordinate clauses. The study examines their effects on textual processing, comprehension, perceived difficulty, and text preferences. Methodologically, it mirrors the first empirical study by employing eye-tracking as an online method and using the same participants. Comprehension questions are assessed only for null and overt pronouns, while the other offline methods are assessed for all linguistic aspects.

As noted in §1.2.3.1 and supported by Perfetti and Helder (2022), online and offline data complement each other by reporting on comprehension processes and outcomes. The present studies follow this combined approach, contributing to a more robust and empirical evaluation of effective practices in EL. Figure 2 provides an overview of the online and offline methods used in our studies.

Figure 2 Online and offline methods used in the empirical studies (Test 1, Test 2)

Both empirical tests included 52 participants divided into two groups: users with ID ($n = 26$) and neurotypical users ($n = 26$). All participants provided written informed consent, completed a demographics form (Annex 5), and were given the opportunity to raise questions or concerns. They then completed a group reading comprehension screening test (*Test de lectura comprensiva* [TLC]; Comes, 1990) and an abstract reasoning screening test (*Raven's Progressive Matrices* [RPM]; Raven, 1998). As emphasised by Borghardt et al. (2021), assessing neuropsychological skills is essential in research on language processing, particularly in EL studies. Participants subsequently completed the reading tasks individually in a separate room with the observing researcher (see the stimuli in Annexes 3 and 4). To reduce fatigue and allow additional support, participants with ID completed the screening and reading sessions on separate days (Deilen & Schiffli, 2020), whereas neurotypical participants completed both sessions on the same day. Figure 3 outlines the procedure followed in our tests.

Figure 3 Procedure used in the empirical studies for both participant groups

26 participants with an ID
(Recruited through collaborating institutions
Som — Fundació and Taller Jeroni de Moragas)

26 neurotypical participants
(Recruited through word-of-mouth)

1

Around 40'

On **day 1**, participants complete the screening tests (LTC and RPM) in a room with 2–6 individuals. Each participant answers on a sheet of paper individually, in silence. A researcher is present to provide support if needed.



2

Around 40'

Participants with an ID come back on a different day (**day 2**) to perform Test 1. They do this in a separate room with an eye tracker, individually. A researcher is present to record participants' answers and provide support if needed.

Around 75'

Right after the screening tests (**day 1**), neurotypical participants complete the reading tasks (Test 1 and Test 2) individually in a separate room with an eye tracker. A researcher is present to record participants' answers and provide support if needed.

3

Around 35'

Participants with an ID come back on a different day (**day 3**) to perform Test 2. They do this in a separate room with an eye tracker, individually. A researcher is present to record participants' answers and provide support if needed.



1.3.1. Eye tracking

Eye tracking is one of the most prominent methods for examining the cognitive processes involved in reading (Rayner, 1992; Rayner, 1998) and has been particularly valuable in research on reading comprehension (Rastelli, 2024; Hansen-Schirra & Gutermuth, 2024). A substantial body of research has employed eye tracking to investigate text processing by examining how readers visually engage with written material, thereby providing inferences about underlying cognitive mechanisms involved in reading (e.g., Rayner, 1986; Deilen, 2020; Rivero-Contreras et al., 2023). The technique relies on natural eye movements as people shift their gaze to focus on specific parts of what they see in order to process those details more deeply. Usually, visual attention moves together with the eyes, allowing concentration on the object or area of interest (AOI) (Duchowski, 2007). Because language processing and eye movements are closely connected, observing a reader's gaze provides valuable insight into which elements of a text attract attention, which features capture interest, and how different textual components are cognitively processed (Rastelli, 2024). Thus, the observation of eye movement behavior during linguistic tasks allows us to understand how the visual and language processing systems interact by inferring moment-to-moment cognitive processes (Hyönä & Kaakinen, 2019; Justino & Kolinsky, 2023). This helps researchers unravel how reading skill takes place and how this process changes across reading acquisition (e.g., Rayner, 1986). Importantly, eye tracking offers a relatively direct indicator of processing effort as it occurs during the task itself, rather than relying on post-task measures such as recall or decision-making, which may be influenced by strategic factors (Rayner & Castelhana, 2008).

Most contemporary eye tracking systems use infrared video-based technology that is either positioned below or integrated within a display screen. These systems gather large amounts of data about the position and motion of the eyes, expressed through changes in pixel coordinates. Researchers define particular regions of the visual field as areas of interest (AOIs) (Borghardt et al., 2021; Rastelli, 2024). The system records both the rapid eye movements known as saccades and the moments when the eyes remain still, known as fixations. Fixations are key indicators of attentional focus and help determine which part

of a sentence or visual element is being processed at a given time. Longer fixation durations generally reflect greater cognitive effort, and repeated fixations in the same location often suggest difficulty in word recognition or comprehension (Duchowski, 2007; Borghardt et al., 2021).

The characteristics of fixations and saccades are influenced by the complexity and difficulty of the material being processed. More demanding texts typically elicit longer and more frequent fixations, increased regressions, and shorter saccades (Conklin et al., 2018). Similarly, visually dense or cluttered scenes tend to produce longer fixations and reduced saccade amplitudes (Conklin et al., 2018). Research by Schiffli (2020) further showed that readers with cognitive disabilities exhibit eye movement patterns resembling those of children. Compared with skilled readers, they tend to have longer fixations, make more regressions, read more slowly, and produce shorter saccades (Rayner, 1983).

Consequently, eye tracking is widely used to draw conclusions about cognitive processing and text readability (Hansen-Schirra & Gutermuth, 2024). Its non-invasive nature allows reading tests to be conducted in settings that closely mimic natural conditions (Hansen-Schirra & Gutermuth, 2024). Although eye tracking is often associated with laboratory research, participants are generally able to read, re-read, and visually explore materials at their own pace (as is the case of our studies), thereby preserving relatively natural viewing behavior.

Nevertheless, carrying out online eye tracking studies with target readers of EL presents particular methodological challenges. Researchers must anticipate higher rates of data loss and be flexible in adapting their experimental designs. Traditional procedures and data cleaning methods that work for neurotypical participants are often unsuitable for participants with cognitive impairments (Deilen & Schiffli, 2020). In this study, several adaptations were introduced both in the experimental procedure and in the data processing stages. As discussed in Chapters 3 and 4, some participants' data had to be excluded because of calibration issues. This was often related to visual conditions such as strabismus, difficulty to sit still, or the use of thick corrective lenses, all of which can interfere with or even prevent the calibration of the eye tracking system (Deilen & Schiffli, 2020; Gutermuth, 2020; Borghardt et al., 2021; Frondén and Kaakinen, 2023).



Tobii T60 in use. *Source: Tobii.*

Other adjustments were made to accommodate the needs of different participant groups. For individuals with ID, the testing sessions took place in familiar and comfortable settings, specifically at the offices of the partner association they frequently visit. In contrast, neurotypical participants completed their sessions at the university laboratory. The researcher maintained a patient and supportive approach, explaining the instructions clearly and

repeating them whenever necessary to ensure full understanding.

The study used a Tobii T60 eye tracker. The technical specifications of this model, as well as detailed information about the eye tracking measures and their rationale, are provided in the Method sections of Chapters 3 and 4.

1.4. Structure of the dissertation

This dissertation follows a compendium format and brings together three research articles published in peer-reviewed academic journals (Chapters 2–4). The full original versions of these articles are included in the annexes (Annexes 7–9). To ensure coherence across the dissertation, minor formal adjustments to layout and to the numbering of figures and tables in chapters 2, 3 and 4 have been made, while the content has been preserved.

The work is organised into six chapters and a set of annexes. Chapter 1 establishes the foundations of the research by presenting its background and motivation, defining the aims and hypotheses, and introducing the theoretical framework related to cognitive accessibility and EL. This chapter also outlines the methodological approach adopted throughout the dissertation, with particular attention to the use of eye-tracking in the empirical studies.

The core of the dissertation is developed in Chapters 2, 3, and 4, each corresponding to one of the research articles. Chapter 2 presents a systematic review of the literature and examines the empirical evidence on current EL recommendations in Catalan, English, and Spanish. Chapters 3 and 4 report two experimental studies using online and offline methods to investigate different

features of EL. Chapter 3 focuses on the role of visual support, while Chapter 4 analyses the effects of null and overt pronouns and subordinate clauses on comprehension, perceived difficulty, reader preference, and text processing in adults with ID and neurotypical adults.

The final part of the dissertation synthesises the findings and reflects on their broader implications. Chapter 5 summarises the main results of the three studies, and Chapter 6 presents the general conclusions, discussing the contributions and limitations of the work and outlining directions for future research. Chapter 7 contains the complete, updated bibliography, which compiles all references cited throughout the dissertation, including those previously listed in the bibliographies of Chapters 2–4.

The annexes contain relevant complementary materials, including a summary of the results in EL, additional data, experimental stimuli, ethical approval documents, and the published articles, providing full transparency and supporting the research presented in this dissertation.

CHAPTER 2



2. Article 1

Empirical evaluation of Easy Language recommendations: a systematic literature review from journal research in Catalan, English, and Spanish

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Abstract

Easy Language is a language variety that aims to make information more comprehensible and, ultimately, more accessible. Content in this variety is written and designed following a set of recommendations that have been published in different guidelines. However, it remains uncertain to what extent these recommendations are backed up by empirical research. The aim of this study is to review the existing literature that evaluates current recommendations in Easy Language guidelines, based on the following research questions: (a) is there empirical research that evaluates current international EL recommendations? and, (b) if so, what current international EL recommendations are supported by empirical research and what results were obtained? To this end, we conducted a systematic literature review based on journal articles in three languages: Catalan, English, and Spanish. First, a systematic search was designed and performed in 10 databases of different fields of science. Then, we reviewed every article that resulted from the search and found that six publications out of the initial 617 met the inclusion criteria and could be considered relevant for the study. Based on the data extracted from the included publications, and after an overall review of our systematic search results, we safely state that there is indeed empirical research on some current Easy Language recommendations. Nevertheless, empirical research in the field (at least in the publication format and languages considered in our study) is not enough in terms of the number of publications,

and the findings obtained are far from generalisable. Our literature review suggests future lines of research, and we hope that it fosters empirical studies in the field that help support the existing findings.

Keywords

Easy Language, easy-to-understand language, accessible information, systematic review, literature review

2.1. Introduction

Reaching accessible information and communication requires eliminating linguistic, sensory, and cognitive barriers (Richard-Marset & Calamita, 2020). Audio description and subtitling for the deaf and hard-of-hearing may be the best-known modalities, but accessible communication can be reached by means of different access services, relates to various types of media, and targets different groups of people. Making information more accessible and communicating easier for everyone is the shared goal of many different practices, one of them being easy-to-understand languages.

The ISO standard on making written texts easier to read and understand defines an “easy-to-understand language” as “any language variety which enhances comprehensibility” (ISO, 2023b, p. 1). Easy-to-understand language has been used as an umbrella term for different simplified language varieties, among which we find Plain Language (less-simplified language) and Easy Language (more-simplified language) (Matamala, 2022). Maaß (2020) defends that Plain Language is less perceptible and comprehensible, more acceptable and avoids stigmatisation, whereas Easy Language does the opposite: it is more perceptible and comprehensible, less acceptable and can lead to stigmatisation. This article will focus on Easy Language (EL), the most simplified functional variety of easy-to-understand languages.

EL is defined in the ISO standard (ISO, 2023b, p. 2) as a “language variety in which a set of recommendations regarding wording, structure, design and evaluation are applied to make information accessible to persons with reading

comprehension difficulties for any reason”. But an official definition of the term is yet to be set (Lindholm & Vanhatalo, 2021), and researchers and professionals of the field are yet to reach a consensus on one consolidated term. Today, EL is also referred to as “Easy-to-read” and “Easy Read” (Nomura et al., 2010; Miesenberger & Petz, 2014; Chinn, 2019; Schmutz et al., 2019; Buell et al., 2020), among other less-popular terms. We decided to consistently use the term “Easy Language” in our paper on account of its recent extended usage by experts (Maaß, 2020; Lindholm & Vanhatalo, 2021; García-Muñoz & Matamala, 2021) and because, contrary to the terms “Easy Read” and “Easy-to-read”, it does not denote that the variety is limited to written text (ISO, 2023b, p. 2) or content intended to be read.

EL deviates from standard use in specific aspects related to content, vocabulary, and structure (Nomura et al., 2010; Bernabé, 2020; Lindholm & Vanhatalo, 2021), as well as in paratextual elements, like the use of illustrations as visual support, the design, or the layout of the documents (Nomura et al., 2010).

Any person who finds it hard to understand standard language at any level is a target user of EL (Lindholm & Vanhatalo, 2021). A very heterogeneous group of people can experience comprehension barriers: low levels of literacy, intellectual disability, dyslexia, aphasia, advanced age, or limited language skills (a frequent characteristic of second-language learners or immigrants) can all be the cause of experiencing comprehension difficulties or declined reading abilities (Nomura et al., 2010; García-Muñoz, 2012; Orero et al., 2020) alongside contextual circumstances. After all, literacy is not a native ability but rather acquired and dependant on many factors (Orero et al., 2020). It is estimated that nowadays a total of 750 million adults around the world (UNESCO, 2017) and a third of the population in Spain (García-Muñoz & Matamala, 2021) could benefit from accessible communication and EL. Ultimately, since EL can serve everyone (Dalton & Proctor, 2007; Lindholm & Vanhatalo, 2021), everyone should be able to choose between information in EL and standard language (Lindholm & Vanhatalo, 2021).

The reality and practice of EL is different from one country to another and from one language to another. This paper adopts a European point of view, as well as

having a special focus on Spain and Catalonia, which is the context the authors are more familiar with and in which Spanish and Catalan, languages that are in our inclusion criteria for publications (see § 2.2.2), are official.

Many researchers state that current recommendations lack empirical support (see § 2.1.1.2), and both professionals and academics manifest that more research on the field is needed (Sutherland & Isherwood, 2016; Hansen-Schirra & Maaß, 2020). A literature review from Rivero-Contreras and Saldaña (2020) assessed the existing research that evaluates the effects of EL on comprehensibility. An earlier review by Sutherland and Isherwood (2016) also searched for evidence related to different characteristics of EL (e.g. symbols, photographs) and their effects on comprehension. Finally, Chinn and Homeyard (2017) performed a meta-narrative literature review centred on the impact of accessible health information for people with intellectual disability (ID).

These studies resulted, in the most part, in finding no conclusive evidence to support the alleged positive effect on the reader's comprehension of EL. Our review is the first to set the EL recommendations as the focus and starting point of the search, although we also acknowledge the limitations of our search (see § 2.4.1) in terms of language and publication outlet choices. Naturally, the results of all these reviews (including ours) are meant to complement each other.

Our main aim is to review the existing literature that evaluates current recommendations in EL guidelines in three languages and discover if these recommendations have empirical support, and if further research would be needed. More specifically, our research questions are the following: (a) is there empirical research that evaluates current international EL recommendations? and (b) if so, what current international EL recommendations are supported by empirical research and what results were obtained?

The article presents, firstly, an overview of the main guidelines and standards, and references to research performed on the field. Then, the methodology is set forth, followed by the main results of our systematic literature review. Finally, we will discuss the results and arrive at conclusions.

2.1.1. Easy Language

The main guidelines on EL will be presented in this section, focusing on international and Spanish guidelines. Recommendations on other languages and on other easy-to-understand language varieties are outside the scope of this article, although a few can be mentioned.

2.1.1.1. Guidelines and standards

In 1997, the International Federation of Library Associations and Institutions (IFLA) published their first EL guidelines. An updated version was published in 2010 (Nomura et al., 2010). Adaptations of the latter have become the main guidelines for Easy Language practice in a few countries, like Croatia or Sweden (Bohman, 2021; Lenček & Kuvač-Kraljević, 2021).

Inclusion Europe (called “International League of Societies for Persons with Mental Handicap-European Association” [ILSMH] until 2000) also published some guidelines in 1997 (ILSMH, 1997), which were updated in 2009 (Inclusion Europe, 2009). These guidelines have been translated and adapted to various European languages and have become the most popular—and, in some cases, the first—EL guidelines in many countries (e.g. Latvia, Lithuania, Poland, Czech Republic) (Anča & Meļņika, 2021; Cinková & Latimier, 2021; Przybyła-Wilkin, 2021; Šumskienė & Baltrūnaitė, 2021).

An International Organization for Standardization (ISO) project has recently been working on composing and publishing the first international standard for writing in EL (ISO, 2023b). This ISO project is an adaptation from the first-ever EL standard, the UNE 153,101:2018 EX (UNE, 2018), published in 2018 in Spain, which presents some specificities from the Spanish language (García-Muñoz, 2012; UNE, 2018). The UNE standard is currently the main guide for EL practice in Spain. That being said, there are several handbooks with recommendations on how to create and evaluate content in EL available in Spanish (Associació Lectura Fàcil, 2011; García-Muñoz & Matalama, 2021), and a few international guidelines have been translated into Spanish, Catalan, and other co-official languages of Spain. Inclusion Europe had its first EL guidelines (ILSMH, 1997) translated into Catalan and Spanish (ILSMH, 1998a & 1998b) and its 2009 guidelines (Inclusion Europe, 2009) translated into the same languages in 2016. The 2010 IFLA

guidelines (Nomura et al., 2010) were also translated into Catalan and Spanish in 2012.

Guidelines can include language-independent as well as language-specific rules, but the recommendations in international EL guidelines like the ones by Inclusion Europe (2009) or IFLA (Nomura et al., 2010) are not focused on language-specific requirements and provide mainly generalisable recommendations instead. EL is language-dependant (Orero et al., 2020), but language-independent guidelines can function as a source of standard, replicable recommendations to be later reviewed, questioned, and adjusted into language-specific rules or practices.

EL guidelines can include recommendations related to not only linguistic aspects of the text, but also to the paratextual aspects of it, like the need for visual support or the communication channels that can be used. Most guidelines will include recommendations on both types of elements, with a few exceptions. Guidelines *Make it easy. A guide to preparing Easy-to-read*, by the Accessible Information Working Group (2011), for example, present a set of recommendations that go scarcely over the linguistic aspects of EL only to focus on other aspects of the text (e.g. graphic and stylistic elements).

Finally, guidelines can be designed for different uses and can be generic or case-specific. A few guidelines for making accessible content were designed to be relevant and applicable to one specific context. One example of this is the W3C Web Content Accessibility Guidelines 3.0 that include a set of recommendations for “making web content more accessible to users with disabilities” (W3C, 2022), in which writing in Plain Language is recommended. The Techniques for the Cognitive and Learning Disabilities Accessibility Task Force (W3C, 2021) also give designers some corresponding recommendations to make sites more usable for people with cognitive and learning disabilities, although EL is not mentioned. Another example of case-specific accessibility guideline is *Resum de les principals pautes de Lectura Fàcil per a elaborar textos narratius* (Associació Lectura Fàcil, 2011), a set of recommendations for writing prose fiction in EL.

2.1.1.2. Research

EL guidelines and standards may not suffice “neither for consistent text practice nor for research purposes” (Maaß, 2020, p. 78), but “they show good intuition as to what makes information easier to understand [...] [and] it is interesting to see where those rules overgeneralise or underspecify” (Maaß, 2020, p. 78). These statements sprout from a lack of evidence supporting EL recommendations, an issue that has been outlined by many authors (Sutherland & Isherwood, 2016, pp. 297–298, Chinn & Homeyard, 2017, p. 2; Lindholm & Vanhatalo, 2021, p. 15). As a matter of fact, even if there was existing evidence to support certain recommendations, it would be very hard to know, since most of the existing guidelines do not reference previous studies (Sutherland & Isherwood, 2016, p. 298). It is difficult to trace each recommendation back to the study that might assess it (Fajardo et al., 2014) and, therefore, it could not be easy to understand why and how the adaptation of the text following certain recommendations makes the text more accessible—that is, why they should be included in EL guidelines. In a recent literature review by Sutherland and Isherwood (2016, p. 308), it is determined that “aside from the simplified written text, it is not clear from the current paucity of experimental research whether other aspects of [EL] such as symbols, pictures (line drawings), or photographs necessarily enhance understanding [...]. Overall, there is little supporting evidence in the literature for the recommendations contained in many [EL] design guidelines.” Rivero-Contreras and Saldaña (2020, p. 726) also concluded in their review that “it seems like the adaptation of written content facilitates reading, [...] but, in general, it does not allow a better comprehension of the information” (“*Parece ser que la adaptación del material escrito facilita la lectura, [...] pero, en general, no permite una mayor comprensión de la información*”). On account of this, Chinn (2019) mentions that the process of producing EL resources is still unclear, and “rationales for design decisions are lacking” (Chinn, 2019, p. 411). Thereby, without evidence to base the creation of guidelines on, no hierarchy of recommendations has yet been set, and a few inconsistencies between different publications can be found (Sutherland & Isherwood, 2016). For example, in García Muñoz (2012, p. 76), it is recommended to always indicate the picture’s copyright (“*Señalar el copyright de la foto*”), with no further instruction given. This

instruction could give the reader the idea that the copyright should be placed under the image, but at the same time, the UNE standard (UNE, 2018, p. 31) specifies the following: “copyright information should not accompany the image. It should be placed on a different section or a credits section” (“*La información sobre derechos de uso de imagen no debe incorporarse junto a ella. Se debería situar en un apartado de créditos o en otro apartado*”). Another inconsistency would be the placement of images, with instructions to place them on the left of the text (Department of Health, 2010), as well as on the right (Social Care Institute for Excellence, 2005).

In 2015, Wengelin (2015) pointed out that, until then, only a few studies had provided supporting evidence for EL guidelines, and that the results of these studies were mostly outdated. Lindholm and Vanhatalo (2021) defended that systematic research on EL was incipient in most countries, and the existing studies often referred to specific applications of EL (e.g. online content and websites (Miesenberger & Petz, 2014; Vollenwyder et al., 2018; Schmutz et al., 2019), health and social care (Turnpenny et al., 2018; Chinn, 2020), or to certain target groups (e.g. people with autism [Yaneva et al., 2016a; Turnpenny et al., 2018] or ID [Yaneva et al., 2016b; Chinn, 2020])). In a related manner, Miesenberger and Petz (2013) presented a state of the art of website content in EL and pointed out the need for research in that specific field.

German-speaking countries (and, specially, Germany) are an encouraging exception because of their recently increasing research on EL (Hansen-Schirra & Maaß, 2020; Lindholm & Vanhatalo, 2021). It is also remarkable that German EL does have scientifically based rulebooks, in addition to practical guidelines, the first dating back to 2015 (Maaß, 2015). All scientifically based rulebooks have been developed at the University of Hildesheim in Germany (Maaß et al., 2021), but even these guidelines are supported by previous non-specific research (studies that were not related to or focused on EL). As Maaß (2020) defends, more studies that clearly evaluate EL recommendations, as well as more studies performed with the primary users of EL, are necessary to back up the guidelines. One main limitation of this paper is that, due to the language barrier, publications written in German will not be included in our review (see § 2.2.2 and § 2.4.1).

2.2. Methods

Our systematic literature review followed two different complementary processes: first, IDentification of EL recommendations shared across guidelines that would become the focus of our research, and second, the actual systematic literature review of possible research supporting these recommendations. § 2.2.1 provides an overview of the methodology followed for the first goal, and § 2.2.2 reports on the methodology of the later review.

2.2.1. *Easy Language recommendations*

Defining the EL guidelines—and, consequently, the recommendations—that were to be taken into consideration in our study helped us later sort and analyse the results of our literature review. As has been partially exposed in § 2.1.1.1, numerous guidelines with different characteristics and target audiences have been published. In the following section, we will present the criteria used to select the included guidelines and standards, as well as the procedure followed to extract and classify the recommendations in each one.

- *Selection criteria*

We selected recent guidelines and standards written in English, Spanish, and Catalan that met the selection criteria in Table 2. The initial bibliography of guidelines had been built over the previous months, based on read literature on EL and the guidelines and standards referred in them. The initial bibliography included a total of 23 publications (see Appendix 1).

Table 2 *Criteria for including and excluding guidelines*

Inclusion criterion	Published in the last 15 years (2006 or later) Written in English, Spanish, or Catalan Not a translation or adaptation of a diferent guideline Guidelines to produce written content in Easy Language Majority of recommendations are language-independent
Exclusion criterion	Published in 2005 or earlier Written in a language other than English, Spanish, or Catalan Translation or adaptation from a diferent guideline Guidelines to produce a type of content other than written text Sets out a specifc context of application (e.g. websites) Majority of recommendations are dependent to one language

By applying the set criteria in Table 2, eight guidelines and standards were selected:

(1) Guidelines for easy-to-read materials (Nomura et al., 2010), (2) Information for all (Inclusion Europe, 2009), (3) ISO/IEC DIS 23859–1 (ISO, 2023b), (4) Lectura fácil: Métodos de redacción y evaluación (García-Muñoz, 2012), (5) UNE 153,101:2018 EX (UNE, 2018), (6) How To Make Information Accessible (CHANGE, 2016), (7) Make it easy: A guideline to preparing Easy-to-read (Accessible Information Working Group, 2014), and (8) Make It Clear (Mencap, 2013).

- *Data extraction and synthesis*

Recommendations were manually extracted from the selected documents. Our classification system was shaped by the categories in the guidelines by García-Muñoz (2012), which were adapted by the authors to fit this study and its data specifically (see Table 3). Extracting and classifying the recommendations in a systematic way helped us obtain comparable data.

Table 3 *Classification of guideline recommendations*

Type of recommendation	Category	Subcategory
Language	Orthography and writing	Capitalisation
		Punctuation
		Other punctuation marks and diacritics
		Numbers
		Time and date
	Grammar	Verbs
		Parts of the sentence
		Sentences
	Vocabulary	Complexity of the vocabulary
		Lexical units
		Semantic aspects
	Style	

Design and layout	Images	Semantic features
		Technical aspects
		Layout of the page
	Font	
	Layout	Lines
		Paragraphs
		Page layout
		Presenting lists
	Pagination	
	Other graphic aspects	
	Paratextual elements	Table of contents
		Glosses and glossaries
		Summaries
		Maps
		Graphics

For each recommendation, the following information was noted: type of recommendation, category, subcategory, source, year of publication, author, country of publication, language of publication, page in the source document that the recommendation appears in, examples or additional notes provided for it, and keywords. Figure 4 depicts the information noted for each recommendation.

Type of suggestion	Category	Subcategory	Suggestion	Guideline	Year of publication	Authors	Country of publication	Language of publication	Page	Examples provided	Additional notes	Keywords
Language	Grammar	Sentences	Be concise. Avoid several actions in a single sentence.	Guidelines for easy-to-read materials	2010	International Federation of Library Association and Institutions	The Netherlands	English	11			sentence, sentence structure
Design and layout	Images	Layout on the page	Illustrations should [...] be placed in direct connection to the text.	Guidelines for easy-to-read materials	2010	International Federation of Library Association and Institutions	The Netherlands	English	13			image, layout, page

Figure 4 Sample of data extracted from *Easy Language guidelines*

Keywords were added for each entry in order to create relationships of closeness or correspondence between different recommendations. Keywords included terms that appeared in the recommendation or that were related to either the recommendation itself or the category it was included in. The list of keywords

already in use was consulted for each new entry to make sure that consistency was kept. Every time that a new keyword needed to be included, this was added to the list.

2.2.2. Literature search

In the following subsections, we present the criteria and the methodology followed in our literature review. All the steps and decisions along this procedure were taken keeping into consideration that our search and review had to be systematic.

- *Search strategy*

With the aim of detecting studies that potentially provided evidence to support Easy Language recommendations, we systematically searched for publications on the following electronic databases: Scopus, Web of Science, ERIC (Education Resources Information Center), JSTOR (Journal STORage), DOAJ (Directory of Open Access Journals), PubMed, Helka, DiVA (*Digitala Vetenskapliga Arkivet* [“Digital Scientific Archive”]), APA PsychInfo and MLA International Bibliography. EL may be of interest for professionals and researchers in many fields, hence searching on multiple databases that encompass different fields of science gave us a higher chance to find relevant publications. This search strategy entails a notable limitation: these databases mostly list academic journals, and other types of relevant publications may be missed. This will be discussed in § 2.4.1.

In the systematic searches, we used various sets of keywords that were linked to different aspects relevant for our review: (1) EL recommendations and guidelines and (2) the type of studies that we were aiming to retrieve (see the different sets of keywords as [A], [B], [C] and [D] on Table 4).

Table 4 Database search keywords

(A) "Information for all" OR "UNE 153101:2018 EX." OR "AENOR" OR "ISO/IEC DIS 23859-1" OR "Lectura facil: Metodos de redaccion y evaluacion" OR "Guidelines for easy-to-read materials" OR "Garcia Muñoz" OR "International Organization for Standardization" OR "IFLA" OR "Asociacion Española de Normalizacion" OR "Inclusion Europe"		
(B), (C), (D) "easy-to-read" OR "easy to read" OR "easy read" OR "easy reading" OR "lectura facil" OR "easy to understand language" OR "E2U"		
  		
"empirical" OR "empiric" OR "empirico"	"guideline" OR "recommendation" OR "recomendacion" OR "recomendaciones" OR "recomanacio" OR "recomanacions" OR "guia" OR "guies" OR "standard" OR "norma" OR "norm"	"Information for all" OR "UNE 153101:2018 EX." OR "AENOR" OR "ISO/IEC DIS 23859- 1" OR "Lectura facil: Metodos de redaccion y evaluacion" OR "Guidelines for easy-to-read materials" OR "Garcia Muñoz" OR "ISO" OR "IFLA" OR "UNE" OR "International Organization for Standardization" OR "International Federation of Library Associations and Institutions" OR "Asociacion Española de Normalizacion" OR "Inclusion Europe"

Our searches were designed to include the following:

- (A) Keywords that refer to EL guidelines;
- (B) Keywords that refer to EL;
 - + keywords that refer to the empirical aspect of searched publications;
- (C) Keywords that refer to EL;
 - + keywords related to guidelines and recommendations;
- (D) Keywords that refer to EL;
 - + keywords that refer to specific EL guidelines or standards

It has to be noted that the search engines in the databases explored do not discriminate between a word with accent marks and the same word without them; hence, the text in Table 4 does not consider these marks. These search engines do not restrict based on capitalisation either.

We made sure to include the most common terms used to refer to “Easy Language”, as well as to search all terms in all the languages considered in the inclusion criteria of our study (Tables 2 and 5). The keywords were searched for in abstracts, in the keywords of publications, and/or in the full texts, depending on the more or less precise search options, and on the information that was included in the indexed entries for each database.

Table 5 *Criteria for including and excluding publications*

Inclusion criterion	Published in the last 15 years (2006 or later) Written in English, Spanish, or Catalan The research puts a focus on EL Provides evidence to support or evaluate EL guidelines' recommendations
Exclusion criterion	Published in 2005 or earlier Written in a language other than English, Spanish, or Catalan The research is not focused on EL Does not provide evidence to support or evaluate EL guidelines' recommendations

Because of these differences between the database search options, a few of them (DOAJ, JSTOR and Web of Science) would not allow combining two or more strings of keywords. For these, searches [B], [C], and [D] presented in Table 4 could not be performed, and each independent set of keywords needed to be searched for separately. In these cases, results were filtered manually applying the selection criteria in the next subsection.

The systematic searches resulted in a total of 617 publications.

- *Selection criteria*

The 617 retrieved publications were reviewed and filtered manually using the criteria in Table 5.

First, titles and abstracts were reviewed for all 617 publications. Some articles were excluded because they addressed topics that were not relevant for our review (e.g. publications related to chemical processes, programming language, or mechanics). The authors also excluded publications that mentioned or were focused on EL, but that did not perform evaluations or empirical studies (e.g. non-

empirical, descriptive studies; studies on the promotion of Easy Language). A few other results were discarded because, although having gone through the language filter of the database, they were written in a language other than English, Spanish, or Catalan (see the limitation this entails in § 2.4.1). Finally, some results, like news or informational pamphlets, were excluded because of their format, in addition to their content (e.g. medical pamphlets). This first selection step resulted in the exclusion of 597 publications that did not meet the inclusion criteria. Figure 5 presents a summary of the selection process.

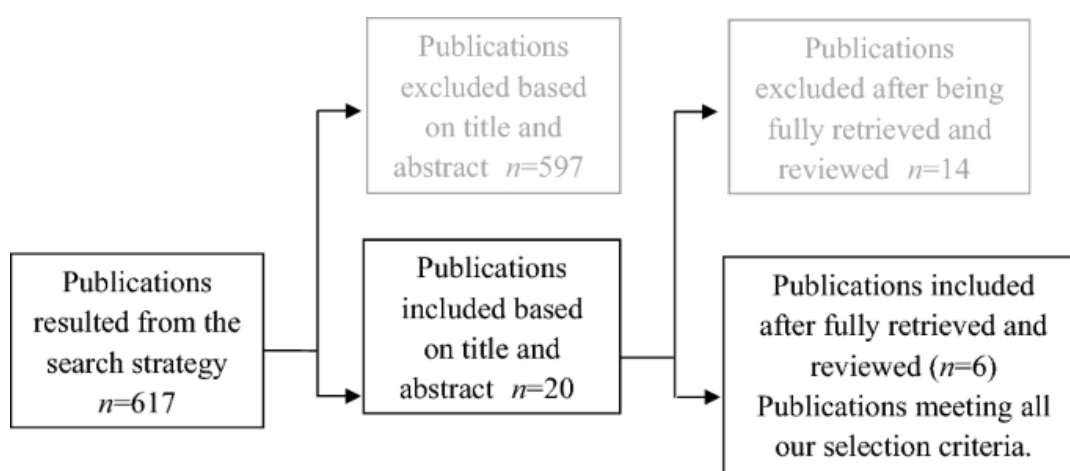


Figure 5 *Publications selection process*

The next step taken was to fully review the remaining 20 publications. In the end, only six of them met the pre-set criteria and were included in our study. All six of these studies provided empirical findings directly linked to EL recommendations. The studies that were excluded after being fully reviewed resulted to finally be (a) not directly related to Easy Language, (b) not mentioning EL recommendations or guidelines, and/or (c) not providing empirical findings related to EL recommendations. Consequently, criteria for inclusion were not completely met in these cases, and 14 more publications had to be excluded.

- *Data extraction and synthesis*

To analyse the six included publications, we created a matrix including the following data: aims, design, participants, EL recommendations that are evaluated, findings, and limitations. The data extracted will be presented in § 2.3.

- *Quality appraisal*

In literature reviews, a quality appraisal assessment should be performed on the selected publications (Sutherland & Isherwood, 2016; Linares-Espinós et al., 2018). Numerous academic institutions and scientific organisations have created quality appraisal checklists to perform these assessments, but most target health science studies (this is the case for some of the main providers of quality appraisal tools: Critical Appraisal Skills Program [CASP], the Johanna Briggs Institute, the Centre for Evidence Based Medicine of Oxford University or the Scottish Intercollegiate Guidelines Network) or a specific study design (e.g. randomised controlled trials, case control studies).

For that reason, we created a list of general quality indicators that could be applicable to the studies included in our review and that were based on the quality indicators in checklists of CASP (2020), Johanna Briggs Institute (2017), as well as the indicators in Sutherland and Isherwood (2016).

All six publications included in our analysis passed the assessment.

2.3. Results

The findings retrieved from the review of studies are grouped according to the linguistic aspect they evaluate. Our literature review found studies that evaluated (1) visual support, (2) linguistic simplification, (3) word frequency, (4) literacy mediation, (5) connectives, (6) co-references, and (7) number of sentences, text length, and word length.

In § 2.4, we will present the relationship between these aspects and EL recommendations.

2.3.1. Visual support

Visual support (notably, using pictures and vignettes to enhance comprehension) is evaluated in Rivero-Contreras et al. (2021) and Schatz et al. (2017).

Rivero-Contreras et al. (2021) performed an eye-tracking study on 20 university students with dyslexia (seven males and 13 females) and 20 chronological age-matched controls. The aim of this study was to evaluate the influence of visual

representation and word frequency both on processing and on readers with dyslexia. For this, they designed a test where participants read 60 sentences: half the sentences contained an image, and the other half did not. At the same time, half contained a low-frequency word and half a high-frequency word. In this study, Rivero-Contreras et al. (2021) found that, for people with lower vocabulary and less reading experience, the use of images related to the information in the text helps with the initial processing of words in the sentence and with the prediction of upcoming information, as well as with the recognition of semantic content in the text, which facilitates lexical access. However, it is not clear that the use of images helps with overall comprehension of the text, neither that it affects reading accuracy for this group of users (Rivero-Contreras et al., 2021).

Schatz et al. (2017) performed an online study with 159 adults who were presented simulated medical informed consent procedures. Researchers aimed to determine the effects that the use of pictures and the different varieties of Easy-to-understand languages (that is, their different levels of language simplification) might have on comprehension. Participants were randomly assigned to one of the five ways of presenting information: standard version (with or without visual support), EL (with or without visual support), or Plain Language. After each section, participants were directly asked comprehension questions. Schatz et al. (2017) also found that, for young neurotypical participants, vignettes supporting EL texts yielded no significant benefit in comprehension. This group of participants performed better when the EL version was accompanied by images than when it was not, but not better than with the standard language version. The EL version with visual support just compensated the negative effect of the EL version without visual support and showed similar comprehensibility than the standard version (Schatz et al., 2017). Therefore, this study found no benefits of using EL with images rather than standard language with young neurotypical participants.

2.3.2. Linguistic simplification

Linguistic simplification on a general, textual level is evaluated in Buell et al. (2020) and Schmutz et al. (2019).

Buell et al. (2020) performed a test on 60 adults with ID. Participants had to read a text that could be linguistically simple or complex and come with or without mediation. Conditions were allocated randomly, and participants were later asked questions that assessed reading comprehension and that were formulated to tap recall and the inferential application of information from the text. The aim of this study was to investigate how extrinsic (linguistic complexity of the text and literacy mediation), and intrinsic (participants' receptive vocabulary and reading comprehension abilities) factors affect the understanding of EL material.

Schmutz et al. (2019) aimed to examine the consequences of EL as a web accessibility criterion for users with no disabilities. In their study, 128 participants that were mainly psychology students needed to solve tasks in a website that was either in EL or in standard language (conditions were assigned randomly). Participants also filled in questionnaires to evaluate the website and had to answer free-recall, recognition of content, and true/false tasks.

In Buell et al. (2020), linguistic simplification was found to not have any significant effect on comprehension for people with ID. The repetition of vocabulary only reinforced certain concepts but failed in improving comprehension for this group of users. On the other hand, Schmutz et al. (2019) found that users in the control group processed information better when reading a simplified text.

Schmutz et al. (2019) found that linguistic simplification also showed an increase in reading time (due to the fact that text simplification resulted in more characters), as well as a decrease in text liking for the control group users. Users performed better when the text was simplified, but still showed a preference for the standard text (Schmutz et al., 2019).

Finally, Buell et al. (2020) suggest that adjusting the linguistic complexity of the text may have less impact on required cognitive effort than the presence of familiar, frequent vocabulary.

2.3.3. Word frequency

Lexical simplification using high-frequency words is evaluated in Rivero-Contreras et al. (Rivero-Contreras et al., 2021). Fajardo et al. (2013), and Fajardo et al. (2014).

Rivero-Contreras et al. (2021, p. 182) (design and characteristics of the study were discussed in § 2.3.1) found that “participants with lower vocabulary and lower print exposure [which are common characteristics of people with dyslexia] benefited the most from lexical simplification”. High-frequency words showed to result in shorter reading time at text-level and to facilitate overall sentence comprehension and processing (Rivero-Contreras et al., 2021). Their presence was also found to be beneficial to lexical access to particular words (Rivero-Contreras et al., 2021).

Fajardo et al. (2013) studied the effects of word frequency and connectives on reading comprehension in their study. Two experiments were performed: in the first one, participants read four versions of Spanish journalistic texts and answered literal and inferential comprehension questions after each one. Word frequency and connectives were adapted and measured. In the second experiment, participants performed a text cohesion task, in which they were “asked to read sentences that are missing a connective [...] and choose the connective that makes the most contextual sense from three choices” (Fajardo et al., 2013, p. 1274).

Fajardo et al. (2014) performed a study that aimed to assess the comprehensibility levels of different Easy Language texts and to examine the relationships between reading comprehension and various linguistic features of this type of texts. The participants were 16 students with ID, and each week, for a period of 16 weeks, they had to read three pieces of news in EL and complete a reading comprehension test. For each text, different levels of linguistic variables were measured.

The findings in Fajardo et al. (2013) indicate that the inclusion of high-frequency words does not improve inferential comprehension for people with ID. Opposing this statement, no correlation was found between word frequency and literal or inferential comprehension scores for people with ID in Fajardo et al. (2014)

2.3.4. Literacy mediation

In Buell et al. (2020), literacy mediation is evaluated through testing the effects of (1) structured summaries, (2) explanations of the text, (3) clarification of points, (4) examples of inferential information, (5) explanations to make inferences explicit, (6) the reinforcement of keywords and their corresponding images through pointing, and (7) the use of gestures with people with ID. In Buell et al. (2020), no specific results are given of the effect of each one of these separate items, but rather of the effect of the mediation resource in general.

Mediation showed to have no effect on the comprehensibility of EL texts (nor in standard language texts) for people with ID (Buell et al., 2020). Mediation only showed to be beneficial for comprehension when the influence of receptive vocabulary was controlled (Buell et al., 2020). This literacy mediation in the study by Buell et al. (Buell et al., 2020) was based on auditory-verbal-gestural repetition of the content, and the participants showed an extraordinarily passive response to the intervention.

Finally, Schmutz et al. (2019) mention that it should always be considered that explaining difficult words will result in longer texts which, as shown in findings in § 2.3.7, can affect comprehension negatively.

2.3.5. Connectives

The presence of connectives is evaluated in Fajardo et al. (2014) and Fajardo et al. (2013) with people with ID.

Fajardo et al. (2014) showed that the number of connectives is negatively correlated with literal comprehension. When it comes to inferential comprehension, connectives proved to produce no improvements in Fajardo et al. (2013). To try to explain the latter finding, Fajardo et al. (2013) also tested the role of connective familiarity and its interaction with connective type, which showed that performance in both neurotypical participants and participants with ID was indeed affected by the type of connective and its familiarity: low familiar additive connectives and contrastive connectives resulted in lower comprehension scores, while low familiar temporal and causal connectives showed higher comprehension scores (2013).

Finally, Fajardo et al. (2014) suggest that the negative effect connectives showed on literal comprehension can be linked to the fact that sentences with more connectives tend to be longer and contain more ideas that require to be integrated.

2.3.6. Co-references

Fajardo et al. (2014) found that the number of co-references has a negative relationship with literal comprehension in people with ID: that is, a higher number of co-references predicted higher difficulty and lower literal comprehension. The authors suggest that this negative effect can be linked to the fact that sentences with a high number of co-references tend to be longer (the same factor that could explain the negative effect on comprehension that the number of connectives showed (2014) [see § 2.3.5]) and the fact that the grammar in these sentences tends to be more complex and unnatural (2014).

No other reviewed publications studied the effects of co-references.

2.3.7. Number of sentences, text length, and word length

Fajardo et al. (2014) found that word length had no effect on comprehension for people with ID. On the other hand, they found that the number of sentences in the text had a negative relationship with inferential comprehension for the same group. The authors argue that, since individuals with ID tend to have problems with retaining information from memory, a higher number of information units logically results in the participants showing higher difficulty in the process of “making inferences between parts of the text or between the text and prior knowledge” (2014, p. 18).

Fajardo et al. (2014) also suggest that the length of the text can affect self-efficacy and motivation. Higher sentence and text length was also suggested as the reason for a decrease in literal comprehension when there is a high presence of co-references and connectives in the text (2014).

Finally, Schmutz et al. (2019) link the increase in reading time and the users liking EL texts less than those in standard language to the fact that following the tested recommendation of “making only one statement per sentence” (UNE, 2018; García-Muñoz & Matamala, 2021) results in a higher number of sentences.

2.4. Discussion

The information discussed in this section is a synthesis of the evidence found in the studies included in our review. Upcoming statements are not conclusive and, therefore, should be delicately considered.

One consistently evaluated variable throughout the included studies is comprehension. Based on the evidence in these studies, it is unclear if both visual support and linguistic simplification affect comprehension in any way. Lexical simplification using high-frequency words showed a positive effect on literal comprehension, but its effect on inferential comprehension remains unclear.

Mediation resources and word length did not show any effects on comprehension. On the contrary, the number of both connectives and co-referents present in the text showed to be linked to a decrease in comprehension. The number of sentences in the text and text length also caused a decrease in inferential comprehension, specifically, and connectives showed different effects on comprehension depending on their type.

Finally, in Schmutz et al. (2019), some subjective user reactions were also evaluated. In their study, centred on linguistic simplification, a decrease in text liking was observed when the EL texts with these adaptations were presented to neurotypical people.

After having summarised the findings, we will now go over our research questions and answer them based on the results of our literature review.

- *Q1.* Is there empirical research that evaluates current international EL recommendations?

Our research has proven that there are empirical findings that evaluate multiple EL recommendations. However, although we cannot deny that there is research being done on the field, the number of publications resulting from our systematic literature review exhibits the small extent of empirical evidence in academic journals and in the languages chosen. See the limitations of this in § 2.4.1.

- Q2. If so, what current international EL recommendations are supported by empirical research and what results were obtained?

Our literature review found studies that evaluated (1) visual support, (2) linguistic simplification, (3) word frequency, (4) literacy mediation, (5) connectives, (6) co-references, and (7) number of sentences, text length, and word length (see the results in § 2.3).

Although all the aspects evaluated are directly linked to recommendations in the reviewed Easy Language guidelines, not all the empirical findings turned out to be conclusive, and we did not find evaluations of all EL recommendations.

- *Results of the literature search*

Although the search strategy was pre-set as a first filter to aim for relevant results, the retrieved publications were mainly unrelated to EL and, therefore, not relevant to our study. Only 20 publications were considered to possibly meet the inclusion criteria after their titles and abstracts were reviewed (that is 3.24% of the total of initial results), and only six of them were finally considered relevant, after being fully reviewed (that is 0.97% of the initial results).

The fact that only six studies were included in our review is telling of the incipient state of empirical research on EL guideline recommendations, although it must be pointed out that a total of 102 publications (16.53% of the initial results) were marked as related to linguistics when their title and abstracts were read (of which 82 were discarded because of the study being descriptive or focusing on aspects not relevant to our review). Although this will be discussed in § 2.4.1, it is important to keep in mind that our search was performed on databases that mostly listed academic journals and their articles, and that other type of publications would have been missed.

As already mentioned, Sutherland and Isherwood (2016) also performed a literature review on the evidence for EL and specifically for people with ID. In their review, they finally included only 11 studies from the initial 8063 publications retrieved. Rivero-Contreras and Saldaña (2020) included 13 publications in their review, from the initial 235 retrieved. Taking this into account, we can suggest

that the incipient state of empirical research is extensive to EL in general—not only to empirical evaluations of EL recommendations.

Finally, the results of our review manifest that only some recommendations in EL guidelines have been empirically evaluated in academic journals written in English, Spanish, and Catalan. Nevertheless, even the recommendations that have been assessed could use complementary or reviewing research, given that the evidence in the retrieved studies is inconclusive.

- *Empirical findings on Easy Language recommendations*

The relevant findings in the reviewed publications were grouped according to the linguistic aspects that they evaluated. At the same time, these linguistic aspects are all explicitly linked to EL recommendations. Ultimately, the empirical findings in these articles can all be directly linked to EL recommendations. See the recommendations that relate to each evaluated linguistic aspect in Appendix 2.

With that being said, the empirical data found in our review are not sufficient: most findings are not comparable or complementary, and none of the results is decisive enough to be able to drive us to conclusive statements.

For instance, in Buell et al. (2020) and Schmutz et al. (2019), we find evaluations of “linguistic simplification”, a nonconcrete concept which is not broken down into more specific measures or explained in detail. This makes it difficult to determine to what extent the results of these evaluations would be comparable to other findings.

In some cases, we encountered results that go against the statements in EL recommendations, but since the evidence is not generalisable or conclusive, this is not enough to re-evaluate EL guidelines—although it does highlight issues to revise and perform research on.

The findings in Rivero-Contreras et al. (2021) and Schatz et al. (2017) related to visual support are a clear example. These studies found some benefits in using images to support the text, but did not lead to an improvement on comprehension, while the early guidelines by Inclusion Europe (ILSMH, 1997 & 1998a & 1998b) and the ISO standard (ISO, 2023b) precisely state the opposite: that the use of images enhances comprehension. These findings should be carefully considered

and investigated. Rivero-Contreras et al. (2021) and Schatz et al. (2017) themselves state that their results may not be representative or generalisable. Again, future research should corroborate their findings.

Another example of findings that are contrary to EL recommendations are those in Schmutz et al. (2019) and Fajardo et al. (2014), which showed that including a high number of sentences in the text has a negative effect on inferential comprehension, increases reading time, and decreases acceptability. These statements oppose the ISO standard (ISO, 2023b) and guidelines by García Muñoz (2012) and Asociación Española de Normalización (UNE, 2018), which defend that EL texts should express only one idea per sentence. Following this recommendation would normally result in longer texts with a higher number of sentences. It is uncertain if the possible benefits on comprehension of expressing one idea per sentence compensates for the negative effects that the higher number of sentences presumably has on inferential comprehension, reading time and acceptability. Once again, further research would be necessary to ponder this topic and possibly revise EL guidelines accordingly.

2.4.1. Limitations

The results of our literature search and review lead to mostly case-specific conclusions and can only be generalised to some degree. The research questions and systematic search were designed to find focused and specific results: we aimed to review the literature that included empirical research on EL that was explicitly related to its recommendations. We acknowledge that empirical findings in missed publications from other fields of research may have evaluated linguistic aspects intrinsic to some EL recommendations. Nevertheless, we intentionally opted for a more focused search to review the state of the empirical research *on* EL, rather than *associated with* EL. With that being said, we suspect that more results would have come up if a more generic search was made—that is, if the results were not as restricted by the very specific keyword search that was performed.

As Grant and Booth (2009) mention, there are no methods for literature reviews to ensure that all the literature is considered, no matter the topic. For that reason, this is considered an inherent limitation of this type of study, as was also

encountered by Campoverde-Molina et al. (2021), Chinn and Homeyard (2017), and Sutherland and Isherwood (2016). As Chinn and Homeyard (2017, p. 9) state in their meta-narrative literature review, “[these studies] regard intuition, personal and professional knowledge and networks, and serendipity as resources available to reviewers, although at the expense of the replicability of the review. [...] Other reviewers might well identify different groupings of studies and highlight different themes”.

In addition to that, some relevant publications surely may have not been retrieved and, therefore, not reviewed because of the databases we perform our search in. As stated earlier in the paper, the design of our systematic review only contemplated the pool of publications available in online databases. EL is a new, largely unexplored field of science, and it is very probable that relevant results in handbooks, congress publications, monographical work, or even grey literature have not been considered, as normally only academic journals are listed in the searched online databases. For instance, a seminal book such as the one edited by Lindholm and Vanhatalo (2021), or the book on theoretical and empirical perspectives on Easy Language research edited by Hansen-Schirra and Maaß (2020), are not included. This limitation is one that we fully acknowledge and the results in this literature review should be considered relevant only according to our research scope.

Finally, the languages considered in our inclusion criteria for both guidelines and publications (English, Spanish, and Catalan) (see § 2.2) also entailed a big limitation for this review. As explained in § 2.1.1.2, German-speaking countries are in the lead when it comes to both the creation of EL guidelines and research on the field. Therefore, several publications (like journal articles by Deilern et al. [2019], Hansen-Schirra et al. [2009] or Maaß and Rink [2017]) might have been relevant and have most probably been missed due to the language barrier.

2.5. Conclusions

We fulfilled the aims of our study and can state that there is empirical evidence for some of the recommendations in current EL guidelines. Our systematic literature search showed that the studies performed on that specific topic are scarce, and the later review of the results showed that the empirical findings in the studies are also non-conclusive and non-generalisable. Nevertheless, as stated in § 2.4.1, our search results were limited to academic journals in three languages and, therefore, these statements are only conclusive to that extent.

The studies included in our review had different numbers and types of participants and used very different methodologies in their research. This made it difficult to know if the resulting data were comparable or generalisable. Performing more research on EL recommendations could (1) determine if the data in these studies are anecdotal or can be conclusive, and (2) create a pool of complementary data large enough to allow researchers to make outright statements, and to evaluate and possibly redesign the current EL guidelines based on it.

This review ultimately aims to act as a portrayal of the current state of empirical research on EL recommendations to a certain extent and to foster future research in the field. We would suggest research to focus either on the recommendations that are missing empirical evaluation, on complementing previous studies, or on balancing out the limitations in these. As Rivero-Contreras and Saldaña (2020) defend, we need more research in the field, but we need to especially foster new research of high methodological quality.

This is a call to join forces towards effective, optimal and scientifically based guidelines, which would ultimately entail effective and optimal EL content.

2.6. Appendix

2.6.1. Appendix 1

1. A brief guide to easy read (Scottish Accessible Information Forum, 2014)
2. A guide to producing written information in easy read (North Yorkshire County Council, 2021)
3. Basic guidelines for people who commission Easy Read information (Department of Health, 2009)
4. Finestra Oberta: Materials de Lectura-fàcil, anàlisi, directrius internacionals i proposta per a elaborar aquests materials a Catalunya (Salvador, 1999)
5. Guía de lectura fácil: normas e recomendacións (Down Galicia, 2017)
6. Guía para validar textos en lectura fácil (Jareño Galán, 2018)
7. Guide to Making Information Accessible for People with a Learning Disability (NHS England, 2018)
8. Guidelines for easy-to-read materials (ILFA, 2010)
9. Guidelines for writing and translating into Easy Read Welsh (Learning Disability Wales & Mencap Cymru, 2012)
10. How to use Easy Words and Pictures (Disability Rights Commission, 2006)
11. Information for all: European standards for making information easy to read and understand (Inclusion Europe, 2009)
12. ISO/IEC DIS 23859-1. Guidance on making written text easy to read and easy to understand (International Organization for Standardization, 2021)
13. Kent County Council Easy Read Guidelines (Kent County, 2010)
14. Lectura fácil: Métodos de redacción y evaluación (García Muñoz, 2012)
15. LF, una necessitat per a la inclusió de l'alumnat nouvingut d'ESO (Serra Milà, 2008)
16. Make it easy: A guideline to preparing Easy-to-read (Accessible Information Working Group, 2014)
17. Make it Simple: European Guidelines for the Production of Easy-to-Read Information (ILSMH, 1997)
18. Making written information easier to understand for people with learning disabilities (Department of Health, 2010)
19. How To Make Information Accessible (CHANGE, 2016)
20. Mencap's Make it clear: A guide to making easy read information (Mencap, 2013)

21. Resum de les principals pautes de Lectura Fàcil per a elaborar textos narratius (Associació Lectura Fàcil, 2011)
22. UNE 153,101 EX. Lectura Fácil: Pautas y recomendaciones para la elaboración de documentos (UNE, 2018)
23. Validación de textos en lectura fácil: aspectos prácticos y sociolaborales (Plena Inclusión Madrid, 2018)

2.6.2. Appendix 2

Easy Language recommendations that are evaluated on the reviewed publications.

(1) Visual support
(2) Linguistic simplification
(3) Word frequency
(4) Literacy mediation
(5) Connectives
(6) Co-references
(7) Number of sentences, text length, and word length

Category		Recommendation
(1)	Images	Easy-to-read materials with pictograms help persons with intellectual and cognitive disabilities understand content. (Nomura et al., 2010, p. 13)
(1)	Images	Many people find it hard to read text. To help them understand your text, you should put images next to it to describe what it is about. Images are things like photographs, drawings, or symbols. (Inclusion Europe, 2009, p. 20)
(1)	Images	Images can be used to enhance comprehension. (ISO, 2023b, p. 18)
(1)	Images	Non-verbal paratextual elements such as images and other graphical elements can enhance comprehension. (ISO, 2023b, p. 17)
(2)	Vocabulary > Complexity of the vocabulary	Avoid difficult words but use language that is adult and dignified. (Nomura et al., 2010, p. 11)

(2), (4)	Grammar > Parts of the sentence	It is OK to repeat important information. It is OK to explain difficult words more than once. (Inclusion Europe, 2009, p. 11)
(2), (3)	Vocabulary > Complexity of the vocabulary	Use easy to understand that people will know well. (Inclusion Europe, 2009, p. 10)
(2)	Vocabulary > Complexity of the vocabulary	Do not use difficult words. (Inclusion Europe, 2009, p. 15)
(2)	Vocabulary > Complexity of the vocabulary	When writing information in easy read it is not enough to avoid jargon words. Your text should also be free of any hard words. Hard words are words that are not generally used in everyday conversation. (CHANGE, 2016, p. 8)
(2)	Vocabulary > Complexity of the vocabulary	Try to write your information in short, clear sentences. Do not use complicated words, words that are hard to understand or jargon words. (CHANGE, 2016, p. 28)
(2), (4)	Vocabulary > Complexity of the vocabulary	Do not use difficult words. If you need to use difficult words, make sure you always explain them clearly. (Inclusion Europe, 2009, p. 10)
(2), (3), (4)	Vocabulary > Complexity of the vocabulary	Avoid difficult or unfamiliar words. If you do need to use one, put the difficult or unfamiliar word in bold and explain it. If it is an abstract concept, try to explain it with a clear, practical example. Some people will find a word list or glossary useful. (Accessible Information Working Group, 2011, p. 17)
(2), (4)	Vocabulary > Complexity of the vocabulary	Simplify complex information and explain it using examples from everyday life. (CHANGE, 2016, p. 9)
(2), (3)	Vocabulary > Complexity of the vocabulary	Vocabulary should be suitable for the intended target reader. Some words are more difficult to understand than others. Unusual words are more likely to be difficult to understand. Therefore, one should use simple, frequent, and every-day vocabulary. (ISO, 2023b, p. 10)
(2), (3)	Vocabulary > Complexity of the vocabulary	<i>Se debe utilizar un lenguaje sencillo y de uso frecuente.</i> (UNE, 2018, p. 18) ("Simple, frequently used language should be used.")
(2), (3), (7)	Vocabulary > Complexity of the vocabulary	<i>Utilizar palabras sencillas expresadas de forma simple. Utilizar vocablos cortos, con el menor número de sílabas y con las sílabas menos complejas (es decir, utilizar las sílabas de mayor frecuencia de uso en el castellano). Utilizar vocablos de alta frecuencia léxica (de uso cotidiano) y cercanos al lenguaje hablado, que utilice el público objetivo del texto.</i> (García-Muñoz, 2012, p. 70)

		(“Use simple words expressed in a simple way. Use short words, with the least number of syllables and with the least complex syllables (that is, use the syllables with the highest frequency of use in Spanish). Use words of high lexical frequency (everyday use) and close to spoken language, used by the target audience of the text.”)
(3)	Vocabulary > Complexity of the vocabulary	Non-frequent forms of verbs should be avoided. (ISO, 2023b, p. 12)
(3)	Vocabulary > Complexity of the vocabulary	Use words that we use all the time. (Mencap, 2013, p. 3)
(3)	Grammar > Verbs	<i>Se deberían evitar los tiempos verbales compuestos o poco frecuentes y el uso de los condicionales y subjuntivos.</i> (UNE, 2018, p. 22) (“Compound or infrequent tenses and the use of conditionals and subjunctives should be avoided.”)
(3), (4)	Vocabulary > Complexity of the vocabulary	Foreign language words should be avoided unless they are well established in the source language or explained. (ISO, 2023b, p. 11)
(4)	Vocabulary > Lexical units	The meaning of non-frequent acronyms should be explained the first time they are used. (ISO, 2023b, p. 12)
(4), (2)	Paratextual elements > Summaries	Repeating or summarizing content allows the reader to remember relevant information. This is called redundancy and it increases comprehension. It is especially important in long content. (ISO, 2023b, p. 19)
(4), (2)	Paratextual elements > Summaries	<i>Repetir y resumir las ideas principales. Aunque el resumen final del contenido es importante, todavía lo es más el tema central del documento, es decir, la información que se transmite a lo largo del mismo. El resumen se puede presentar en las páginas centrales en un formato de papel más amplio.</i> (García-Muñoz, 2012, p. 73) (“Repeat and summarise the main ideas. Although the final summary of the content is important, the central theme of the document is even more important, that is, the information that is transmitted throughout it. The abstract can be presented on the central pages in a larger paper format.”)
(4), (2)	Paratextual elements > Summaries	<i>La repetición de información debería aparecer cuando se requiera que el lector recuerde un contenido necesario para comprender el texto de la página que está leyendo y que fue abordado con anterioridad en el documento.</i> (UNE, 2018, p. 36)

		(“The repetition of information should appear when the reader is required to remember content that is necessary to understand the text of the page they are reading and that was addressed earlier in the document.”)
(4)	Paratextual elements	Use examples to explain things. Try to use examples that people will know from their everyday lives. (Inclusion Europe, 2009, p. 10)
(4)	Paratextual elements	Where possible, explain the words at the time you are using them. In written documents, you could also have a list of useful words at the end of the document. (Inclusion Europe, 2009, p. 15)
(4)	Paratextual elements	If you must use a hard word or a jargon word, make sure you explain it clearly in easy words. If you do not have room to explain the word in the paragraph, it is best to create a paragraph below that defines the word with easy words and pictures. Or you could try an illustrated word bank. (CHANGE, 2009, p. 27)
(4)	Vocabulary > Complexity of the vocabulary	Technical terms used in a specific context can also be difficult to understand for a lay person. Abstract, technical, and complex terms should be avoided when addressing a lay audience. If they cannot be avoided, they should be explained. (ISO, 2023b, p. 11)
(4)	Vocabulary > Complexity of the vocabulary	<i>Evitar tecnicismos, jergas y xenismos, aunque se debe explicar el significado si se usan.</i> (García-Muñoz, 2012, p. 71) (“Avoid technical terms, jargon and xenisms; but their meaning should be explained if they are used.”)
(4)	Vocabulary > Complexity of the vocabulary	<i>Explicar las palabras menos comunes o complejas a través de la contextualización, el apoyo en imágenes y la explicación del significado. Para esto último, es conveniente destacarlas en negrita o subrayadas la primera vez que aparecen y explicar al margen o en un glosario final su significado. Hay que señalar que no todo se puede contar con un léxico básico: habrá objetos, situaciones, hechos, características de los personajes y ambientes, lugares desconocidos para el lector que deben introducirse, pero favorecerá la ampliación del vocabulario.</i> (García-Muñoz, 2012, p. 70) (“Explain less common or complex words through contextualisation, support with images and explanation of meaning. For the latter, it is convenient to highlight them in bold or underlined the first time they appear and explain their meaning in the margin or in a final glossary. It should be noted that not everything can be explained

		with a basic lexicon: there will be objects, situations, facts, characteristics of the characters and environments, places unknown to the reader, etc., that must be introduced, but it will favour the expansion of vocabulary.”)
(4)	Vocabulary > Lexical units	<i>Se pueden utilizar acrónimos cuando su uso esté extendido en el idioma. No obstante, la primera vez que se utilicen se debería explicar su significado.</i> (UNE, 2018, p. 20) (“Acronyms can be used when their use is widespread in the language. However, the first time they are used, their meaning should be explained.”)
(4)	Vocabulary > Lexical units	<i>Evitar abreviaturas, acrónimos y siglas, aunque se pueden utilizar si son muy conocidas o necesarias, explicando el significado la primera vez que aparezcan.</i> (García-Muñoz, 2012, p. 71) (“Avoid abbreviations, acronyms and initialisms, although they can be used if they are well known or necessary, explaining their meaning the first time they appear.”)
(4)	Vocabulary > Semantic aspects	<i>Evitar conceptos abstractos e ilustrarlos con ejemplos concretos y comparaciones, ejemplos prácticos y de la vida diaria. No obstante, es difícil evitarlos totalmente, por lo que se pueden utilizar los de fácil comprensión y uso habitual, apoyados en una construcción semántica sencilla y no introduciendo más de un término abstracto por oración.</i> (García-Muñoz, 2012, p. 71) (“Avoid abstract concepts and illustrate them with concrete examples and comparisons, practical examples and examples from daily life. However, it is difficult to avoid them completely, so those that are easy to understand and frequently used can be used if supported by a simple semantic construction and not introducing more than one abstract term per sentence.”)
(4)	Vocabulary > Semantic aspects	<i>Se debería evitar el uso de enunciados con sentido figurado (frases hechas o refranes, ironías, metáforas o semejantes). En caso de que su inclusión sea necesaria para mantener la viveza del texto o enriquecerlo se debe incluir una explicación con su significado.</i> (UNE, 2018, p. 20) (“The use of statements with a figurative meaning [set phrases or proverbs, ironies, metaphors or the like] should be avoided. In case its inclusion is necessary to maintain the vividness of the text or to enrich it, an explanation with its meaning must be included.”)

(5)	Vocabulary > Lexical units	<i>Utilizar las preposiciones y conjunciones más habituales y actuales, puesto que dan información determinante para la comprensión del sintagma que antecede. La coherencia del bloque de oraciones o párrafos se produce por elementos de enlace y de transición que ofrecen un mensaje ágil. Estos marcadores discursivos actúan como conectores y facilitan la introducción de un orden lógico.</i> (García-Muñoz, 2012, p. 71) (“Use the most common and current prepositions and conjunctions since they provide decisive information for understanding the preceding phrase. The coherence of the block of sentences or paragraphs is produced by linking and transition elements that offer an agile message. These discourse markers act as connectors and facilitate the introduction of a logical order.”)
(5)	Grammar > Sentences	<i>Se debería evitar el uso de conectores complejos entre oraciones, como "por lo tanto", "no obstante", "por consiguiente" o "sin embargo".</i> (UNE, 2018, p. 24) (“The use of complex connectors between sentences, such as ‘therefore’, ‘however’, ‘consequently’ or ‘however’, should be avoided.”)
(6)	Grammar > Parts of the sentence	<i>Evitar la elisión del sujeto. Es preferible repetir el sujeto a elidirlo o sustituirlo por un pronombre para reiterar el protagonista de la acción y facilitar la comprensión. Se acepta como excepción la elisión o su sustitución por un pronombre, si el referente contextual es muy claro.</i> (García-Muñoz, 2012, p. 69) (“Avoid elision of the subject. Repeating the subject is preferable to eliding it or replacing it with a pronoun to reiterate the protagonist of the action and facilitate understanding. Elision or its replacement by a pronoun is accepted as an exception if the contextual referent is very clear.”)
(6)	Grammar > Parts of the sentence	<i>No se debería utilizar elipsis. Se debería evitar que el lector tenga que hacer inferencias. En todo caso, hay que procurar que las omisiones sean mínimas y garantizar la identificación referencial.</i> (UNE, 2018, p. 23) (“Ellipses should not be used. The reader should be prevented from having to make inferences. In any case, it is necessary to ensure that omissions are minimal and guarantee referential identification.”)

(6)	Grammar > Parts of the sentence	<i>Se debería evitar que el lector tenga que realizar inferencias para comprender el texto.</i> (UNE, 2018, p. 24]) (“The reader should be prevented from having to make inferences to understand the text.”)
(6)	Grammar > Parts of the sentence	Be careful when you use pronouns. Pronouns are words like “I”, “him” or “it” that you use instead of the actual person or thing you are talking about. Make sure it is always clear who or what the pronoun is talking about. If it is not clear, then use the proper name instead. (Inclusion Europe, 2009, p. 15)
(6)	Grammar > Parts of the sentence	Information should be explicitly formulated. Implied meaning and omissions should be avoided if they make understanding difficult for the target reader. (ISO, 2021, p. 13)
(7)	Vocabulary > Lexical units	In alphabetical languages, long words are more likely to be difficult to understand and should be avoided where possible. (ISO, 2023b, p. 11)
(7)	Vocabulary > Lexical units	<i>Se debería evitar el uso de palabras muy largas o que contengan sílabas complejas.</i> (UNE, 2018, p. 19) (“The use of very long words or those containing complex syllables should be avoided.”)
(7)	Grammar > Sentences	Be concise. Avoid several actions in a single sentence. (Nomura et al., 2010, p. 11)
(7)	Grammar > Sentences	<i>No se deben presentar más de dos ideas en una misma frase.</i> (UNE, 2018, p. 24) (“No more than two ideas should be presented in the same sentence.”)
(7)	Grammar > Sentences	<i>Se deberían utilizar frases sencillas y evitar las oraciones complejas. Si no se pueden evitar en algún caso, conviene separar las ideas en distintas líneas.</i> (UNE, 2018, p. 22) (“Simple phrases should be used, and complex sentences should be avoided. If they cannot be avoided in some case, it is convenient to separate the ideas in different lines.”)
(7)	Grammar > Sentences	Always keep your sentences short. (Inclusion Europe, 2009, p. 11)
(7)	Grammar > Sentences	Keep your sentences short. You could do this by writing only 1 idea per sentence or using a full stop before starting a new idea, instead of using a comma or an “and”. (Inclusion Europe, 2009, p. 17)
(7)	Grammar > Sentences	Unnecessary long sentences should be avoided. It is recommended to include one idea per sentence. It is also recommended to vary the length of the sentences. (ISO, 2023b, p. 13)

(7)	Grammar > Sentences	In easy language, if it is not possible to avoid a complex sentence, ideas should be separated in different lines. (ISO, 2023b, p. 13)
(7)	Grammar > Sentences	Complex sentences with many subordinate clauses should be avoided. It is recommended to write different sentences instead. (ISO, 2023b, p. 13)
(7)	Grammar > Sentences	<i>Utilizar oraciones simples cortas, con la estructura «sujeto + verbo + complementos». Esta estructura puede sufrir algunas modulaciones, como la posposición del sujeto en el caso del discurso directo y en discursos de contenido informativo o la dislocación del objeto directo al inicio de la frase.</i> (García-Muñoz, 2012, p. 69) ("Use short simple sentences, with the structure 'subject + verb + complements'. This structure can undergo some modulations, such as the postposition of the subject in the case of direct speech and in speeches with informative content, or the dislocation of the direct object at the beginning of the sentence.")
(7)	Vocabulary > Semantic aspects	Expressions which make the written text longer and do not add information should be avoided. (ISO, 2023b, p. 11)
(7)	Vocabulary > Semantic aspects	<i>Se debería evitar el uso de palabras que no aportan información al texto y alargan su lectura.</i> (UNE, 2018, p. 19) ("The use of words that do not add information to the text and lengthen its reading should be avoided.")

2.7. References

- Accessible Information Working Group. (2014). *Make it easy: A guideline to preparing Easy to Read information*. WALK. <https://www.walk.ie/userfiles/file/Make%20It%20Easy%20-%20A%20guide%20to%20preparing%20Easy%20to%20Read%20Information.pdf>
- Anča, G., & Meļņika, I. (2021). Easy language in Latvia. In C. Lindholm & U. Vanhatalo (Eds.), *Handbook of easy languages in Europe* (pp. 305–325). Frank & Timme.
- Associació Lectura Fàcil. (2011). *Resum de les principals pautes de Lectura Fàcil per a elaborar textos narratius*. <https://drive.google.com/file/d/1WmoKoRWIO9B9bmflzSdUBHJc52LgVSIV/view>
- Bernabé, R. (2020). New taxonomy of easy-to-understand access services. *MonTi Monografías De Traducción E Interpretación*, (12), 345–380. <https://doi.org/10.6035/MonTi.2020.12.12>
- Bohman, U. (2021). Easy language in Sweden. In C. Lindholm & U. Vanhatalo (Eds.), *Handbook of easy languages in Europe* (pp. 527–567). Frank & Timme.
- Buell, S., Langdon, P. E., Pounds, G., & Bunning, K. (2020). An open randomized controlled trial of the effects of linguistic simplification and mediation on the comprehension of “easy read” text by people with intellectual disabilities. *Journal of Applied Research in Intellectual Disabilities*, 33(2), 219–231. <https://doi.org/10.1111/jar.12666>
- Campoverde-Molina, M., Luján-Mora, S., & Valverde, L. (2021). Accessibility of university websites worldwide: A systematic literature review. *Universal Access in the Information Society*, 22, 133–168. <https://doi.org/10.1007/s10209-021-00825-z>
- CASP. (2020). *CASP checklists*. Critical Appraisal Skills Programme. <https://casp-uk.net/casp-tools-checklists/>
- CHANGE. (2016). *How to make information accessible*. <https://www.changepeople.org/images/001-how-to-make-information-accessible.pdf>
- Chinn, D. (2019). Talking to producers of Easy Read health information for people with intellectual disability: Production practices, textual features, and imagined audiences. *Journal of Intellectual & Developmental Disability*, 44(4), 410–420. <https://doi.org/10.3109/13668250.2019.1577640>
- Chinn, D. (2020). An empirical examination of the use of Easy Read health information in health consultations involving patients with intellectual disabilities. *Journal of Applied Research in Intellectual Disabilities*, 33(2), 232–247. <https://doi.org/10.1111/jar.12657>
- Chinn, D., & Homeyard, C. (2017). Easy read and accessible information for people with intellectual disabilities: Is it worth it? A meta-narrative literature review. *Health Expectations*, 20(6), 1189–1200. <https://doi.org/10.1111/hex.12520>
- Cinková, S., & Latimier, C. (2021). Easy language in Czechia. In C. Lindholm & U. Vanhatalo (Eds.), *Handbook of easy languages in Europe* (pp. 119–147). Frank & Timme.
- Dalton, B., & Proctor, C. P. (2007). Reading as thinking: Integrating strategy instruction in a universally designed digital literacy environment. In D. S. McNamara (Ed.), *Reading*

comprehension strategies: Theories, interventions, and technologies (pp. 421–439). Lawrence Erlbaum Associates.

- Deilen, S., Hansen-Schirra, S., & Maaß, C. (2019). Anwendbarkeit der ISO 17100 auf intralinguales Übersetzen in Leichte und Einfache Sprache. *Magazin*, 27, 43–53.
<https://doi.org/10.12795/mAGAzin.2020.i28.01>
- Department of Health. (2010). *Making written information easier to understand for people with learning disabilities: Guidance for people who commission or produce Easy Read information—Revised Edition 2010*.
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/215923/dh_121927.pdf
- Fajardo, I., Ávila, V., Ferrer, A., Tavares, G., Gómez, M., & Hernández, A. (2014). Easy-to-read texts for students with intellectual disability: Linguistic factors affecting comprehension. *Journal of Applied Research in Intellectual Disabilities*, 27, 212–225. <https://doi.org/10.1111/jar.12065>
- Fajardo, I., Tavares, G., Ávila, V., & Ferrer, A. (2013). Towards text simplification for poor readers with intellectual disability: When do connectives enhance text cohesion? *Research in Developmental Disabilities*, 34(4), 1267–1279. <https://doi.org/10.1016/j.ridd.2013.01.006>
- García Muñoz, Ó. (2012). *Lectura fácil: Métodos de redacción y evaluación*. Plena Inclusión.
<https://www.plenainclusion.org/sites/default/files/lectura-facil-metodos.pdf>
- García Muñoz, Ó., & Matamala, A. (2021). Easy languages in Spain. In C. Lindholm & U. Vanhatalo (Eds.), *Handbook of easy languages in Europe* (pp. 493–525). Frank & Timme.
- Grant, M. J., & Booth, A. (2009). A typology of reviews: An analysis of 14 review types and associated methodologies. *Health Information & Libraries Journal*, 26(2), 91–108.
<https://doi.org/10.1111/j.1471-1842.2009.00848.x>
- Hansen-Schirra, S., & Maaß, C. (2020). *Easy language research: Text and user perspectives*. Frank & Timme.
- Hansen-Schirra, S., Hansen, S., Wolfer, S., & Konieczny, L. (2009). Fachkommunikation, Popularisierung, Übersetzung: Empirische Vergleiche am Beispiel der Nominalphrase im Englischen und Deutschen. *Linguistik Online*, 39(3). <https://doi.org/10.13092/lo.39.480>
- ILSMH. (1997). *Make it simple: European guidelines for the production of easy-to-read information for people with learning disability*. Associació Lectura Fàcil.
https://repositori.lecturafacil.net/sites/default/files/1998%20EI%20cam%C3%AD%20m%C3%A9s%20f%C3%A1cil%20Directrius%20europees%20per%20gernar%20informaci%C3%B3%20de%20Lectura%20F%C3%A0cil%20ILSMH_ANG.pdf
- ILSMH. (1998a). *El Camí Més Fàcil: Directrius Europees per Generar Informació de Lectura Fàcil*. Associació Lectura Fàcil. http://www.lecturafacil.net/media/resources/ILSMH_catal%C3%A0.pdf
- ILSMH. (1998b). *El Camino Más Fácil: Directrices Europeas para Generar Información de Fácil Lectura*. Associació Lectura Fàcil.
<http://www.lecturafacil.net/media/resources/ILSMHcastell%C3%A0.pdf>

- Inclusion Europe. (2009). *Information for all: European standards for making information easy to read and understand*. https://www.inclusion-europe.eu/wp-content/uploads/2017/06/EN_Information_for_all.pdf
- ISO - International Organization for Standardization. (2023b). *Information technology — User interfaces — Requirements and recommendations on making written text easy to read and understand*. (ISO Standard No. ISO/IEC 23859).
- Johanna Briggs Institute. (2017). *Checklist for systematic reviews and research syntheses*. https://jbi.global/sites/default/files/2019-05/JBI_Critical_Appraisal-Checklist_for_Systematic_Reviews2017_0.pdf
- Lenček, M., & Kuvač Kraljević, J. (2021). Easy language in Croatia. In C. Lindholm & U. Vanhatalo (Eds.), *Handbook of easy languages in Europe* (pp. 92–118). Frank & Timme.
- Linares-Espinós, E., Hernández, V., Domínguez-Escrig, J. L., Fernández-Pello, S., Hevia, V., Mayor, J., Padilla-Fernández, B., & Ribal, M. J. (2018). Metodología de una revisión sistemática. *Actas Urológicas Españolas*, 42(8), 499–506.
- Lindholm, C., & Vanhatalo, U. (2021). *Handbook of easy languages in Europe*. Frank & Timme.
- Maaß, C. (2015). *Leichte Sprache. Das Regelbuch*. LIT Verlag.
- Maaß, C. (2020). *Easy language—Plain language—Easy language plus*. Frank & Timme.
- Maaß, C., & Rink, I. (2017). Leichte Sprache: Verständlichkeit ermöglicht Gesundheitskompetenz. *Public Health Forum*, 25(1), 50–53. <https://doi.org/10.1515/pubhef-2016-2148>
- Maaß, C., Rink, I., & Hansen-Schirra, S. (2021). Easy languages in Germany. In C. Lindholm & U. Vanhatalo (Eds.), *Handbook of easy languages in Europe* (pp. 191–218). Frank & Timme.
- Matamala, A. (2022). Easy-to-understand language in audiovisual translation and accessibility: State of the art and future challenges. *XLinguae*, 15(2), 130–144. <https://doi.org/10.18355/XL.2022.15.02.10>
- Mencap. (2013). *Make it clear*. Inclusion Ireland. <https://inclusionireland.ie/wp-content/uploads/2020/10/makeitclearapr09.pdf>
- Miesenberger, K., & Petz, A. (2014). Easy-to-read on the web: State of the art and needed research. In K. Miesenberger, D. Fels, D. Archambault, P. Peñáz, & W. Zagler (Eds.), *ICCHP 2014. LNCS, 8547* (pp. 161–168). https://doi.org/10.1007/978-3-319-08596-8_25
- Nomura, M., Nielsen, G., & Tronbacke, B. (2010). *Guidelines for easy-to-read materials (IFLA Professional Reports 120)*. IFLA.
- Orero, P., Delgado, C., & Matamala, A. L. (2020). Easy to read standardisation. Some steps towards an international standard. *DSAI 2020: 9th International Conference on Software Development and Technologies for Enhancing Accessibility and Fighting Info-exclusion*, 44–46. <https://doi.org/10.1145/3439231.3440605>
- Przybyła-Wilkin, A. (2021). Easy language in Poland. In C. Lindholm & U. Vanhatalo (Eds.), *Handbook of easy languages in Europe* (pp. 401–412). Frank & Timme.

- Richart-Marset, M., & Calamita, F. (2020). El gran reto de la traducción y la accesibilidad audiovisual en los medios de comunicación. *MonTI: Monografías de Traducción e Interpretación*, 12, 29–52. <https://doi.org/10.6035/MonTI.2020.12.01>
- Rivero-Contreras, M., & Saldaña, D. (2020). ¿Legibilidad es sinónimo de comprensión en Lectura Fácil? Una revisión de estudios sobre comprensión lectora en textos adaptados o simplificados y su calidad metodológica. In A. E. Díez Mediavilla & R. Gutiérrez Fresneda (Coords.), *Lectura y dificultades lectoras en el siglo XXI* (pp. 714–728). Octaedro.
- Rivero-Contreras, M., Engelhardt, P. E., & Saldaña, D. (2021). An experimental eye-tracking study of text adaptation for readers with dyslexia: Effects of visual support and word frequency. *Annals of Dyslexia*, 71(1), 170–187. <https://doi.org/10.1007/s11881-021-00217-1>
- Schatz, T., Haberstroh, J., Bindel, K., Oswald, P., Pantel, J., Paulitsch, M., Konopik, N., & Knopf, M. (2017). Improving comprehension in written medical informed consent procedures. *GeroPsych: Journal of Gerontopsychology and Geriatric Psychiatry*, 30(3), 97–108. <https://doi.org/10.1024/1662-9647/a000169>
- Schmutz, S., Sonderegger, A., & Sauer, J. (2019). Easy-to-read language in disability-friendly websites: Effects on nondisabled users. *Applied Ergonomics*, 74, 97–106. <https://doi.org/10.1016/j.apergo.2018.08.013>
- Social Care Institute for Excellence. (2005). *How to produce information in an accessible way (Social Care Accessibility Guidelines)*. <https://web.archive.org/web/20220119220308/https://www.scie.org.uk/publications/misc/accessguidelinespublications.asp>
- Šumskienė, E., & Baltrušaitė, M. (2021). Easy language in Lithuania. In C. Lindholm & U. Vanhatalo (Eds.), *Handbook of easy languages in Europe* (pp. 327–344). Frank & Timme.
- Sutherland, R. T., & Isherwood, T. (2016). The evidence for easy-read for people with intellectual disabilities: A systematic literature review. *Journal of Policy and Practice in Intellectual Disabilities*, 12(4), 297–310. <https://doi.org/10.1111/jppi.12201>
- Turnpenny, A., Caiels, J., Whelton, B., Richardson, L., Beadle-Brown, J., Crowther, T., Forder, J., Apps, J., & Rand, S. (2018). Developing an easy read version of the adult social care outcomes toolkit (ASCOT). *Journal of Applied Research in Intellectual Disabilities*, 31(1), e36–e48. <https://doi.org/10.1111/jar.12294>
- UNE - Asociación Española de Normalización. (2018). *Lectura fácil. Pautas y recomendaciones para la elaboración de documentos*. (UNE norm No. 153101:2018 EX).
- UNESCO Institute for Statistics. (2017). *Literacy rates continue to rise from one generation to the next*. https://www.uis.unesco.org/sites/default/files/medias/fichiers/2025/04/fs45-literacy-rates-continue-rise-generation-to-next-en-2017_0.pdf
- Vollenwyder, B., Schneider, A., Krueger, E., & Brühlmann, F. (2018). How to use plain and easy-to-read language for a positive user experience on websites. In K. Miesenberger & G. Kouroupetroglou (Eds.), *Computers helping people with special needs: 16th International Conference, ICCHP 2018* (pp. 514–522). Springer.

- W3C - World Wide Web Consortium. (2021). *Techniques for the Cognitive and Learning Disabilities Accessibility Task Force (COGA)*. <https://w3c.github.io/coga/techniques/index.html>
- W3C - World Wide Web Consortium. (2022). *W3C accessibility standards overview: Accessibility guidelines*. <https://www.w3.org/WAI/standards-guidelines/#guidelines>
- Wengelin, Å. (2015). Mot en evidensbaserad språkvård? En kritisk granskning av några svenska klarspråksråd i ljuset av forskning om läsbarhet och språkbearbetning. *Sakprosa*, 7(2), 17. <https://doi.org/10.5617/sakprosa.983>
- Yaneva, V., Temnikova, I., & Mitkov, R. (2016a). Accessible texts for autism: An eye-tracking study. *ASSETS 2015, the 17th International ACM SIGACCESS Conference of Computer and Accessibility*, 49–57. <https://doi.org/10.1145/2700648.2809852>
- Yaneva, V., Temnikova, I., & Mitkov, R. (2016b). Evaluating the readability of text simplification output for readers with cognitive disabilities. *Proceedings of the Tenth International Conference on Language Resources and Evaluation (LREC'16)*, 293–299. <https://aclanthology.org/L16-1045/>

CHAPTER 3



3. Article 2

Visual support in Easy Language: the impact of images on comprehension, perceived difficulty, and eye movements

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Abstract

Easy Language presents information in a simplified way and benefits people that have difficulty understanding standard language. The present study evaluates the effects of visual support inclusion, as it is a recurring recommendation in Easy Language guidelines. We examined 52 adults (23 men and 29 women; mean age of 39.9; 26 with intellectual disability [ID], 26 neurotypical) in a mixed design study. They read Easy Language texts that presented either no visual support, photographs, or illustrations. Their eye movements were recorded, and they answered comprehension, text difficulty and style preference questions.

The inclusion of visual support had no effects on comprehension, nor did the type of visual support (photographs/illustrations). The group (ID/neurotypical) and the type of visual support also showed no effects on the perceived difficulty of the text. Neurotypical participants showed a preference for illustrations. Photographs may be more difficult to interpret than illustrations due to longer fixations and shorter saccades in both groups. The group with ID showed more and longer fixations, especially on text and whitespace, while the neurotypical group tended to explore the image more.

Results prompt a discussion on the potential improvements of Easy Language guidelines and highlight the need for similar empirical studies in the area.

Keywords

Easy Language, visual support, intellectual disability, comprehension, eye tracking

3.1. Introduction

Working towards accessible communication means aiming for information to be available to everyone in a way that it is “accurate, clear, direct, precise and easy to understand” (Perego, 2020, p. 21). Everyone can benefit from making standard communication more accessible. In that regard, one could opt to use Plain Language (less-simplified variant of easy-to-understand languages) or Easy Language (more-simplified) (Matamala, 2022) to convey information in a clearer way.

Easy Language (EL) is a “language variety in which a set of recommendations regarding wording, structure, design and evaluation are applied to make information accessible to people with reading comprehension difficulties for any reason”, as stated in the ISO standard dedicated to it (ISO, 2023b, p. 2). If the standardised recommendations are followed and applied, the resulting EL text should deviate from standard use with linguistic elements related to content, vocabulary, and structure (Nomura et al., 2010; Bernabé, 2020; Lindholm and Vanhatalo, 2021), and with graphic elements, such as visual support, design, or layout (Nomura et al., 2010).

The present study, as outlined in § 3.2, investigates the effects of incorporating visual support in texts, in line with what is recommended in EL guidelines. First, the theoretical foundations and previous research on which this study builds will be reviewed (§ 3.1.1–3.1.3). We then provide a detailed explanation of the study itself, including its objectives (§ 3.2) and methodology (§ 3.3). The findings are presented in § 3.4, followed by a discussion in § 3.5. Finally, the paper concludes with a summary of the main results and a reflection on its limitations.

3.1.1. The use of images in text

- *The multimedia principle*

Cognitive psychology has shown that mental imagery, concreteness, and verbal association play an important role in supporting learning across different domains (Clark & Paivio, 1991). Building on that foundation, Cognitive Load Theory (Sweller et al., 1998) argues that working memory has a limited capacity and operates through partially independent systems for processing verbal/auditory information and visual/spatial material, whereas long-term memory is essentially unlimited and stores structured knowledge that can become increasingly automated.

Mayer's Cognitive Theory of Multimedia Learning (Mayer, 2014) integrates these perspectives, proposing that learners gain more from words and pictures presented together than from words alone. Cognitive Theory of Multimedia Learning is based on three assumptions: (1) visual and auditory information are processed through separate channels (drawing on dual-coding theory), (2) each channel has limited capacity (consistent with Cognitive Load Theory), and (3) learning is an active process of selecting, organizing, and integrating new information with prior knowledge. The theory also outlines twelve design principles, including the multimedia principle itself, which emphasizes the use of both verbal (text or narration) and visual (images, animations, or video) representations to promote deeper understanding by engaging multiple processing channels.

Based on this theory, empirical research has demonstrated that combining text with images generally leads to more effective learning than relying on text alone or pictures alone, a phenomenon often referred to as the multimedia principle (Anglin & Cunningham, 2004; Mayer, 2014; Butcher, 2014). However, not all images are equally beneficial. Research shows that while relevant visuals can significantly enhance comprehension, decorative or tangential images may have little effect or even hinder learning. For instance, Sung and Mayer (2012) found that graphics often increased learners' enjoyment of online lessons but did not consistently improve understanding, highlighting the potentially seductive effect of irrelevant visuals. Similar findings are reported in Levie and Lentz (1982), Guo

et al. (2020), and Beymer et al. (2007). A more detailed discussion of empirical studies in this area will be presented in § 3.1.2.

- *Visual support in Easy Language texts*

Visual support is mentioned in some way and has a prominent position in all 23 reviewed EL guidelines in González-Sordé and Matamala (2023). Photographs, illustrations, and symbols may accompany text “so that if a reader encounters an unknown word, the visual representation can be used to bootstrap understanding of the text, allowing the reader to obtain the intended meaning” (Rivero-Contreras et al., 2023, p. 2). Nevertheless, while EL guidelines widely promote the use of images, there is not a unanimous guidance on how to put this into practice. In fact, recommendations from different guidelines can be contradictory. For example, guidelines by The Department of Health in the UK (2010) state that images should be placed on the left of the text, while the Social Care Institute for Excellence’s Accessibility Guidelines (2005) defend that they should appear on the right. Since both were published in the UK, differences cannot be linked to cultural preferences.

It is also unclear which type of visual support is best to use. For example, in García-Muñoz (2012, p. 74), it is advised to “explore if the public prefers drawings [or] photography [...] and keep the same style in all the text”. Nevertheless, these guidelines do not explain how to determine what the public prefers. On this, Sutherland and Isherwood (2016, p. 308) determined that “aside from the simplified written text, it is not clear from the current paucity of experimental research whether other aspects of [EL] such as symbols, pictures (line drawings), or photographs necessarily enhance understanding [...]”. Overall, there is little supporting evidence in the literature for the recommendations contained in many [EL] design guidelines.”

Although literature reviews show that there has been a rise of empirical studies on EL (Sutherland and Isherwood, 2016, pp. 297-298; Chinn and Homeyard, 2017, p. 1190; Rivero-Contreras and Saldaña, 2020; Lindholm and Vanhatalo, 2021, p. 15; González-Sordé and Matamala, 2023), it is observably necessary to foster research that evaluates the effectiveness of certain aspects of this language

variety. In the following section, we will explore some findings that the present study premises on.

3.1.2. Research background

Studies collected through the review of recent literature in the area will be presented according to their results: (1) the inclusion of visual support showed positive effects, (2) negative effects or (3) no effects.

Rivero-Contreras et al. (2021; 2023) showed that visual support facilitated sentence processing for adults with and without dyslexia (2021) and with different levels of education (2023). In Schatz et al. (2017), neurotypical participants performed better when the EL version was accompanied by simple illustrations than when it was not. Jones et al. (2007) found that comprehension scores of participants with mild or borderline learning disabilities were significantly higher for the symbolized texts than the non-symbolized ones. Hibbing and Rankin-Erikson (2003) found that the addition of illustrations to text could enhance struggling middle-school readers' comprehension. Levie and Lentz (1982) reviewed 55 experimental studies and found that meaningful, well-integrated visuals consistently improve comprehension and recall compared to text found alone, and that they are especially beneficial to poorer readers. When it comes to studies on people with ID, Wadihah and Fauzi (2021) found that the use of images accompanying text improved reading comprehension for intellectually disabled students. Buell (2017) tested adults with ID and found evidence to demonstrate that images decreased cognitive effort.

Saletta et al. (2019) and Hurtado et al. (2014), on the other hand, found negative and uncertain effects of visual support when it comes to reading comprehension. Saletta et al. (2019) found that adding images in EL texts did not improve reading comprehension for young adults with intellectual or developmental disabilities. They tested three types of images (photographs, line drawings, and control images), all with the same outcome. And Hurtado et al. (2014) demonstrated that under certain conditions, photographs can even increase cognitive effort for readers with ID. Additionally, this last study found no significant differences on comprehension (which was assessed through a questionnaire) between

participants when showed a “picture only” and when showed an EL text with a picture.

Likewise, Dye et al. (2004) observed that the inclusion of photographs in the questionnaire did not affect the ability of adults with learning disabilities to complete it. Yaneva et al. (2016a) also found no effects in comprehension after showing neurotypical adults and participants with autism EL texts both with and without pictures (photographs and icons). Finally, Poncelas and Murphy (2007) declare that the participants with ID did not understand any of the versions (text-based and symbol-based) of the simplified manifesto they showed them.

All said, extensive research confirms that adding relevant visuals to text improves learning (Sung & Mayer, 2012) and comprehension (Levie & Lentz, 1982; Beymer et al., 2007; Guo et al., 2020), whereas decorative images provide little benefit and can even distract readers (Levie & Lentz, 1982; Guo et al., 2020).

As shown, there are not enough studies performed in the area to be able to have conclusive findings regarding what type of images to use, or whether visual support should be considered an essential feature of EL. As stated in Hurtado et al., “the generalised use of text and picture formats for all people with ID in spite of the scant evidence supporting its effectiveness is concerning” (2014, p. 822). The use of eye tracking in EL research is growing (Deilen & Schiffli, 2020; Borghardt et al., 2021), but has still not been used to its full potential.

3.1.3. Monitoring eye movements

Eye tracking measures eye position, eye movement, and pupil size to detect zones in which the user has a particular interest at a specific time (Gonzalez-Sanchez et al., 2017). One of the basic output measures of interest is fixations, which are eye movements that stabilise the retina over a stationary object of interest and indicate that the participant focused their attention on it (Duchowski, 2007, p. 46). For instance, when looking at text, the fixation position indicates which part of the sentence is currently being processed to a certain extent (Borghardt et al., 2021). In that regard, eye movements have been shown to be directly influenced by textual variables (e.g., “increased linguistic complexity leads to increased fixation duration and decreased saccade length” [Borghardt et al., 2021, p. 4])

and provide information on different cognitive processes (e.g., Rayner, 1998; White et al., 2006) (see § 3.3.5). Nevertheless, eye movements alone do not provide the complete picture of text processing and reading comprehension that we aim to build (Boland, 2004). For that reason, it is advised to combine eye-tracking data with other data (Van Gog et al., 2005), as has been done in the present study with comprehension, perceived difficulty, and preference questions.

For years, researchers have been using eye tracking to explore the processing of information in text and images or the integration of information in both elements, with a recurrent focus on education and learning. For example, Hannus and Hyönä (1999) determined that children (10-year-olds of high and low intellectual ability) inspected the illustrations in science textbooks minimally and that learning was mainly driven by the text. Zhao et al. (2014) later found that, although text (rather than a picture) is more likely used to construct mental models in initial coherence-formation processing of text and picture, secondary students seemed to also rely on the picture to answer the question after having had a first contact with the material. Additionally, Krejtz et al. (2016) showed that interactive elements are optimal to spur reading, leading to a more complete visual inspection of the material, rather than static illustrations.

Eye tracking has also already been used to study EL (Denzen et al., 2012; Yaneva et al., 2016a; Rivero-Contreras et al., 2021; Rivero-Contreras et al., 2023), as the tracking of eye movements is a non-invasive method to assess online cognitive skills and processes involved in reading (Rayner et al., 2006; Rayner et al., 2011; Mézière et al., 2023). The German research group “Simply complex – Easy Language” stands out in the use of this technology in EL research (Schiffl, 2020; Deilen, 2020). The findings of Rivero-Contreras et al. (2021) and Yaneva et al. (2016a), which examine visual support through eye-tracking methods, have already been discussed in § 3.1.2.

It is important to bear in mind that opting for this technology for a study on EL can also present some challenges. Participants with ID are among the primary users of EL and require researchers to carefully consider necessary adaptations in the experiment's design and implementation, as well as the associated ethical

constraints (Csákvári & Gyori, 2015; Deilen & Schifffl, 2020; Borghardt et al., 2021). Listed below are some challenges researchers may face when performing eye-tracking tests on users with ID, compiled by Deilen and Schifffl (2020); with comments from the authors on how these were acknowledged or resolved in the present study:

- (1) Participants with ID may not be able to communicate their desires or comprehend given information as easily as neurotypical participants (Csakvari and Gyori, 2015; Deilen & Schifffl, 2020). For this reason, we provided all written information in EL (including all data collection information and consents) and frequently asked the participant if they wanted to carry on with the test or if they had any doubts.
- (2) Participants with ID may find it hard to limit their movement throughout the experiment due to memory or executive control deficits (Deilen & Schifffl, 2020). In our study, we identified that the participants with ID often turned their heads when the researcher started talking. For this reason, we had to frequently remind them to stay still and later review the gaze plots² in search of any issues that might invalidate the recording of eye movements. This led to the rejection of two recordings.

Participants with ID are more prone to present problems of vision or wear thick glasses that interfere with an optimal calibration³ process (Warburg, 2001; Csakvari and Gyori, 2015), an issue that still has no general solution (Deilen & Schifffl, 2020). In our study, we identified that two participants with ID wore thick glasses that deformed their eyes, and another user with ID squinted their eyes while reading. For this reason, we asked participants if they had any problems of vision we should acknowledge at the beginning of the test (3 users with ID said they did), and we searched for any issues in the gaze plots once the test was finished. This issue led to the rejection of two additional recordings.

² Gaze plots are a way of reviewing the participant's eye movements after the recording has stopped. Gaze plots show the location, order, and time spent looking at locations on the stimulus, which in our study was a page including text and an image or text only.

³ Calibration is the process by which the characteristics of a participant's eyes are estimated as the basis for a fully customised and accurate calculation of the gaze points (where the participant is looking). The participant is presented with targets, and the tracker collects data about the participant's eyes and their gaze to that target.

3.2. Aims of the study

As argued in the previous section, the limited research on the impact of visual support on EL comprehension does not help determine whether visual support is beneficial for a user facing reading or comprehension barriers. In fact, many of the reviewed studies showed no beneficial effects of visual support for the reader (e.g., Dye et al., 2004; Poncelas and Murphy, 2007; Yaneva et al., 2016a), as did two studies that resembled the present one in terms of aims and method (Hurtado et al., 2014; Saletta et al., 2019).

The contribution of the present paper is threefold. First, we examine how the type of visual support used (illustrations, photographs, or no image) affects content comprehension, perceived difficulty, and preference. Second, we monitor the reading behaviour with the means of eye tracking. Finally, we study the effects of visual support in EL comprehension both on a group of people with ID, and on a group of neurotypical participants.

Our hypotheses are:

- *H1.* Visual support of any type has significant effects on text comprehension for readers with ID.

Easy Language guidelines (García-Muñoz, 2012; Nomura et al., 2010; ISO, 2023b; UNE, 2021) suggest that appropriate visual support facilitates text comprehension. As per previous research (§ 1.2), a significant difference is expected for individuals with ID (Wadihah and Fauzi, 2021; Buell, 2017).

- *H2.* People with and without ID explore the page differently.

Authors expect the group with ID to make more and longer fixations; thus, also a longer fixation time. This group is also expected to perform shorter saccades (see § 3.5 for a discussion on eye-tracking metrics and how they can reveal how readers engage with and process textual information).

Finally, a part of our study is exploratory due to the lack of previous consistent findings. For this reason, we also formulate two open research questions:

- *Q1.* How does the presence and type of visual support influence perceived level of text difficulty?
- *Q2.* How does the presence and type of visual support influence the way readers explore the page?

3.3. Method

We designed an eye-tracking study combined with three questionnaires on comprehension, perceived difficulty, and preference of visual support. This is a mixed design study which presents an independent variable with three levels: (1) no visual support, (2) illustration and (3) photograph; and the two groups of participants (ID / neurotypical) as the between-subjects factor.

Before the study, we performed a pilot test with six participants (medium age of 28.5; five women and one man). These participants had no ID or reading difficulties and followed the full procedure of the test. This experience allowed the researchers to perform slight changes to the design based on their observation and the analysis of the results. We will now expose in detail the final test design and method.

3.3.1. Participants

Initially, we aimed for a total of 60 participants, 30 in each group, but some of the users with ID had to be discarded due to eye-tracking calibration or data collection problems (see § 3.1.3). The final sample includes 52 participants (23 men and 29 women; mean age of 39.9 [SD = 14.5]). 26 of them had ID, and 26 did not. Participants with ID (12 men and 14 women; mean age of 44.4 [SD = 13.2]) were recruited by contacting two local non-profit organisations that work on watching over the quality of life and giving jobs to people with intellectual or developmental disabilities (Som — Fundació, Taller Jeroni de Moragas). Neurotypical participants (11 men and 15 women; mean age of 34.8 [SD = 11.5]) were recruited through word-of-mouth promoting. In all cases, participation was strictly voluntary, and no participant was reimbursed.

All participants were native speakers of Catalan with normal or corrected vision (the recordings of two out of the three participants that declared having eye problems had to be discarded). Participants were not asked to provide a formal diagnosis of ID. Since having ID was already a requirement to receive support from the collaborating foundations, this was considered sufficient to meet the diagnostic criterion. To ensure consistency within the group, two screening tests were administered, confirming that none of the participants showed intelligence levels or reading comprehension skills that differed significantly from the rest. Refer to § 3.4.1 for the participants' results on the screening tests on (1) reading comprehension and (2) intelligence and abstract reasoning.

3.3.2. Materials

3.3.2.1. Evaluation instruments

We used two screening tests, one that assessed reading comprehension (Test de lectura comprensiva [TLC]) (Comes, 1990) and one that evaluated intelligence and abstract reasoning (Raven's Progressive Matrices [RPM]) (Raven, 1998), to collect data on these aspects for each participant and group. TLC has been proven to be a fully valid initial assessment of text comprehension skills in readers with varying proficiency levels (Ferrerres et al., 2009; Baez-Naghelli et al., 2015; Del Cueto et al., 2019). Similarly, RPM has demonstrated strong validity and reliability and is widely regarded as an appropriate measure of nonverbal and general intelligence (Kazem et al., 2007; Queiroz-Garcia et al., 2021).

Screening tests were conducted prior to the eye-tracking assessment and took approximately one hour per participant. The TLC and RPM tests were administered in group sessions, where participants completed the assessments individually and autonomously, all within the same room. Responses were recorded on paper, and participants could request assistance from the researcher if needed. In contrast, questions assessing comprehension, perceived difficulty, and preference were administered on a separate day during individual one-on-one sessions with the researcher, held in the eye-tracker room. During these sessions, participants provided their responses orally.

All **comprehension questions** were of a similar low difficulty and asked on explicit information in the text (Fajardo et al., 2014) and on elements that appeared or were related to the image. See an example:

Què envolta el poble de Rupit?
A) Un pantà. B) Una riera. C) Salts d'aigua.

What is the town of Rupit surrounded by?
 A) A swamp. B) A stream. C) Waterfalls.

Perceived difficulty was assessed through a Likert scale (Yaneva et al., 2016b) after each page, which presented options from 1 to 4 to avoid a neutral answer. This measure reflects the subjective impressions of the participants on text difficulty.

Has trobat aquest text difícil de llegir?

<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>
<i>Gens, ha estat fàcil.</i>	<i>No gaire.</i>	<i>M'ha costat una mica.</i>	<i>M'ha costat molt.</i>

Did you find the text difficult to read?
 1) Not at all, it was easy. 2) Not very. 3) It was a little difficult. 4) It was very difficult.

Finally, at the end of the experiment, participants were asked an open question on their **preference** in terms of visual support (“would you rather read plain text, a text with a photograph or a text with an illustration?”).

3.3.2.2. *Stimuli*

Stimuli shown in the experiment were based on an EL brochure-style publication on tourist attractions of the Catalan towns of Rupit and Pruit (Vidal, 2021). The texts were in EL, included no low-frequency words and had low text complexity. Researchers chose this brochure due to its adequacy to the purpose of the test: images in it share the same representative function (Carney & Levin, 2002), which facilitated the task of formulating adequate and homogeneous comprehension questions. The content in the original brochure was complemented with other information about the described locations from different touristy guides and it was slightly adapted so all the pages shown (6 in total) (1) had the same layout,

(2) had about the same length (between 65 and 70 words) and (3) presented a similar number of ideas. The Fernández Huerta readability index⁴ for all six texts was between 90.12 – 102.70, in which results over 90 are labelled as “very easy” for adult readers. Sentences were presented in black 14-point Arial font on a white background, and paragraphs were double-spaced.

Each of the six texts had three different presentations, corresponding to the three levels of the independent variable: no visual support, photograph and illustration. All participants read the same six texts in the same order, but with different conditions regarding visual support. This was achieved through a Latin square array. For the sake of minimising the possible influence of extraneous factors, a set of stimuli was arbitrarily assigned to each participant with only one criterion: making sure that in the end, the same number of participants would have read through each set of stimuli.

When it comes to images, stimuli presented (1) the original photographs used in the brochure and (2) illustration-style copies of them, created with digital illustration tools. All images were representational (Carney & Levin, 2002) and relevant to the content in the text. Pages had a size of 1230 x 819. On the pages with visual support, a 520 x 390 (4:3) the image appeared in the top left corner, as this is their usual placement in Spanish and Catalan EL texts (Plena Inclusión, 2021). Photographs and illustrations were in colour and of high resolution. The right half of the page showed the text, which, as stated before, was always between 65 and 70 words in length and were presented in 10 lines. On pages where no visual support was provided, the text was centred on the screen. See Table 6 for an example.

⁴ Adaptation of the Flesch–Kincaid test to assess Spanish texts; also used for Catalan in the absence of a specific index.

Table 6 *Example of different versions of a stimulus*

1)  Les rutes guiades A la primavera i a l'estiu, Rupit organitza diverses rutes guiades per conèixer el municipi. Una de les rutes porta fins al salt de Sallent. La ruta passa pels boscos del voltant del poble. Pel camí, podem veure antics molins abandonats, gorgs, salts d'aigua i fonts. Al final de la ruta, arribem al salt del Sallent. Aquest lloc és on acaba la riera de Rupit.	2)  Les rutes guiades A la primavera i a l'estiu, Rupit organitza diverses rutes guiades per conèixer el municipi. Una de les rutes porta fins al salt de Sallent. La ruta passa pels boscos del voltant del poble. Pel camí, podem veure antics molins abandonats, gorgs, salts d'aigua i fonts. Al final de la ruta, arribem al salt del Sallent. Aquest lloc és on acaba la riera de Rupit.
3) Les rutes guiades A la primavera i a l'estiu, Rupit organitza diverses rutes guiades per conèixer el municipi. Una de les rutes porta fins al salt de Sallent. La ruta passa pels boscos del voltant del poble. Pel camí, podem veure antics molins abandonats, gorgs, salts d'aigua i fonts. Al final de la ruta, arribem al salt del Sallent. Aquest lloc és on acaba la riera de Rupit.	<i>(Direct translation)</i> Guided routes In spring and summer, Rupit organises several guided tours for people to get to know the town. One of the routes leads to the Sallent jump. The route passes through the woods around the village. Along the way, we can see old, abandoned mills, gorges, waterfalls, and fountains. At the end of the route, we arrive at the Sallent jump. This place is where the Rupit stream ends.

It is important to consider that a group of people belonging to the EL target group validated both the original text and the supporting images and considered them adequate for an EL adaptation before publication. Validation with the target group is strongly recommended to publish under the “Easy Language” category. At Plena Inclusión, an advocacy movement that fights for the rights of people with intellectual and developmental disabilities in Spain, they validate images by asking the participants “what do you see in the image?” and “how does the image relate to the text?”. If an issue arises, they ask the follow-up questions “how

should the image be to explain this topic well?” and “what do we do to ensure the image is properly related to the text?” (Plena Inclusión, 2021).

3.3.3. Apparatus

Eye movements were recorded with a Tobii T60 (sampling rate of 60 Hz) in a desk monitor setup. Head movements were not restrained, although participants were given instructions to stay still while performing the test (as discussed in § 3.1.3, this was hard for some participants with ID). Viewing was binocular, and the movements of both eyes were recorded. Participants were seated approximately 60 cm away from the 43 cm display size monitor with a screen resolution of 1280 x 1024 pixels. The Tobii T60 eye tracker and the stimuli were controlled through a laptop. A different laptop was used to record the participant's answers and comments in a digital document.

3.3.4. Procedure

Participants first signed the written informed consent and demographics form. They then performed the TLC and RPM tests in a group session. Later, they proceeded with the eye-tracking experiment in a separate room, with the only company of the observing researcher. For participants with ID, the two sessions were conducted on different days to reduce the risk of fatigue (Deilen & Schiffli, 2020) and to allow extra time for explanation and assistance. In contrast, the sessions for neurotypical participants were conducted on the same day. The eye-tracking test lasted around 40 minutes and for each participant we retrieved a maximum of 25 minutes of recorded eye movements (around 4 minutes per page of stimuli). The recording was paused while the participants answered the comprehension, perceived difficulty, and preference questions, which explains the difference in these times.

The researcher always explained the procedure and calibrated the eye tracker before starting this last test. Then the participant read the first page of stimuli describing a tourist attraction on Rupit and Pruit and answered two multiple-answer comprehension questions orally (see the stimuli explained in § 3.3.2.2). The researcher switched to the next screen once the participant told them they had finished reading. They could read the text again if they needed to once the questions were asked, since the aim was not to measure short-term memory or

recall. As mentioned, the eye tracker only recorded eye movements performed while the participants were reading the text prior to the posing of the question. Participants were also asked their perceived difficulty of the text, which they also answered orally. This process was repeated until readers had read through all six pages of the stimuli.

The study protocol (CEEAH CA40) was approved by the Research Ethics Committee of the Universitat Autònoma de Barcelona in February 2022.

3.3.5. Eye-tracking measures

Eye-tracking measures can be categorized as local or global. Global measures are aggregated over broader regions, such as sentences or multiple sentences, and provide information on overall reading behaviour, including individual differences between groups with varying reading skills (Mézière et al., 2023, p. 428). For example, Rayner et al. (2006) showed that reading more difficult texts results in longer average fixation durations. Similarly, Reichle et al. (2013) and Blythe and Joseph (2012) found that less skilled readers tend to make more and longer fixations than skilled readers, with longer fixations reflecting prolonged processing times or processing difficulties.

Recent studies have also demonstrated that global eye-tracking measures can predict reading comprehension. Southwell et al. (2020) had participants read long passages silently and then answer multiple-choice questions. They found that eye movements predicted comprehension scores with correlations ranging from 0.35 to 0.40, with more fixations and shorter fixation durations being associated with better performance. D'Mello et al. (2020) reported similar findings, further highlighting the predictive value of global measures.

In contrast, local measures provide more detailed insights into the specific cognitive processes affected by reading ability (Mézière et al., 2023). However, because most research has emphasized global measures, it remains unclear whether local eye movements can reliably predict reading comprehension accuracy.

Given this background, the present study will focus on the global measures listed below, as they have been more consistently linked to reading comprehension

outcomes and offer a robust starting point for examining individual differences in reading behaviour.

1. Fixation count: the sum of the number of fixations (defined in § 3.1.3) in an area (Clifton et al., 2007; Duchowski, 2007).

Fixation count is an indicator of visual processing of that area or stimuli (e.g., the image, the text) (Krejtz et al., 2016). More (and shorter) fixations may reflect attentive reading (Faber et al., 2018; Southwell et al., 2020) as the number of fixations tend to increase when the text is difficult (Rayner et al., 2006) and more fixations are shown to be linked to help memory performance (Fehlmann et al., 2020). Orduna-Hospital et al. (2023) showed that people with ID tended to exhibit a higher number of fixations.

2. Average fixation duration: the average duration of a single fixation (White et al., 2022).

Longer fixations are associated with reading difficulty and poor readers tend to exhibit them (Rayner et al., 2006) while shorter fixations are associated with better comprehension (Copeland & Gedeon, 2013; Southwell et al., 2020). The slower the cognitive processing, the longer the fixation (He et al., 2015). Studies suggest that unskilled readers (such as readers with ID or learning disabilities) will have longer fixation duration (Everatt & Underwood, 1994; Rivero-Contreras, 2023).

3. Total fixation time: the sum of all single fixations on a certain area (Clifton et al., 2007; Duchowski, 2007).

It reflects encoding processes (Child et al., 2020) and is an indicator of lexical access and integration (Morton, 1969; Whaley, 1978; Inhoff and Rayner, 1986). A longer total fixation time is considered an indicator of a deeper and more effortful processing of visual information (Just and Carpenter, 1980; Krejtz et al., 2016).

4. Average saccade amplitude: the average distance travelled by the eye between two fixation points (Paeye and Madelain, 2011, p. 149).

A pattern of long saccade indicates greater exploration (Wang and Sparks, 2016). Poor readers tend to exhibit shorter saccades (Rayner et al., 2006). Orduna-Hospital et al. (2023) showed that people with ID exhibited a higher number of saccades. The neurotypical grup showed faster saccades and with a higher amplitude than participants with ID.

Finally, areas of interest (AOIs) are an analytical tool that allows for calculating these measures and receiving quantitative, relevant metrics. Put simply, AOIs are the boundaries drawn around an area of each page of stimuli that fall into different categories. In the present study, researchers determined three types of AOIs: image, text and whitespace (see Fig. 6).

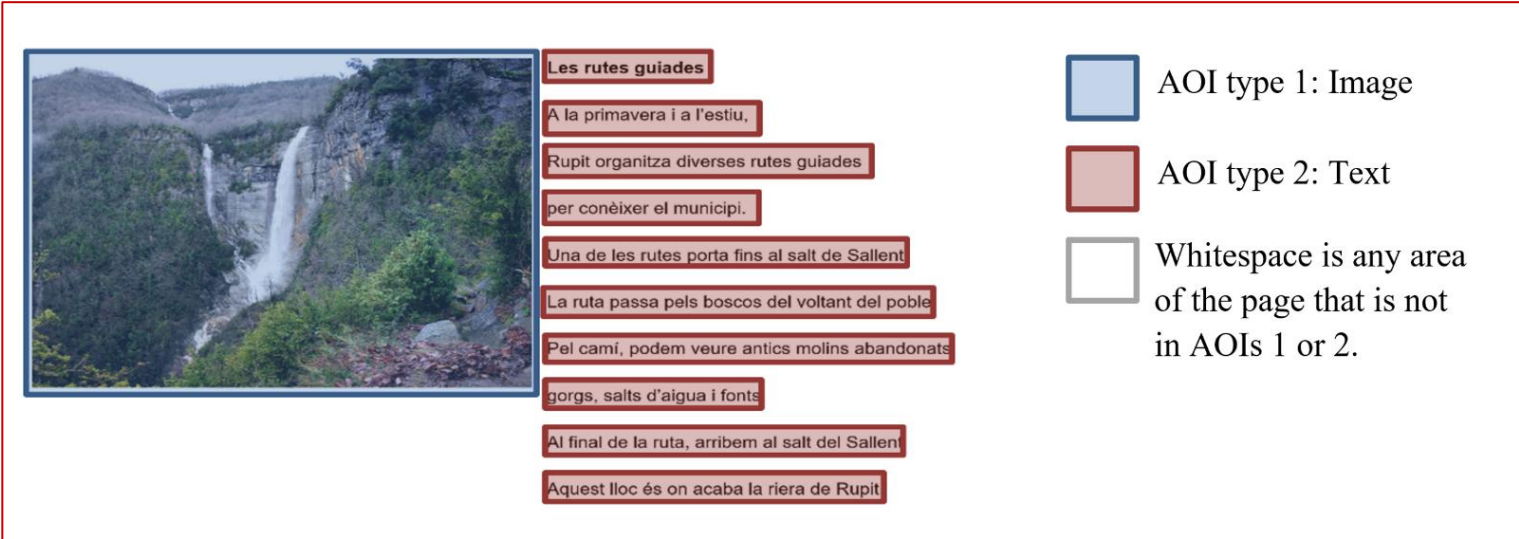


Figure 6 *Groups of AOIs in a page of stimuli*

3.4. Results

To examine differences in the screening tests, comprehension, perceived difficulty, and style preference we have run an analogous 3-way analysis of variance and a series of independent t-tests. These results, as well as the ones from the participant’s eye movements, will be presented in this section. We used R for the statistical analysis. Results will be discussed in § 3.5.

3.4.1. Screening tests

There were no intra-group outliers in the results from the screening tests. Participants with ID got on average 33.7% of the answers correct in the TLC test on reading comprehension ($SE = 0.829$), whereas the neurotypical group scored 85.8% ($SE = 0.443$). The difference was significant, $t(52) = 17.198$, $p < .001$.

In regard to the RPM test on abstract reasoning and intelligence, the ID group got 62.9% of the questions right ($SE = 1.604$), whereas the neurotypical group obtained 95.1% of accurate answers ($SE = 0.374$). The difference was also significant ($t(52) = 6.54$, $p < .001$).

Table 7 *T-Test results from the screening tests*

	T-Test scores (between group with ID and neurotypical)
TLC (reading comprehension)	$(t(52) = -17,198, p < .001)$
RPM (intelligence and abstract reasoning)	$(t(52) = -6,54, p < .001)$

Table 8 *Accuracy results from the screening tests*

	TLC score (reading comprehension)	RPM score (intelligence and abstract reasoning)
ID	33.7%	62.9%
Neurotypical	85.8%	95.1%

3.4.2. Comprehension, perceived difficulty, and preference questions

We performed basic percentage and statistical calculus from the participants' answers to the comprehension, perceived difficulty, and preference questions, and a Mann-Whitney U test to compare the tendencies for both groups. Both the comprehension and perceived difficulty questions showed relevant between-group differences. The question on the page layout preference, on the other hand, showed no between-group relevance.

Table 9 *T-Test scores for comprehension, perceived difficulty, and preference questions*

	T-Test scores (between group with ID and neurotypical)
Comprehension questions	($t(624) = -12,967, p < .001$)
Perceived difficulty	($t(312) = 6,16, p < .001$)
Layout preference	($t(48) = 0, p = 1$)

Regarding the perceived difficulty of the texts, interestingly the group with ID gave a mean of 1.69 out of 4 on difficulty for all three types of visual support, showing their rating was independent of the variable. The neurotypical group rated 1.23 out of 4 in difficulty for those texts accompanied by photographs ($p = .002$) or illustrations ($p < .001$), and a slightly lower rate of 1.07 on average to those with no visual support ($p = .002$) and showing a relevant difference between groups for all three types of visual support ($p < .001$).

Table 10 *Perceived difficulty out of 4*

	ID		Neurotypical	
	Mean	Median	Mean	Median
Photograph	1.69	1	1.23	1
Illustration	1.69	1	1.23	1
No visual support	1.69	1	1.07	1

Finally, when analysing the answers to the comprehension questions, we can see a relevant between-group of difference and a non-relevant within-group difference among participants. The inclusion of visual support is non-relevant for any of the groups (ID: $p = .34$; neurotypical: $p = 1$). Neither does the type of visual support show effects in the accuracy of the participants (ID: $p = 1$; neurotypical: $p = .48$), while the between-group difference is shown to be relevant ($p < .001$). The participants with ID answered on average 55.4% of the questions correctly, against the 95.1% of the neurotypical group. These results are portrayed in Table 11 below.

Table 11 *Correct answers to comprehension questions out of 104*

	ID		Neurotypical	
	Correct answers	% in group	Correct answers	% in group
Photograph	58	55.7	98	94.2
Illustration	59	56.7	100	96.1
No visual support	56	53.8	99	95.1

Finally, most participants (53.8%) showed no clear preference when it came to the type of visual support in the text. Among those who did show a preference, most participants preferred the use of pictures (34.6% of ID, 26.9% of neurotypical). While the preference of no visual support is anecdotal and very low for both groups (only one participant and 3.8% in both groups), the between-group difference is only bigger when it comes to the preference of illustrations: only one participant (3.8%) chose this typology in the group with ID, versus the 19.2% of participants in the neurotypical group. Nevertheless, between-group differences show no relevance ($p = 1$). These results are displayed in Table 12.

Table 12 *Visual support preference*

	ID		Neurotypical	
	Participants	% of group	Participants	% of group
Photograph	9	34.6	7	26.9
Illustration	1	3.8	5	19.2
No visual support	1	3.8	1	3.8
No preference	15	57.6	13	50

3.4.3. Differences in eye movements

To verify whether there were differences in reading depending on the characteristics of the stimuli and the participant groups, as per our initial hypotheses, we ran a 3-way mixed design ANOVA with group (neurotypical vs. ID) as the between-subjects variable, areas of the page (whitespace vs. image

vs. text), and experimental condition (photograph vs. illustration) as within-subjects independent variables.

Before conducting statistical tests, outlying fixations in terms of duration were identified using the standard $\pm 1.58 \text{ IQR}/\sqrt{n}$ criterion (Chambers, 1983). Fixations exceeding 1032 ms were classified as outliers, accounting for 11.79% of cases. Prior to analysis, these outliers were replaced with the largest non-outlying fixation duration (1031 ms), following a procedure known as winterization (Kuwak & Kim, 2017). A similar approach was applied to outliers in saccadic amplitude (11.17%).

- *Fixation count*

The analysis on the fixation count yielded a significant difference between groups, individuals with ID exhibited a higher number of fixations ($M = 10.82$, $SE = .956$) than the cognitively neurotypical ($M = 5.63$, $SE = .996$), ($F(1, 46) < .001$, $p < .001$, $\eta^2 = .105$).

The difference in the number of fixations for different types of images was not significant ($F(1, 46) = .2$, $p = .660$, $\eta^2 < .001$), nor was the interaction between group and type of image ($F(1, 46) = .07$, $p = .793$, $\eta^2 < .001$), showing that both groups had a similar number of fixations on the two types of images (illustrations and photographs).

The analysis also revealed significant differences in fixation count between areas of the page, ($F(1.23, 56.54) = 27.32$, $p < .001$, $\eta^2 = .213$), see Fig. 7. Post hoc comparisons indicated that both groups had the highest number of fixations on whitespace ($M = 12.89$, $SE = 1.65$), followed by text ($M = 8.51$, $SE = .59$), and image ($M = 3.25$, $SE = .231$).

Interestingly, the interaction effect between participant group and areas of the page was significant, ($F(1.23, 56.54) = .007$, $p = .007$, $\eta^2 = .065$), see Fig. 7. Post hoc comparisons indicated that participants with ID had a significantly higher number of fixations on whitespace ($M = 18.17$, $SE = 2.286$) than the neurotypical participants ($M = 7.62$, $SE = 2.383$), ($t(46) = 3.195$, $p < .001$). They also looked significantly more at text ($M = 10.55$, $SE = .827$) than the neurotypical group ($M = 6.48$, $SE = .862$), ($t(46) = 3.413$, $p = .001$). The difference between

groups was smallest for the image, yet still significant ($t(46) = 2.050$, $p = .046$). Participants with ID exhibited more fixations ($M = 3.73$, $SE = .319$) than the neurotypical participants ($M = 2.78$, $SE = .333$).

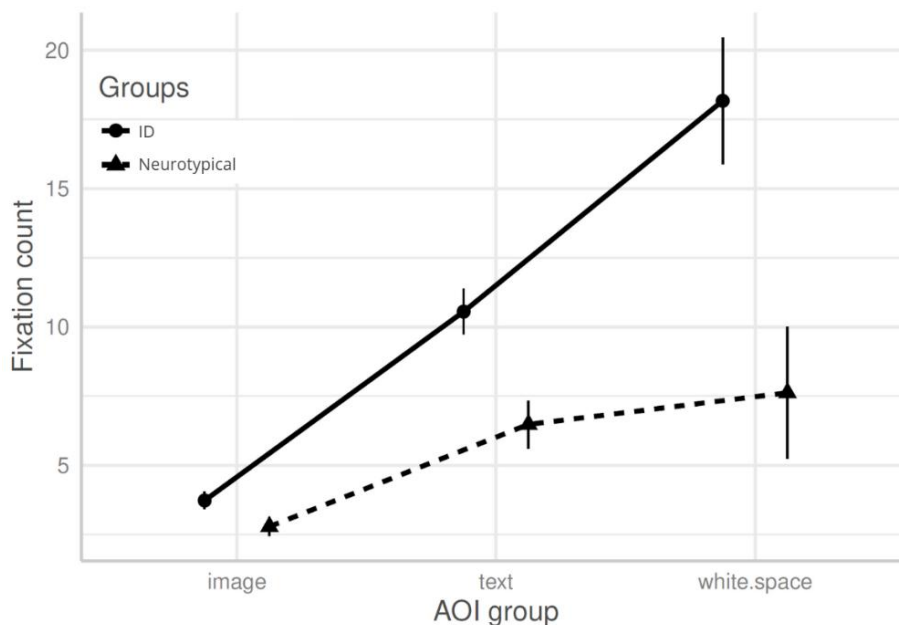


Figure 7 *The interaction between participant group and AOI group on fixation count*

- *Average fixation duration*

Participants with ID also showed significantly longer average fixations ($M = 308$, $SE = 11.3$) than the users in the neurotypical group ($M = 266$, $SE = 11.8$), ($F(1, 46) = .006$, $p = .012$, $\eta^2 = .066$).

The analysis revealed a significant interaction effect between the group and the area of the page ($F(1.44, 66.24) < .001$, $p < .001$), see Fig. 8. Post hoc comparisons suggested that the longest fixations of the group with ID were on the text ($M = 358$, $SE = 14.4$), while their fixations on whitespace ($M = 293$, $SE = 15.1$) and the image ($M = 274$, $SE = 12.7$) were much shorter. Interestingly, neurotypical users show the longest fixations on images ($M = 291$, $SE = 13.2$), while their fixations on text ($M = 261$, $SE = 15.1$) and white space ($M = 245$, $SE = 15.8$) are shorter ($F(1.44, 66.24) < .001$, $p < .001$). Interestingly, the relevance of differences on average fixation duration between areas of the page for one group is opposed to the other: for the group with ID, we only see a relevant

difference between image and text ($p < .001$) and image and whitespace ($p < .001$), but not between image and whitespace ($p = .5$). On the contrary, the neurotypical group only show relevant differences in their average fixation duration between image and whitespace ($p = .02$), but not for the other two pairs of AOIs (image-text ($p = .2$), text-whitespace ($p = .22$)).

With this, there is a highly significant difference between the duration of the fixations on the text ($t(46) = 4.635$, $p < .001$) and on whitespace ($t(46) = 2.181$, $p = .034$) between the two groups, being much higher in both cases for the participants with ID. This difference is not observed for images ($t(46) = -.905$, $p = .37$).

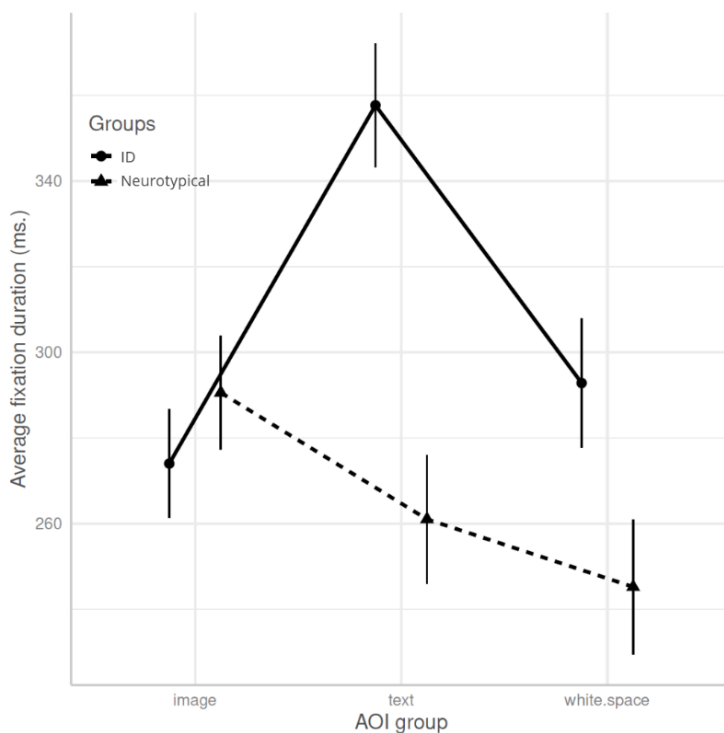


Figure 8 Interaction between participant group and AOI group on average fix. duration

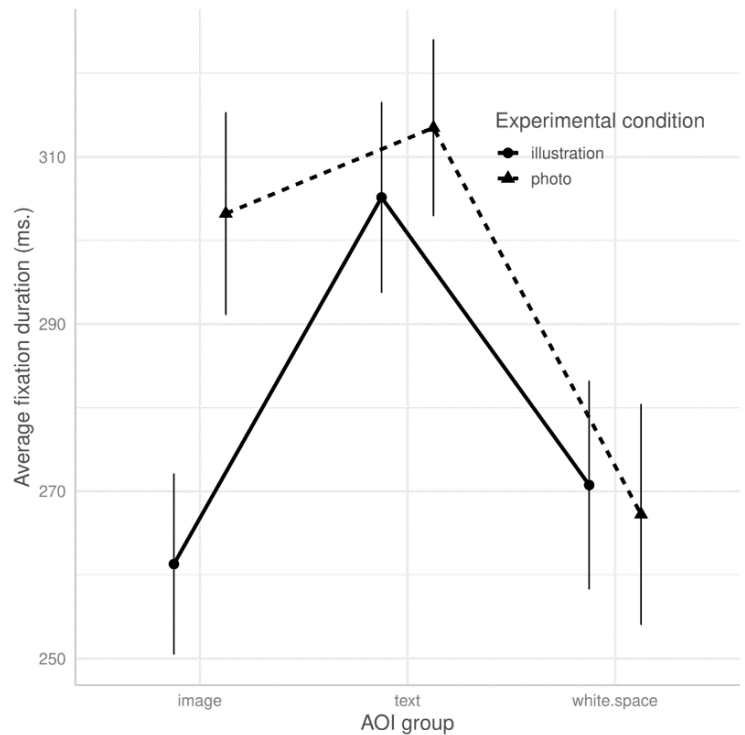


Figure 9 Interaction between experimental condition and AOI group on average fix. duration

There was also a significant interaction between type of image and page area, ($F(1.66, 76.42) = .039$, $p = .031$), see Fig. 3. Both groups performed longer fixations on the image when it was a photograph ($M = 303$, $SE = 12.1$) than when it was an illustration ($M = 261$, $SE = 10.8$), ($t(46) = 3.035$, $p = .039$), whereas type of image did not affect the average fixation durations on text ($t(46) = 1.215$, $p = .231$) and white space ($t(46) = .262$, $p = .795$).

- *Total fixation time*

The difference in the total fixation time (tft) depending on the image type was not significant ($F(1, 46) = .15, p = .696, \eta^2 = < .001$). However, we observed a significant main effect of the page areas. Both groups showed a significantly higher tft on whitespace ($M = 3626, SE = 496$) and text ($M = 2745, SE = 253$) than on images ($M = 914, SE = 70$), ($F(1.44, 66.31) < .001, p < .001, \eta^2 = .189$). See Fig. 10.

The participants with ID fixated on whitespace for longer ($M = 5406, SE = 686$) than the neurotypical group ($M = 1847, SE = 715$), ($t(46) = 3.592, p < .001$). The same happens with text, where the group with ID fixated for more time ($M = 3818, SE = 350$) than the neurotypical group ($M = 1673, SE = 365$), ($t(46) = 4.243, p < .001$). However, there was not a significant effect on total fixation time of the interaction between image type and participant group ($F(1, 46) = .04, p = .846, \eta^2 < .001$), and the two groups did not differ significantly in the time they looked at the images ($t(46) = 1.292, p = .203$).

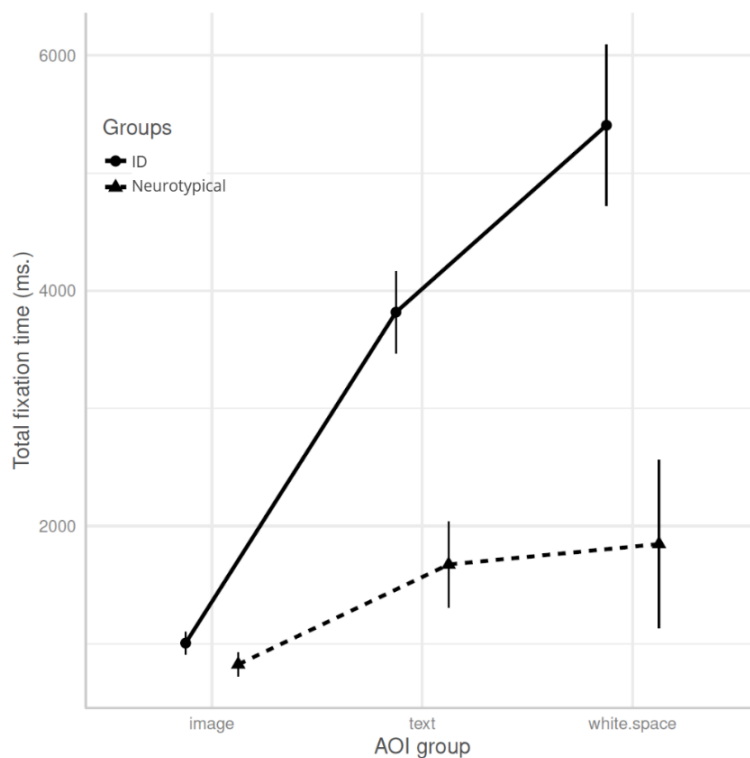


Figure 10 *The interaction between participant group and AOI group on total fixation time*

- *Saccadic amplitude*

Regarding saccadic amplitude, we observed a significant interaction effect between group and page area, ($F(1.29, 59.35) = .04, p = .022, \eta^2 = .044$). We see a significant between-group difference in the saccadic amplitude on image, with smaller saccades for the group with ID ($M = 5.77, SE = .692$) than for the neurotypical group ($M = 8.45, SE = .722$), ($t(46) = 2.680, p = .01$). See Fig. 11.

Analogous comparisons for text ($t(46) = .239, p = .8121$) and white space ($t(46) = -.243, p = .8089$) were not significant. In addition, participants performed smaller saccades on the photographs ($M = 4.72, SE = .244$) than on the illustrations ($M = 5.48, SE = .244$), ($F(1, 46) = 6.47, p = .014, \eta^2 = .016$). This effect of image type was quantified by group ($F(1, 46) = .372, p = .06, \eta^2 = .016$). The neurotypical group showed significantly bigger saccades for illustrations ($M = 6.22, SE = .353$) than photographs ($M = 4.88, SE = .353$), ($t(46) = 3.100, p = .003$), whereas the group with ID showed small saccades for both types of images, with non-relevant differences ($t(46) = .444, p = .6591$). These results also show a significant between-group difference in saccadic amplitude for illustrations, with the neurotypical participants performing significantly bigger saccades ($M = 6.22, SE = .353$) than the participants with ID ($M = 4.74, SE = .338$), ($t(46) = 3.030, p = .004$). This difference was not significant for saccades on photographs, which were small for both groups ($t(46) = .5$). See Fig. 12.

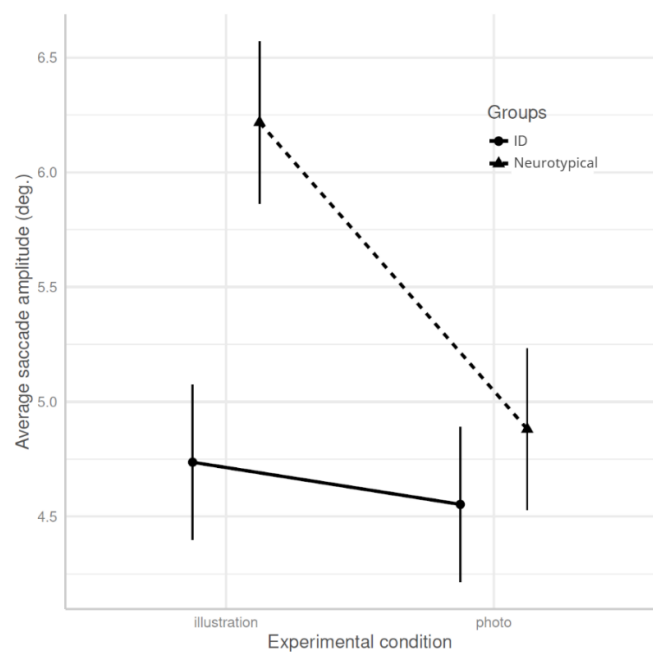
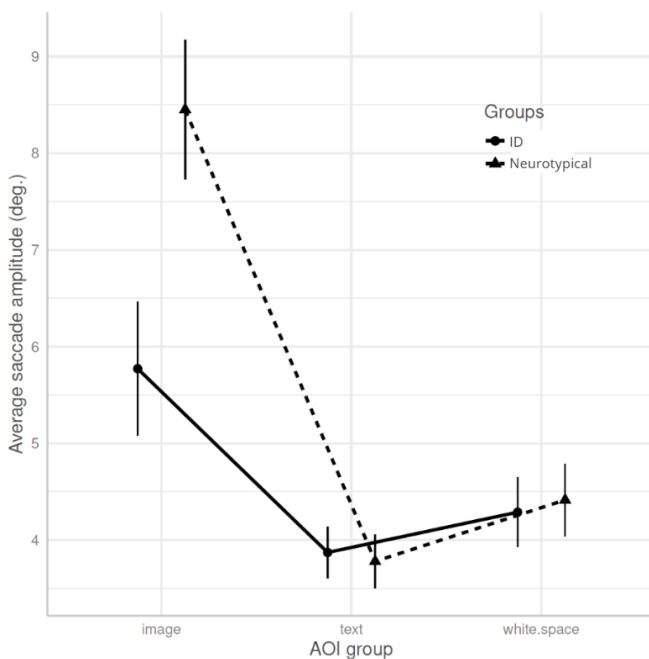


Figure 11 Interaction between participant group and AOI group on average saccade amplitude

Figure 12 Interaction between participant group and image type on average saccade amplitude

3.5. Discussion

We will first review the hypotheses and contrast them with the results of our study (findings reject H1 and confirm H2). We will also answer the exploratory research questions Q1 and Q2. Later, we will discuss other interesting findings outside the scope of our initial hypotheses.

- *H1.* Visual support of any type has significant effects on text comprehension for readers with ID.

Visual support inclusion was not related to accuracy in comprehension questions in any of the groups of participants. The type of visual support also showed no effects on reading comprehension. Therefore, we found no evidence of differential influence of photographs or illustrations helping in the comprehension of the text that they accompany.

- *H2.* People with and without ID explore the page differently.

The group with ID was expected to make more and longer fixations, show a longer fixation time, and perform shorter saccades. The total fixation time of the participants with ID on the text was also higher than those in the neurotypical group, probably indicating a higher difficulty to decode the text or interpret its content (Rayner, 1998). The same happens with the average fixation duration: the group with ID shows much longer fixations on text and whitespace, indicating a higher cognitive effort when reading (Southwell et al., 2020). Differently, the neurotypical group shows shorter fixations overall, with their longest ones being on the image (opposite to the results of the group with ID), arguably because they may find more interest in exploring that area.

Regarding saccades, the neurotypical participants performed longer ones on the image area, possibly due to them searching for items or details in the scene. Saccades were also longer when the image was an illustration, showing extensive eye movements around the abstract picture. The overall smaller saccades of the group with ID show that they were focusing on areas of interest on the page with more and longer fixations, rather than scanning and exploring around it.

- *Q1.* How does the presence and type of visual support influence perceived level of text difficulty?

There were no significant differences on the perceived difficulty of the text that could be linked to the inclusion or type of visual support.

- Q2. How does the presence and type of visual support influence the readers' eye movements?

We found that saccades were longer on illustrations than on photographs, a difference that was especially significant in the neurotypical group. This group showed extensive eye movements around the abstract picture.

Having assessed the initially posed hypotheses and questions, it is also very interesting to see that the participants, especially those on the group with ID, had the highest number of fixations and average total fixation time on whitespace. We suggest that this may have occurred because the texts shown lengthened between 65 and 70 words rather than being of sentence-length, and the participants might have needed to rest their gaze on the whitespace briefly; although it may also reflect a difference in how the two groups scan the scene and integrate the different areas of the page (Skversky-Blocq et al., 2022).

Other aspects worth discussing would be the between-group difference on the answers on perceived difficulty, style preference and comprehension questions. There were no relevant differences on the perceived difficulty of the text that could be linked to the participant groups. Regarding preference on the inclusion and type of visual support in the page, most participants showed no preference, or would rather not communicate it. Photographs were the preferred style for both groups, but it is very interesting to discuss the number of participants that chose illustrations, which is much higher in the neurotypical group (19.2%) than in the group with ID (3.8%). This may possibly be due to participants with ID being more aware and averse to infantile styles of visual support, as some participants in the group communicated to the researcher. Lastly, results make it clear that the comprehension questions were easy for the neurotypical group (95.1% of correct answers), and quite difficult to answer for the participants with ID (55.4% of accuracy). It is hard to determine whether these results are fully due to the participants with ID being unable to comprehend the needed information in the text, but it probably indicates a difference in the reading comprehension capacities of each group.

3.6. Conclusions

We were able to assess our initial hypotheses and shed light on the more exploratory aspects analysed. On one hand, contrary to H1, visual support was not related to accuracy in comprehension questions. This questions whether this should be such an established aspect of EL texts. On the other hand, H2 was confirmed, indicating that global eye-tracking measures are a good tool to predict the cognitive effort of processing different types of texts and that, although participants with ID might need some adaptations in the test design and setting, it is possible and advisable to use this methodology with EL primary groups.

Additionally, there was no effect of the group or visual support on how difficult the participants perceived the text. In this regard, the way participants with ID perceive the text in terms of difficulty does not match their lower results on comprehension, showing a misperception of their reading abilities or a reluctance to verbalise their struggles. Notably, neurotypical participants showed a higher preference for illustrations than that of participants with ID, possibly reflecting a desire of the latter for less infantilizing support.

On this basis, the present study makes a meaningful contribution to the limited empirical evidence directly examining EL recommendations and offers valuable insights into the relationship among visual support, eye-tracking measures, and reading comprehension. Nevertheless, it is important to acknowledge its limitations and suggest directions for future research.

3.6.1. Limitations and future research directions

First, regarding the eye-tracking measures used in the present study, global measures are not very informative about the specific cognitive processes affected by reading ability (Mézière et al., 2023, p. 428). For example, we do not know whether the differences between groups in processing times are due to linguistic (e.g., lexical access) or non-linguistic (e.g., working memory) processes. Therefore, it would be valuable for future studies to assess local measures (although since most studies have focused on global measures, it remains uncertain whether local eye movements can also predict reading comprehension accuracy). Second, it would be valuable to examine within-group differences in comprehension by presenting participants with the same information in both

standard language and EL, incorporating this as a within-group variable. Third, while we aimed for a larger sample, our final participant pool included 52 individuals (26 per group). Given the limited research involving adults with ID in this area, we encourage future studies to replicate our findings or conduct similar investigations with larger samples.

We also observed unexpected results outside our original hypotheses that merit further study. For instance, the group with ID reacted negatively to illustrations, while these were much more appreciated by the neurotypical group. In addition, many linguistic and graphical aspects of EL remain unexplored and should be addressed in future work. Validating EL adaptations empirically is key to ensuring their effectiveness and improving accessible communication.

Our study made a significant contribution to the limited empirical evidence directly assessing EL recommendations, although it is essential that future research continues to evaluate their validity and applicability.

3.7. References

- Anglin, G. J., Vaez, H., & Cunningham, K. L. (2004). Visual representations and learning: The role of static and animated graphics. In D. H. Jonassen (Ed.), *Handbook of research on educational communications and technology* (pp. 865–916). Lawrence Erlbaum Associates Publishers.
- Baez-Naghelli, C., Águila, L., Nieves, D., Grande, M., & Mena, T. (2015). *Test Leer para Comprender: Evaluación de la comprensión lectora en educación primaria*. <https://cie.uatx.mx/debates-en-evaluacion-y-curriculum/pdf2015/C036.pdf>
- Bernabé, R. (2020). New taxonomy of easy-to-understand access services. *MonTI: Monografías de Traducción e Interpretación*, 12, 345–380. <https://doi.org/10.6035/MonTI.2020.12.12>
- Beymer, D., Orton, P. Z., & Russell, D. M. (2007). An eye tracking study of how pictures influence online reading. In C. Baranauskas, P. Palanque, J. Abascal, & S. D. J. Barbosa (Eds.), *Human-Computer Interaction – INTERACT 2007* (pp. 3–7). Springer. https://doi.org/10.1007/978-3-540-74800-7_41
- Blythe, H. I., & Joseph, H. S. S. L. (2012). Children's eye movements during reading. In S. P. Liversedge, I. Gilchrist, & S. Everling (Eds.), *The Oxford handbook of eye movements* (pp. 644–662). Oxford University Press.
- Boland, J. (2004). Linking eye movements to sentence comprehension in reading and listening. In M. Carreiras & C. Clifton (Eds.), *The on-line study of sentence comprehension: Eye-tracking, ERP, & beyond* (pp. 51–76). Psychology Press.
- Borghardt, L., Deilen, S., Fuchs, J., Gros, A., Hansen-Schirra, S., Nagels, A., Schiffli, L., & Sommer, J. (2021). Neuroscientific research on the processing of easy language. *Frontiers in Communication*, 6. <https://doi.org/10.3389/fcomm.2021.698044>
- Buell, S. (2017). *Health-based information for people with intellectual disabilities: An investigation into the linguistic properties of 'easy read' literature and its contribution to the construction of meaning: The Easy Read Project* [Doctoral thesis, University of East Anglia]. University of East Anglia digital repository. <https://ueaeprints.uea.ac.uk/id/eprint/65618>
- Butcher, K. R. (2014). The multimedia principle. In R. E. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (pp. 174–205). Cambridge University Press. <https://doi.org/10.1017/CBO9781139547369.010>
- Carney, R. N., & Levin, J. R. (2002). Pictorial illustrations still improve students' learning from text. *Educational Psychology Review*, 14(1), 5–26. <https://doi.org/10.1023/A:1013176309260>
- Chambers, J. M. (1983). *Graphical methods for data analysis* (1st ed.). Chapman and Hall/CRC. <https://doi.org/10.1201/9781351072304>
- Child, S., Oakhill, J., & Garnham, A. (2020). Tracking your emotions: An eye-tracking study on reader's engagement with perspective during text comprehension. *Quarterly Journal of Experimental Psychology*, 73(6), 929–940. <https://doi.org/10.1177/1747021820905561>

- Chinn, D., & Homeyard, C. (2017). Easy read and accessible information for people with intellectual disabilities: Is it worth it? A meta-narrative literature review. *Health Expectations*, 20(6), 1189–1200. <https://doi.org/10.1111/hex.12520>
- Clark, J. M., & Paivio, A. (1991). Dual coding theory and education. *Educational Psychology Review*, 3, 149–210. <https://doi.org/10.1007/BF01320076>
- Clifton, C., Jr., Staub, A., & Rayner, K. (2007). Eye movements in reading words and sentences. In R. P. G. van Gompel, M. H. Fischer, W. S. Murray, & R. L. Hill (Eds.), *Eye movements: A window on mind and brain* (pp. 341–371). Elsevier. <https://doi.org/10.1016/B978-008044980-7/50017-3>
- Comes, A. (1990). *TLC: Test de lectura comprensiva*. TEA Ediciones.
- Copeland, L., & Gedeon, T. (2013). Measuring reading comprehension using eye movements. In *4th IEEE International Conference on Cognitive Infocommunications, CogInfoCom 2013 – Proceedings* (pp. 791–796). IEEE. <https://doi.org/10.1109/CogInfoCom.2013.6719207>
- Csákvári, J., & Gyori, M. (2015). Applicability of standard eye-tracking technique in people with intellectual disability: Methodological conclusions from a series of studies. *Studies in Health Technology and Informatics*, 217, 63–70. <https://pubmed.ncbi.nlm.nih.gov/26294454/>
- Deilen, S. (2020). Visual segmentation of compounds in easy language: Eye movement studies on the effects of visual, morphological and semantic factors on the processing of German noun-noun compounds. In S. Hansen-Schirra & C. Maaß (Eds.), *Easy language research: Text and user perspectives* (pp. 241–256). Frank & Timme.
- Deilen, S., & Schiffl, L. (2020). Using eye-tracking to evaluate language processing in the easy language target group. In S. Hansen-Schirra & C. Maaß (Eds.), *Easy language research: Text and user perspectives* (pp. 273–281). Frank & Timme.
- Deilen, S., Hansen-Schirra, S., & Nagels, A. (2022). The effect of segmentation signs in compounds on reading behavior: An eye-tracking study. *Lebende Sprachen*, 67(1), 45–99. <https://doi.org/10.1515/les-2022-0003>
- Del Cueto, J., Conte, N. B., Parellada, C., & Roldan, L. A. (2019). Validación de un screening académico para evaluar la comprensión lectora. Estudio piloto. *XI Congreso Internacional de Investigación y Práctica Profesional en Psicología*. Acta Académica. <https://www.aacademica.org/000-111/120>
- Denzen, E. M., Santibáñez, M. E., Moore, H., Foley, A., Gersten, I. D., Gurgol, C., Majhail, N. S., Spellecy, R., Horowitz, M. M., & Murphy, E. A. (2012). Easy-to-read informed consent forms for hematopoietic cell transplantation clinical trials. *Biology of Blood and Marrow Transplantation*, 18(2), 183–189. <https://doi.org/10.1016/j.bbmt.2011.07.022>
- Department of Health. (2010). *Making written information easier to understand for people with learning disabilities: Guidance for people who commission or produce Easy Read information—Revised Edition 2010*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/215923/dh_121927.pdf

- D'Mello, S. K., Southwell, R., & Gregg, J. (2020). Machine-learned computational models can enhance the study of text and discourse: A case study using eye tracking to model reading comprehension. *Discourse Processes*, 57(5–6), 420–440.
<https://doi.org/10.1080/0163853X.2020.1739600>
- Duchowski, A. T. (2007). *Eye tracking methodology: Theory and practice*. Springer.
- Dye, L., Hare, D. J., & Hendy, S. (2004). Capacity to consent to participate in research: A reconceptualisation. *British Journal of Learning Disabilities*, 31, 1–7.
<https://doi.org/10.1111/j.1468-3156.2004.00262.x>
- Everatt, J., & Underwood, G. (1994). Individual differences in reading subprocesses: Relationships between reading ability, lexical access, and eye movement control. *Language and Speech*, 37(3), 283–297. <https://doi.org/10.1177/002383099403700305>
- Faber, M., Bixler, R., & D'Mello, S. K. (2018). An automated behavioral measure of mind wandering during computerized reading. *Behavior Research Methods*, 50(1), 134–150.
<https://doi.org/10.3758/s13428-017-0857-y>
- Fajardo, I., Ávila, V., Ferrer, A., Tavares, G., Gómez, M., & Hernández, A. (2014). Easy-to-read texts for students with intellectual disability: Linguistic factors affecting comprehension. *Journal of Applied Research in Intellectual Disabilities*, 27(3), 212–225.
<https://doi.org/10.1111/jar.12065>
- Fehlmann, B., Coynel, D., Schickntanz, N., Milnik, A., Gschwind, L., Hofmann, P., Papassotiropoulos, A., & de Quervain, D. J. (2020). Visual exploration at higher fixation frequency increases subsequent memory recall. *Cerebral Cortex Communications*, 21(1).
<https://doi.org/10.1093/texcom/tgaa032>
- Ferreres, A., Abusamra, V., Casajús, A., Cartoceti, R., Squillace, M., & Sampedro, B. (2009). Pruebas de screening para la evaluación de la comprensión de textos. *Neuropsicología Latinoamericana*, 1(1), 41–56.
https://www.neuropsicolatina.org/index.php/Neuropsicologia_Latinoamericana/article/view/8
- García Muñoz, Ó. (2012). *Lectura fácil: Métodos de redacción y evaluación*. Plena Inclusión.
<https://www.plenainclusion.org/sites/default/files/lectura-facil-metodos.pdf>
- Gonzalez-Sanchez, J., Baydogan, M., Chavez-Echeagaray, M. E., Atkinson, R., & Burleson, W. (2017). Affect measurement: A roadmap through approaches, technologies, and data analysis. In M. Jeon (Ed.), *Emotions and affect in human factors and human-computer interaction* (pp. 255–288). Elsevier. <https://doi.org/10.1016/B978-0-12-801851-4.00011-2>
- González-Sordé, M., & Matamala, A. (2023). Empirical evaluation of Easy Language recommendations: A systematic literature review from journal research in Catalan, English, and Spanish. *Universal Access in the Information Society*. <https://doi.org/10.1007/s10209-023-00975-2>
- Guo, D., McTigue, E. M., Matthews, S. D., & Zimmer, W. (2020). The impact of visual displays on learning across the disciplines: A systematic review. *Educational Psychology Review*, 32, 627–656. <https://doi.org/10.1007/s10648-020-09523-3>

- Hannus, M., & Hyönä, J. (1999). Utilization of illustrations during learning of science textbook passages among low- and high-ability children. *Contemporary Educational Psychology*, 24(2), 95–123. <https://doi.org/10.1006/ceps.1998.0987>
- He, W., Garrido, M. I., Sowman, P. F., Brock, J., & Johnson, B. W. (2015). Development of effective connectivity in the core network for face perception. *Human Brain Mapping*, 36(6), 2161–2173. <https://doi.org/10.1002/hbm.22762>
- Hibbing, A. N., & Rankin-Erickson, J. L. (2003). A picture is worth a thousand words: Using visual images to improve comprehension for middle school struggling readers. *The Reading Teacher*, 56.
- Hurtado, B., Jones, L., & Burniston, F. (2014). Is easy read information really easier to read? *Journal of Intellectual Disability Research*, 58(9), 822–829. <https://doi.org/10.1111/jir.12097>
- Inhoff, A. W., & Rayner, K. (1986). Parafoveal word processing during eye fixations in reading: Effects of word frequency. *Perception & Psychophysics*, 40(6), 431–439. <https://doi.org/10.3758/BF03208203>
- ISO - International Organization for Standardization. (2023b). *Information technology — User interfaces — Requirements and recommendations on making written text easy to read and understand*. (ISO Standard No. ISO/IEC 23859).
- Jones, F. W., Long, K., & Finlay, W. M. L. (2007). Symbols can improve the reading comprehension of adults with learning disabilities. *Journal of Intellectual Disability Research*, 51(7), 545–550. <https://doi.org/10.1111/j.1365-2788.2006.00926.x>
- Just, M. A., & Carpenter, P. A. (1980). A theory of reading: From eye fixations to comprehension. *Psychological Review*, 87(4), 329–354. <https://doi.org/10.1037/0033-295X.87.4.329>
- Kazem, A. M., Alzubiadi, A. S., Yousif, Y. H., Aljamali, F. A., Al-Mashhdany, S. I., Alkharusi, H. A., Al-Busaidi, O. B., Alsarmi, A. M., Al-Bulushi, S. S., Al-Bahrani, W. A., & Al-Fori, S. M. (2007). Psychometric properties of Raven's Colored Progressive Matrices for Omani children aged 5 through 11 years. *Social Behavior and Personality*, 35(10), 1385–1398. <https://doi.org/10.2224/sbp.2007.35.10.1385>
- Krejtz, K., Duchowski, A. T., Krejtz, I., Kopacz, A., & Chrzęstowski-Wachtel, P. (2016). Gaze transitions when learning with multimedia. *Journal of Eye Movement Research*, 9(1). <https://doi.org/10.16910/jemr.9.1.5>
- Levie, W. H., & Lentz, R. (1982). Effects of text illustrations: A review of research. *Educational Technology Research and Development*, 30, 195–232. <https://doi.org/10.1007/BF02765184>
- Lindholm, C., & Vanhatalo, U. (2021). *Handbook of easy languages in Europe*. Frank & Timme.
- Matamala, A. (2022). Easy-to-understand language in audiovisual translation and accessibility: State of the art and future challenges. *XLinguae*, 15(2), 130–144. <https://doi.org/10.18355/XL.2022.15.02.10>
- Mayer, R. E. (Ed.). (2014). *The Cambridge handbook of multimedia learning* (2nd ed.). Cambridge University Press.

- Mézière, D. C., Yu, L., Reichle, E. D., von der Malsburg, T., & McArthur, G. (2023). Using eye-tracking measures to predict reading comprehension. *Reading Research Quarterly*, 58, 425–449. <https://doi.org/10.1002/rrq.498>
- Morton, J. (1969). Interaction of information in word recognition. *Psychological Review*, 76(2), 165–178. <https://doi.org/10.1037/h0027366>
- Nomura, M., Nielsen, G., & Tronbacke, B. (2010). *Guidelines for easy-to-read materials (IFLA Professional Reports 120)*. IFLA.
- Orduna-Hospital, E., Hernández-Aranda, D., & Sanchez-Cano, A. (2023). Ocular motility patterns in intellectual disability: Insights from the developmental eye movement test. *Life*, 13(12). <https://doi.org/10.3390/life13122360>
- Paeye, C., & Madelain, L. (2011). Reinforcing saccadic amplitude variability. *Journal of the Experimental Analysis of Behavior*, 95(2), 149–162. <https://doi.org/10.1901/jeab.2011.95-149>
- Perego, E. (2020). *Accessible communication: A cross-country journey*. Frank & Timme.
- Plena Inclusión. (2021). ¿Cómo usamos las imágenes en la lectura fácil? <https://www.plenainclusion.org/noticias/como-usamos-las-imagenes-en-la-lectura-facil/>
- Poncelas, A., & Murphy, G. (2007). Accessible information for people with intellectual disabilities: Do symbols really help? *Journal of Applied Research in Intellectual Disabilities*, 20(5), 466–474. <https://doi.org/10.1111/j.1468-3148.2006.00334.x>
- Queiroz-Garcia, I., Espirito Santo, H., & Pires, C. (2021). Propriedades psicométricas da forma geral das Matrizes Progressivas de Raven numa amostra portuguesa. *Revista Portuguesa de Investigação Comportamental e Social*, 7(1), 84–101. <https://doi.org/10.31211/rpics.2021.7.1.210>
- Raven, J. C. (1998). *Raven's progressive matrices*. Pearson Clinical.
- Rayner, K. (1998). Eye movements in reading and information processing: 20 years of research. *Psychological Bulletin*, 124(3), 372–422. <https://doi.org/10.1037/0033-2909.124.3.372>
- Rayner, K., Chace, K. H., Slattery, T. J., & Ashby, J. (2006). Eye movements as reflections of comprehension processes in reading. *Scientific Studies of Reading*, 10(3), 241–255. https://doi.org/10.1207/s1532799xssr1003_3
- Rayner, K., Pollatsek, A., Ashby, J., & Clifton, C. (2011). *Psychology of reading*. Psychology Press.
- Reichle, E. D., Liversedge, S. P., Drieghe, D., Blythe, H. I., Joseph, H. S., White, S. J., & Rayner, K. (2013). Using EZ Reader to examine the concurrent development of eye-movement control and reading skill. *Developmental Review*, 33(2), 110–149. <https://doi.org/10.1016/j.dr.2013.03.001>
- Rivero Contreras, M., Engelhardt, P. E., & Saldaña Sage, D. (2023). Do easy-to-read adaptations really facilitate sentence processing for adults with a lower level of education? An experimental eye-tracking study. *Learning and Instruction*, 84. <https://doi.org/10.1016/j.learninstruc.2022.101731>

- Rivero-Contreras, M., & Saldaña, D. (2020). ¿Legibilidad es sinónimo de comprensión en lectura fácil? Una revisión de estudios sobre comprensión lectora en textos adaptados o simplificados y su calidad metodológica. In A. E. Díez Mediavilla & R. Gutiérrez Fresneda (Coords.), *Lectura y dificultades lectoras en el siglo XXI* (pp. 714–728). Octaedro.
- Rivero-Contreras, M., Engelhardt, P. E., & Saldaña, D. (2021). An experimental eye-tracking study of text adaptation for readers with dyslexia: Effects of visual support and word frequency. *Annals of Dyslexia*, 71, 170–187. <https://doi.org/10.1007/s11881-021-00217-1>
- Saletta, M., Kaldenberg, E., Rivera, K., & Wood, A. (2019). Do illustrations promote reading comprehension in adults with intellectual or developmental disabilities? *Education and Training in Autism and Developmental Disabilities*, 54(3), 225–236. <https://doi.org/10.1177/215416471905400303>
- Schatz, T., Haberstroh, J., Bindel, K., Oswald, P., Pantel, J., Paulitsch, M., Konopik, N., & Knopf, M. (2017). Improving comprehension in written medical informed consent procedures. *GeroPsych: The Journal of Gerontopsychology and Geriatric Psychiatry*, 30(3), 97–108. <https://doi.org/10.1024/1662-9647/a000169>
- Schiffli, L. (2020). Hierarchies in lexical complexity: Do effects of word frequency, word length and repetition exist for the visual word processing of people with cognitive impairments? In S. Hansen-Schirra & C. Maaß (Eds.), *Easy language research: Text and user perspectives* (pp. 227–239). Frank & Timme GmbH.
- Skversky-Blocq, Y., Shmuel, S., Cohen, O., & Shechner, T. (2022). Looking fear in the face: Adults but not adolescents gaze at social threat during observational learning. *International Journal of Psychophysiology*, 182, 240–247. <https://doi.org/10.1016/j.ijpsycho.2022.11.004>
- Social Care Institute for Excellence. (2005). *How to produce information in an accessible way (Social Care Accessibility Guidelines)*. <https://web.archive.org/web/20220119220308/https://www.scie.org.uk/publications/misc/accessguidelinespublications.asp>
- Southwell, R., Gregg, J., Bixler, R., & D'Mello, S. K. (2020). What eye movements reveal about later comprehension of long connected texts. *Cognitive Science*, 44(10), 1–24. <https://doi.org/10.1111/cogs.12905>
- Sung, E., & Mayer, R. E. (2012). When graphics improve liking but not learning from online lessons. *Computers in Human Behavior*, 28(5), 1618–1625. <https://doi.org/10.1016/j.chb.2012.03.026>
- Sutherland, R. T., & Isherwood, T. (2016). The evidence for easy-read for people with intellectual disabilities: A systematic literature review. *Journal of Policy and Practice in Intellectual Disabilities*, 12(4), 297–310. <https://doi.org/10.1111/jppi.12201>
- Sweller, J., van Merriënboer, J. J. G., & Paas, F. G. W. C. (1998). Cognitive architecture and instructional design. *Educational Psychology Review*, 10, 251–296. <https://doi.org/10.1023/A:1022193728205>
- UNE - Asociación Española de Normalización. (2018). *Lectura fácil. Pautas y recomendaciones para la elaboración de documentos*. (UNE norm No. 153101:2018 EX).

- Van Gog, T., Ericsson, K. A., & Rikers, R. M. J. P. (2005). Instructional design for advanced learners: Establishing connections between the theoretical frameworks of cognitive load and deliberate practice. *Educational Technology Research and Development*, 53, 73–81. <https://doi.org/10.1007/BF02504799>
- Vidal, L. (2021). *La mirada tàtil. Versió LF: Llocs d'interès de Rupit i Pruit*. Oficina de Patrimoni Cultural, Diputació de Barcelona & Ajuntament de Rupit i Pruit.
- Wadihah, H., & Fauzi, A. (2021). Using image media on reading text to improve reading comprehension of students with intellectual disabilities. *Jurnal Asesmen dan Intervensi Anak Berkebutuhan Khusus*, 21(1).
- Wang, Y., & Sparks, B. A. (2016). An eye-tracking study of tourism photo stimuli: Image characteristics and ethnicity. *Journal of Travel Research*, 55(5), 588–602. <https://doi.org/10.1177/0047287514564598>
- Warburg, M. (2001). Visual impairment in adult people with intellectual disability: Literature review. *Journal of Intellectual Disability Research*, 45(5), 424–438. <https://doi.org/10.1046/j.1365-2788.2001.00348.x>
- Whaley, C. P. (1978). Word-nonword classification time. *Journal of Verbal Learning and Verbal Behavior*, 17(2), 143–154. [https://doi.org/10.1016/S0022-5371\(78\)90110-X](https://doi.org/10.1016/S0022-5371(78)90110-X)
- White, H., Heck, A., Jubran, R., Chroust, A., & Bhatt, R. S. (2022). Average fixation duration in infancy: Stability and predictive utility. *Infancy: The Official Journal of the International Society on Infant Studies*, 27(5), 866–886. <https://doi.org/10.1111/infa.12483>
- Yaneva, V., Temnikova, I., & Mitkov, R. (2016). Accessible texts for autism: An eye-tracking study. *ASSETS 2015, the 17th International ACM SIGACCESS Conference on Computers and Accessibility*, 49–57. <https://doi.org/10.1145/2700648.2809852>
- Zhao, F., Schnotz, W., Wagner, I., & Gaschler, R. (2014). Eye tracking indicators of reading approaches in text-picture comprehension. *Frontline Learning Research*, 2(5), 46–66. <https://doi.org/10.14786/flr.v2i4.98>

CHAPTER 4



4. Article 3

Full and null pronouns and subordinate clauses in Catalan Easy Language: an eye-tracking study on adults with and without intellectual disabilities

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Abstract

Easy Language guidelines discourage the use of full overt pronouns and subordinate clauses. This study examines how manipulating these linguistic elements influences perceived reading difficulty, reader preference, and the cognitive effort involved in text processing. We also assessed the effects of null and overt pronouns on content comprehension. 26 adults with intellectual disability and 26 neurotypical adults participated in a mixed-design experiment involving two reading tasks. For both tasks, we recorded participants' eye movements while they rated the perceived difficulty and reported their preference. Additionally, Task 1 included open-ended comprehension questions. The linguistic elements only had significant effects on fixation patterns and focal attention. Crucially, they did not significantly alter perceived text difficulty. These findings suggest that including subordinate clauses does not significantly hinder comprehension. However, further research is essential to guide the future development of Easy Language, as evidence is still limited regarding its additional linguistic and graphic features and the needs of different target groups.

Keywords

Easy Language, eye tracking, intellectual disability, pronouns, subordinate clauses, accessibility

4.1. Introduction

Usability and accessibility in communication depend heavily on how understandable the content is, and this can be markedly improved through text simplification methods (Saggion et al., 2011; Perego, 2020). Historically, cognitive barriers have received less scholarly attention than physical or sensorial ones (Alarcon et al., 2019). However, the field is evolving, with growing interest in cognitive accessibility among researchers and policymakers, leading to new developments and practices in the field.

To contribute to this expanding area of research, this article details the research undertaken to address this topic. We will begin by outlining key concepts related to this study and the research performed in the area. Next, we will review relevant prior research, followed by the presentation of our hypotheses, study design, and methodology. Finally, we will present the results, discuss their implications, and conclusions.

4.2. Related work

This section reviews the main literature relevant to the present study. It first introduces the concept of Easy Language. Then, it focuses on specific linguistic features that are central to this research (null and overt pronouns, and subordinate clauses), describing how they are used in Catalan and how they are addressed in Easy Language recommendations. Finally, the section outlines the research background that informs this study, identifying areas where further investigation is needed.

4.2.1. *Easy Language*

Easy Language (EL) is a language variety that adapts texts at both the linguistic and graphic levels to make information accessible to people who may have trouble reading and understanding standard language (ISO, 2023b, p. 2).

In the Catalan context, we can refer to the Inclusion Europe (ILSMH, 1997) or International Federation of Library Associations and Institutions (IFLA, 2012) guidelines. The Spanish Association for Standardisation published a standard (UNE, 2018) that is the main guide for EL practice in Spain, and which is also

used as a guide for practice in Catalonia. Although Catalonia and Spain are relatively advanced in terms of EL literature for practitioners, these guidelines have notable shortcomings. For example, the existing literature primarily relies on intuition about text accessibility (Maaß, 2020) and findings from previous studies focused on isolated linguistic elements (Hansen-Schirra et al., 2020). This content therefore often lacks grounding in empirical studies that measure the effects of complexity reduction on cognitive processing in EL texts.

Empirical evidence is therefore needed to determine which adaptations should be recommended in the guidelines (Sutherland & Isherwood, 2016, pp. 297-298; Lindholm & Vanhatalo, 2021, p. 15). The IFLA guidelines for EL in Catalan state: “more scientific research is needed on reading difficulties and the concept of Easy Language” (IFLA, 2012, p. 41). In essence, although research in this field has grown in the past years, it is still not sufficient, as recent literature reviews have suggested (Sutherland & Isherwood, 2016; González-Sordé & Matamala, 2023) and as shown in § 2.2.2.

4.2.2. Ellipses and co-reference through null and overt pronouns

Catalan is a null-subject language or pro-drop language (Mayol & Clark, 2010; Pérez & Mestre, 2022). Subjects are omitted more often than objects in several typologically diverse languages (Allen, 2000; Serratrice et al., 2004). In Catalan, it is common to find the subject of the sentence being omitted once it is considered that it can be easily inferred, as exemplified in Table 13. This occurrence is called “null subject” (Mayol & Clark, 2010). In a broader sense, when a pronoun (subject or not) is omitted for the same reason, it is a “null pronoun” (Mayol & Clark, 2010).

Coherent discourse often includes the repetition of certain concepts. One example of this are anaphors, which are “referential expressions that co-refer with an antecedent found earlier in the same discourse” (Ducrot & Todorov, 2003, p. 323). As it can be observed in Table 13, Catalan regularly uses pronouns as co-referents for different elements of the sentence (IEC, 2022). Some high-frequency overt pronouns are subject pronouns (“*ell*, *ella*, *ells*, *elles*”), direct object pronouns (“*el*, *la*, *els*, *les*”), as well as “*li*” (singular indirect object pronoun), “*en*” and “*hi*” (unstressed or weak pronouns, called “*pronomes febles*” in Catalan).

Table 13 *Examples of null and overt pronouns*

Null pronoun	Overt pronoun
<i>The omission of the null pronoun (in this case, a null subject) is marked with [NULL] in the position where an overt subject would normally appear.</i>	<i>The position of the overt pronoun in Catalan is marked as [OVERT] in the English translation, since the pronoun used in the example (“li”) has no direct equivalent in English.</i>
[Catalan] La Laura va al mercat cada matí. Avui, [NULL] ha comprat taronges. [English] Laura goes to the market every morning. Today, [NULL] bought oranges.	[Catalan] La Laura ha comprat taronges. Li agraden molt. [English] Laura bought oranges. [OVERT] likes them very much.

4.2.3. Subordinate clauses

A subordinate clause does not form a simple sentence by itself and is connected to the main clause of a sentence (Merriam-Webster Dictionary, 2024). Substantive clauses and relative clauses are types of subordinate clauses. As Table 14 illustrates, substantive clauses perform one of the syntactic functions typically associated with a noun phrase, while relative clauses modify the preceding noun or noun phrase (IEC, 2022).

Table 14 *Examples of subordinate clauses*

Substantive clause	Relative clause
[Catalan] M’ha dit que vindrà a la tarda . [English] NULL told me that NULL will come in the afternoon .	[Catalan] L’home que venia cada tarda a la biblioteca fa molts dies que no ve. [English] The man that came to the library every afternoon has not come for a few days.

4.2.4. *Ellipses, co-reference and subordinate clauses in Easy Language guidelines*

The linguistic elements presented (null and overt pronouns, subordinate clauses) are frequent features of standard Catalan, yet their use is discouraged in EL guidelines. To exemplify this, Table 15 presents extracts from the UNE standard on EL (UNE, 2018), as these are the guidelines relevant in both Spanish and Catalan contexts. Nevertheless, the same suggestions are phrased differently in the ISO standard (ISO, 2023b).

Table 15 *Recommendations that refer to the linguistic elements assessed in the study*

Recommendations in the UNE standard	Discouraged linguistic aspects
“Elliptical constructions should not be used. The reader should not have to make inferences. In any case, omissions should be minimal, and referential identification should be guaranteed. (INCORRECT) Juan bought 2 balls. One for himself and another for his nephew. (CORRECT) Juan bought 2 balls. One ball is for himself, and the other is for his nephew.” (UNE, 2018, p. 23)	Null and overt pronouns
“The reader should not have to make inferences to understand the text.” (UNE, 2018, p. 24)	Null and overt pronouns
“The same word must be used throughout the text to refer to the same object or referent.” (UNE, 2018, p. 20)	Overt pronouns
“Simple sentences should be used, and complex sentences should be avoided. If in some cases they cannot be avoided, it is advisable to separate the ideas into different lines. [...] NOTE 2: Subordinate clauses can be used, but with moderation and linked with conjunctions commonly used in spoken language.” (UNE, 2018, p. 22)	Subordinate clauses

In summary, EL recommendations advise against co-referencing and using ellipses, elements that force the reader to make inferences. Subordinate clauses and other complex sentences should also be kept to a minimum, in favour of simple sentences.

4.3. Research background

Since only a small number of studies have addressed EL directly (González-Sordé & Matamala, 2023), most research on the linguistic elements and measures relevant to our work come from other contexts. Moreover, no studies have focused on Catalan EL to date.

4.3.1. *Relevant linguistic research*

Given the lack of research on the linguistic features of EL on readers with intellectual disabilities, empirical studies are essential. A study by Fajardo et al. (2014) assessed linguistic aspects of EL, including the effect of co-referential and inferential information, on students with intellectual disability (ID). Participants, aged between 16 and 22 ($M = 18.9$, $SD = 1.84$), read EL texts and then performed a reading comprehension test. The study found that the only linguistic feature that was a good predictor of inferential comprehension was the number of sentences. The higher the sentence density, the lower the ability of students with ID to find relationships between sentences (Fajardo et al., 2014, p. 221). This finding may reflect the reduced ability of students with ID to effectively store and retrieve information from memory (Wolman, 1991). Other linguistic aspects analysed, such as word frequency and word length, showed no significant effect on comprehension. The authors argue that these results could question the validity of some EL recommendations, such as that of “augmenting word frequency” (Fajardo et al., 2014, p. 212).

While Fajardo et al. (2014) focus on word frequency and word length, other research has considered pronominal structures, particularly in pro-drop languages, although they are mostly performed on children (Grinstead et al., 2018; Mazzagio & Shield, 2020; Dickinson et al., 2023). Grinstead et al. (2018) argued that the presence of null subjects reflects the challenges Spanish-speaking children with specific language impairments face in acquiring discourse-sensitive constructions. More recently, Dickinson et al. (2023) reported that Spanish children with developmental language disorders use overt subject pronouns less frequently than their typically developing peers in switch-reference contexts, that is, when the subject of the prior finite verb differs from the subject of the current clause. In related work, Mazzagio and Shield (2020) observed that

Italian children with autism spectrum disorder showed lower accuracy than typically developing children in producing first-, second-, and third-person singular pronouns. These children often substituted nouns or proper names for pronouns, and in marked contexts they displayed a preference for overt pronouns over null pronouns.

On a different note, Loureda et al. (2024) performed an eye-tracking study on neurotypical adults and found that reading times were higher when the co-referent was an overt pronoun than when the element was repeated. For those elements that can be omitted, they found that null pronouns showed lower reading times than overt pronouns (Gelormini-Lezama & Almor, 2011; Loureda et al., 2024). This could suggest that the presence of null pronouns facilitates reading. Nevertheless, their participant pool did not include the EL target audience, and reading time was shown to be an inconsistent predictor of text comprehension (Wallot et al., 2014).

Finally, few studies have focused on the processing of subordinate clauses. In this regard, studies on neurotypical English-speaking adults showed that working memory plays a significant role in relative clause processing difficulty through reading tasks in which eye movements (Staub, 2010) and comprehension (Roland et al., 2021) were measured. The frequency of the relative embedded clause⁵ also affects relative clause processing, as argued in a corpus analysis by Realí and Christiansen (2007).

4.3.2. Empirical research on EL and the case of German EL

Research on EL remains generally limited, with the notable exception of German EL. González-Sordé and Matamala (2023) highlight that while some empirical studies exist, overall, the field lacks sufficient publications and broadly applicable results. Still, several studies in different contexts shed light on how EL adaptations can influence comprehension.

Frondén and Kaakinen (2023) used eye-tracking to study how adults with ID read Swedish EL texts. They found that short, frequent words were read more quickly,

⁵ Subordinate clauses provide additional information about a noun and is integrated into the main sentence, often modifying a specific element within it.

while long, infrequent words caused difficulties. However, the small sample size and lack of comparison with neurotypical readers limit the generalisability of these results. In the Spanish context, Fajardo et al. (2013) showed that simplified news texts supported students with mild ID, particularly for literal comprehension. Interestingly, reducing coreferences improved performance, while denser texts hindered inferential comprehension.

Other studies extend the scope beyond the group of users with ID. Rivero-Contreras et al. (2021) tested visual support and lexical simplification with young adults with and without dyslexia. Both adaptations aided sentence processing, especially for those with lower print exposure and smaller vocabularies. Similarly, Schmutz et al. (2019) examined EL on web usability on neurotypical users. Despite enhanced content recognition, the EL versions were associated with longer reading times, reduced preference ratings, and a decreased likelihood of revisiting the webpage, highlighting that improvements for certain users may impose disadvantages on others. Finally, Buell et al. (2020) explored health information comprehension among adults with ID, focusing on simplified language and mediation. Although neither factor alone improved understanding, combining both produced better results. Their findings suggest that comprehension relies not only on textual form but also on individual language-processing capacities.

In contrast, and as mentioned earlier, EL in Germany has a well-established research tradition and strong legal support. Under German law (Federal Ministry of Justice and Consumer Protection, 2011), German EL is the preferred means of providing accessible written information. Since 2010, it has been the subject of extensive scientific investigation, particularly by the research group Simply Complex – Easy Language, which has applied methods such as eye-tracking and functional MRI to evaluate and refine EL guidelines. Unlike in other variants, German EL is not only guided by practical recommendations but also by rulebooks validated through interdisciplinary research at the University of Hildesheim, where the Research Centre for Easy Language was founded in 2014.

Several studies have offered important insights. Pappert and Bock (2020) confirmed that segmenting compound nouns improved reading performance for

adults with ID. Schifffl (2020) compared readers with cognitive impairments to neurotypical readers and found no significant differences in how word frequency, length, and repetition influenced comprehension, suggesting that such factors affect both groups in similar ways.

Despite these advances, studies with individuals with cognitive or sensory impairments remain difficult due to ethical concerns and informed consent requirements. For this reason, most research has relied on eye-tracking (e.g., Gutermuth, 2020), though even this method poses challenges when working with participants with ID (Deilen & Schifffl, 2020). As these participants often struggle with instructions or communication, their participation requires careful adjustments in study design and implementation, along with sensitivity to ethical issues (Csákvári & Gyori, 2015; Deilen & Schifffl, 2020; Borghardt et al., 2021).

4.4. Hypotheses

Drawing on the reviewed literature and related work in the field, the present study examines how specific linguistic features of Catalan that are unadvised in EL guidelines, namely null and overt pronouns and subordinate clauses, influence reading comprehension, perceived difficulty, preference, and cognitive effort among adults with and without ID. The following hypotheses are proposed:

H1. The presence of null and overt pronouns makes the text harder to understand for people with ID.

H2a. People with ID perceive texts with null and overt pronouns as more difficult to understand and prefer texts without these elements.

H2b. People with ID perceive texts with subordinate clauses as more difficult to understand and prefer texts without these elements.

H3a. The presence of null and overt pronouns affects the cognitive effort required for text processing.

H3b. The presence of subordinate clauses affects the cognitive effort required for text processing.

4.5. Study design

We tested these hypotheses across two reading tasks performed in one session. Task 1 focused on null and overt pronouns while Task 2 focused on the presence of subordinate clauses. We designed a mixed-design experimental study in which we manipulated independent variables within subjects (absence/presence of the linguistic element). The grouping of participants (ID/neurotypical) was a second main independent variable.

Both tasks measured (1) the cognitive effort of text processing (through eye-tracking), (2) perceived text difficulty (through self-reported questions answered through Likert-type scales), and (3) text preference (through open-ended questions). Task 1 assessed one additional measure: the comprehension of the content through open-ended questions. In Task 2, this type of question was not included because the texts used in this experiment were significantly shorter, making it more difficult to assess content comprehension through such questions. Additionally, this decision was made to reduce the risk of participant fatigue, particularly among those in the group with ID (Deilen & Schiffli, 2020).

It is worth mentioning that we performed a pilot test beforehand with six neurotypical participants (average age of 28.5; 5 women and 1 man) which allowed us to make minor adjustments to the stimuli and questions.

4.6. Method

The study protocol (CEEAH CA40) was approved by Universitat Autònoma de Barcelona in February 2022. The following section outlines the methodological framework, detailing the procedures and tasks included in the study.

4.6.1. Participants

We initially aimed for 30 participants in each group, however, four users in the group with ID had to be excluded due to issues with eye-tracking calibration or data collection (a common issue, as presented in Deilen & Schiffli, 2020). The final sample consists of 52 participants (23 men and 29 women; mean age 39.9, $SD = 14.5$), of which 26 have ID and 26 are neurotypical. The participants with ID (12 men and 14 women; mean age 44.4, $SD = 13.2$) were recruited through two

local non-profit organisations (Som — Fundació, Taller Jeroni de Moragas). The neurotypical participants (11 men and 15 women; mean age 34.8, $SD = 11.5$) were recruited via word-of-mouth. The two groups did not differ significantly in terms of age ($t(25) = 1.276$, $p = 0.213$). Participation was voluntary and unpaid, all participants were Catalan speakers with normal or corrected-to-normal vision, and their identifying data remains confidential.

The formal diagnosis of ID was not requested from the participants. Having ID was a requirement to be a beneficiary of the collaborating foundations, and this condition was considered sufficient to fulfil the diagnostic criteria. It was verified that none of them had an intelligence level or reading comprehension that significantly deviated from the group using two screening tests (see the results in § 6.1).

4.6.2. Procedure

Participants first provided written informed consent and completed a demographics form, after which they were encouraged to ask questions or express any concerns. Next, they took part in the reading comprehension screening test (TLC) (Comes, 1990) and the abstract reasoning screening test (Raven's Progressive Matrices [RPM]) (Raven, 1998) in a small group setting. Subsequently, participants completed reading Tasks 1 and 2 in a separate room, accompanied only by the observing researcher. For participants with ID, these two sessions were held on separate days to minimise fatigue (Deilen & Schiffli, 2020) and allow additional time for clarification and support. In contrast, neurotypical participants completed both sessions on the same day.

For Tasks 1 and 2, participants were seated in front of a computer screen and asked to focus on various points on the screen to calibrate the eye-tracker. After each page of stimuli, participants answered either open-ended comprehension questions (for Task 1) or questions about perceived text difficulty (for both Tasks 1 and 2) orally. To reduce memory bias and because the goal was not to assess memory or retrieval, participants were allowed to re-read the text before answering the questions. At the end of each task, participants were asked about their preferred text style.

Task 1 lasted around 15 minutes and for each participant we retrieved a maximum of 13 minutes of recorded eye movements (around 3 minutes per page of stimuli). Task 2 lasted around 20 minutes and for each participant we retrieved a maximum of 17 minutes of recorded eye movements (around 2 or 3 minutes per page of stimuli). The recording of eye movements was paused while the participants answered the perceived difficulty, preference, and comprehension questions and the researcher registered the oral answers in their computer.

Eye-tracking raw data were pre-processed using the vendor's software to identify fixations and saccades. Prior to the main analyses, we examined individual fixation durations and saccadic amplitudes for outliers, using the criterion $\pm 1.58 \times \text{IQR} / \sqrt{n}$, where IQR denotes the interquartile range (Chambers, 1983). All outlying values (both fixation durations and saccadic amplitudes) were replaced with the nearest non-outlying value (i.e., the respective maximum or minimum; Wickham et al., 2025). Data cleaning and statistical analyses were conducted in R (R Core Team, 2025).

4.6.3. Materials

4.6.3.1. Stimuli

The stimuli in Task 1 included four short Brothers Grimm tales taken from a published Catalan EL adaptation (Grimm & Grimm, 2018) that had been validated by the target group of EL, and the texts used did not contain low-frequency words. All the pages shown (four to each participant) had a similar text length (between 75 and 100 words; and between nine and 12 lines). For Task 1, all texts scored between 87 and 99 (mean = 93.5) on the Fernández Huerta readability index, indicating that they are “easy” (80-89) or “very easy” (90-99) and that they could be suitable for neurotypical children aged 9 to 11. Notably, texts with and without pronouns scored almost identically in terms of readability.

In Task 2, we showed participants six short texts on health recommendations for people living in Barcelona, taken from a published booklet in Catalan EL (Agència de Salut Pública, 2023) validated by the target group of EL. The texts also contained no low-frequency words. All the pages shown (six to each participant) had a similar text length (between 35 and 45 words; and between four and seven lines). For Task 2, all texts scored between 73 and 99 on the Fernández Huerta

readability index ($M = 85.75$), suggesting they range from “somewhat easy” (70-79) to “easy” (80-89) and “very easy” (90-99). These texts are considered appropriate for neurotypical children aged 9 to 12. Interestingly, texts with and without subordinate clauses had very similar readability scores, with those containing subordinate clauses scoring slightly higher.

The pages shown in both tasks presented a similar structure and they all appeared in the centre of the screen. Sentences were presented in black 14-point Arial font on a white background, with double-spaced paragraphs.

We created a different version of the tale for each level of the independent variable: one version had null and object pronouns (in Task 1) or subordinate clauses (in Task 2). In the second version, all subjects were explicit and each referent was identified through one word (in Task 1) or the text only consisted of simple sentences (in Task 2), as per EL recommendations.

All participants read the texts in the same order but with differences in terms of the inclusion of the linguistic aspects assessed. Participants saw the same number of pages of each level of the independent variable (two of each in Task 1, making a total of four pages; three of each in Task 2, making a total of six pages). This was achieved by creating two sets of stimuli for each reading task through a Latin square array.

4.6.3.2. Evaluation instruments

First, participants signed the consent form, which was written in EL and read aloud by the researcher, if requested by the participant. Then, they filled out the demographics form, where they reported their age, gender, whether they had any non-corrected vision problems, and whether they knew about EL. After that, we used a reading comprehension screening test (TLC) (Comes, 1990) and an intelligence and abstract reasoning screening test (Raven's Progressive Matrices [RPM]) (Raven, 1998) to collect data on these aspects for each participant. Both screening tests took about one hour per participant in total and were performed prior to the experiment. TLC and RPM were applied in group sessions, with the users answering the questions autonomously and individually. Participants answered in silence by circling the response on their piece of paper (both screening tests followed an “a, b, c” choice structure). All participants knew how

to read autonomously, and they were always allowed to ask the researcher for assistance.

Task 1 assessed text comprehension using 12 low-difficulty, open-ended questions (three per page across four pages). These questions required participants to recall information directly from the text (Fajardo et al., 2014), specifically referents, subjects or objects. Participants completed the task individually, accompanied by the researcher, and answered the questions orally. An example is provided below.

Table 16 *Extract from Task 1 stimuli and example of a comprehension question*

Text A <i>Explicit referent; no null or overt pronouns.</i>	Text B <i>Null and overt pronouns.</i>
[Catalan] (...) Aleshores, una pagesa va passar pel carrer i va cridar: “venc melmelada!” El sastre va convidar la pagesa a pujar a casa. [English] (...) Then a peasant woman passed by on the street and shouted: “I’m selling jam!” The tailor invited the peasant woman up to the house.	[Catalan] (...) Aleshores, una pagesa va passar pel carrer i va cridar: “venc melmelada!” El sastre la va convidar a pujar a casa. [English] (...) Then a peasant woman passed by on the street and shouted: “I’m selling jam!” The tailor invited her up to the house.
Question: Who entered the tailor’s house?	

Perceived difficulty was assessed in both tasks through a Likert scale (Yaneva et al., 2016b), which presented options from 1 to 4 to avoid a neutral answer. Again, the participants answered these questions individually and orally:

Did you find the text difficult to read?

1) Not at all, it was easy. 2) Not very. 3) I struggled a little bit. 4) I struggled a lot.

Finally, participants were asked an open question on their preference at the end of both tasks after being shown (1) a short text with null and full pronouns (Task 1) or with subordinate clauses (Task 2) and (2) another without those elements.

Participants answered individually and orally to the question “which one of these pages do you prefer?”

4.6.3.3. Apparatus

Eye movements were recorded with a Tobii T60 (sampling rate of 60 Hz) in a desk monitor setup. Head movements were not restrained, although participants were instructed to stay still while completing the test. Viewing was binocular, and the movements of both eyes were recorded. Participants were seated approximately 60 cm away from the 43 cm diagonal display size monitor with a screen resolution of 1280 x 1024 pixels. The Tobii T60 eye tracker was controlled by a laptop computer, and another laptop computer was used to record the participant’s answers in a digital document.

4.6.4. Eye movements and eye-tracking measures

Eye movements are directly influenced by different text elements, like linguistic complexity, which “leads to increased fixation duration and decreased saccade length” (Borghardt et al., 2021, p.4). Eye movements can be a useful indicator of the reader’s cognitive processes (e.g., Rayner, 1998), although they cannot be the only measure used when assessing text processing and reading comprehension (Boland, 2004) and should be combined with data retrieved through different methods (Van Gog et al., 2005). In our study, eye-tracking data is complemented with the results from the perceived difficulty and preference questions. Additionally, for the task on null and overt pronouns, it is complemented with results from comprehension questions.

Eye-tracking measures are categorised as either global or local, each serving distinct analytical purposes. While local measures (e.g., first-fixation duration) reveal detailed cognitive processes influenced by reading ability over small segments, global measures summarise reading behaviour over larger text segments like sentences and capture overall patterns, including differences between readers of varying skill levels (Mézière et al., 2023). Since global measures also predict reading comprehension (Southwell et al., 2020; D’Mello et al., 2020) and local measures have uncertain predictive value, our study focused on global measures. We analysed fixation count and average fixation duration,

widely used indicators of cognitive processing effort (see, for example, Just et al., 1982), along with the K coefficient to assess the ambient and focal attention.

- Ambient/focal attention captured by the second-order metric; K coefficient of ambient-focal attention measures the dynamics of visual attention. A K below 0 indicates ambient processing, and one above 0 indicates focal processing (Krejtz et al., 2014; Krejtz et al., 2016). Ambient attention relates to awareness of the peripheral visual field, while focal attention allows individuals to perceive fine details in the central visual field. Focal processing reflects deeper attention and active information processing (Trevarthen, 1968; Eisenberg & Zacks, 2016). Research indicates that longer fixation durations and shorter saccade amplitudes are characteristic of focal vision (Helmert et al., 2005; Krejtz et al. 2012), which may indicate greater linguistic complexity (Borghardt et al., 2021, p. 4).
- Number of fixations refers to the total number of fixations in one area (Clifton et al., 2007; Duchowski, 2007) and a greater number of fixations indicates a need for more time to process text (Rodríguez et al., 2025). In the present study, we calculated the number of fixations for the whole text.
- Average fixation duration (in milliseconds) is the duration of a single fixation, on average (Duchowski, 2007; White et al., 2022). Slower cognitive processing tends to show longer fixations (He et al., 2015; Borghardt et al., 2021). Rare or unfamiliar words, which lack stored entries in our mental lexicon, are processed through the slower sublexical route. This involves step-by-step decoding via grapheme-phoneme rules, making it more time-consuming than direct lexical access. As a result, long and uncommon words tend to produce the longest gaze times as they are harder to process (Tiffin-Richards & Schroeder, 2015).

We determined distinct areas of interest (AOIs) across the different pages of our stimuli (see Figure 13). As pictured in the example in Figure 13, our AOIs were drawn around each sentence. Working with texts in EL allowed us to make the AOIs also consist of one line of text, as the texts were structured with one unit of meaning or sentence per line, as recommended in the guidelines and standards

(ISO, 2023b; UNE, 2018). Everything outside of the AOIs was considered “whitespace”, as our stimuli only consisted of text.

The area designated as “whitespace” was included to track participants’ eye movements and gaze behaviour across the page (Bruckmaier et al., 2019). Other studies have included whitespace as part of the areas analysed to assess attention patterns (Kim et al., 2012; Wei et al., 2018). Previous research have used the gaze on whitespace as an indicator of cognitive effort (Ferreira et al., 2008; Renkewitz & Jahn, 2010; Scholz et al., 2018; Johansson et al., 2022). This is based on the idea that shifting one’s gaze away from the material aids in retrieving information held in short-term memory.

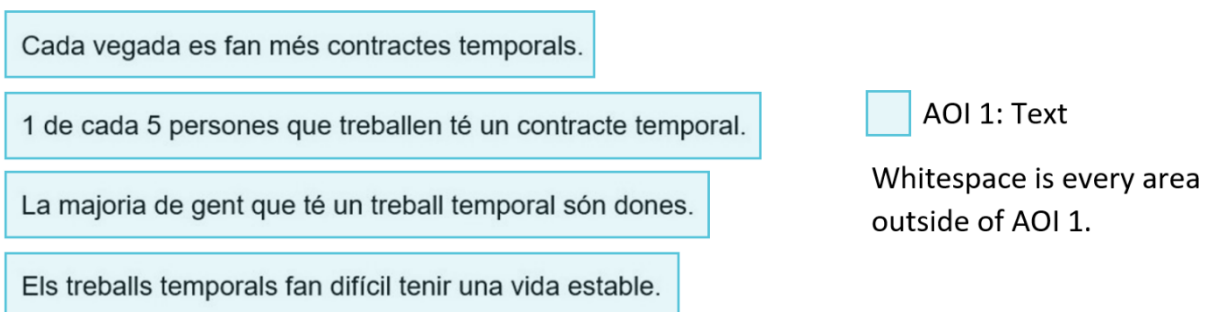


Figure 13 *Areas of interest in a page of stimuli from Task 2*

4.7. Results

After reporting the results of the screening tests, results of Task 1 and Task 2 will be presented separately.

4.7.1. Screening tests

Screening tests confirmed that there were no intra-group outliers in the resulting data. Performance on the TLC reading comprehension test showed a significant difference: Participants with ID achieved an average of 33.7% correct answers ($SE = 0.829$), while the neurotypical group scored 85.8% ($SE = 0.443$). This difference was significant, $t(52) = 17.198$, $p < 0.001$.

The ID group answered 62.9% of the questions correctly on the RPM test on abstract reasoning and intelligence ($SE = 1.604$), whereas the neurotypical group obtained 95.1% on the RPM ($SE = 0.374$). Again, the difference was statistically significant ($t(52) = 6.54$, $p < 0.001$).

4.7.2. Task 1: null and overt pronouns

First, we will present the results of the comprehension, perceived difficulty, and preference questions. Then, we will move on to the results of the eye-tracking metrics. The analysis of comprehension, perceived difficulty, and preference employed the two-way mixed-design ($2 \times 2 \times 2$) analysis of variance (ANOVA) followed by pairwise comparisons with Turkey's range test (HSD) correction for multiple comparisons if necessary.

The ANOVA on comprehension questions proved statistically significant for the main effects of the group ($F(1, 620) = 106.323, p < 0.001, \eta^2 = 0.145$), while neither the main effect of the presence of pronouns ($F(1, 620) = 0.102, p = 0.337, \eta^2 = 0.001$) nor the interaction term of both variables was statistically significant ($F(1, 620) = 1.437, p = 0.230, \eta^2 = 0.001$). When there were full and overt pronouns in the text, the ID group scored the lowest ($M = 67.94\%, SE = 0.025$).

The results on perceived text difficulty revealed that the group variable showed a significant effect ($F(1, 204) = 69.221, p < 0.001, \eta^2 = 0.248$), while the presence of pronouns ($F(1, 204) = 2.433, p = 0.120, \eta^2 = 0.008$) and the interaction of both of the variables ($F(1, 204) = 2.433, p = 0.120, \eta^2 = 0.008$) showed no significant effect on perceived difficulty. In general, the group with ID perceived the texts as more difficult ($M = 1.94, SE = 0.109$) than the neurotypical group ($M = 1.03, SE = 0.018$).

Finally, the results of the preference questions showed no significant intra-group difference ($F(1, 150) = .266, p = 0.109, \eta^2 = 0.05$). Most participants in both groups (ID = 80.7%, neurotypical = 65.3%) showed no clear preference between a text with null and overt pronouns and without these elements.

4.7.2.1. Eye movements

A 2 (group: ID vs typical) $\times$ 2 (pronouns: included vs omitted) $\times$ 2 (AOI type: text vs whitespace) mixed design ANOVA was employed to analyse the eye-movement metrics (K coefficient, number of fixations, and average fixation duration).

Regarding differences in ambient and focal attention, there was a significant effect of group ($F(1, 50) = 9.05, p = 0.004, \eta^2 = 0.112$). The attention of the group

with ID was less ambient ($M = -0.039$, $SE = 0.065$) than the neurotypical group ($M = -0.328$, $SE = 0.07$). There was a significant effect of AOI type, ($F(1, 50) = 31.05$, $p < 0.001$, $\eta^2 = 0.020$). Not surprisingly, both groups were, on average, less ambient while reading text ($M = -0.078$, $SE = 0.05$) than when looking at whitespace ($M = -0.289$, $SE = 0.053$).

The interaction effect between the group and AOI type was also statistically significant ($F(1, 50) = 9.34$, $p = 0.004$, $\eta^2 = 0.020$) (see Figure 14). When reading text AOI, the group with ID was significantly more focal ($M = .124$, $SE = 0.068$) than the neurotypical group ($M = -0.280$, $SE = 0.073$), ($t(50) = 4.03$, $p < 0.001$). The group with ID showed ambient processing on whitespace ($M = -.203$, $SE = .072$) and focal processing on text ($M = .124$, $SE = .068$).

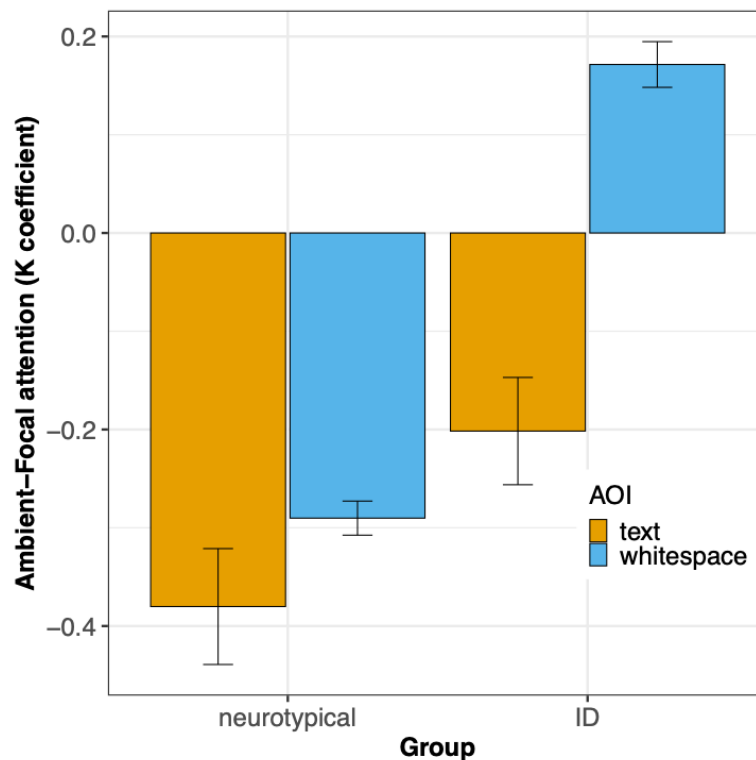


Figure 14 *Ambient and focal attention (K coefficient) depending on group and AOI in Task 1*
Bar heights represent mean values of K coefficient; whiskers indicate the 95% confidence intervals for the means.

The ANOVA for the number of fixations as a dependent variable showed a significant effect of group ($F(1, 50) = 6.21$, $p = 0.016$, $\eta^2 = 0.062$). The group with ID performed more fixations ($M = 17.40$, $SE = 2.02$) than the neurotypical group

($M = 10.00$, $SE = 2.19$). The analysis also revealed a significant main effect of AOI type ($F(1, 50) = 28.82$, $p < 0.001$, $\eta^2 = 0.057$). Both groups, on average, exhibited significantly more fixations on whitespace ($M = 18.44$, $SE = 2.67$) than on text ($M = 8.99$, $SE = 0.62$).

Also, we observed a significant interaction between the inclusion of pronouns and AOI type, ($F(1, 50) = 4.94$, $p = 0.031$, $\eta^2 = 0.005$), as illustrated in Figure 15. The pairwise comparisons decomposing this interaction term revealed a significant difference in the number of fixations in the text depending on the inclusion of null and overt pronouns with a significantly higher number of fixations on texts without these elements ($M = 9.39$, $SE = 0.641$) than those that included them ($M = 8.58$, $SE = 0.631$), ($t(50) = 3.18$, $p = 0.002$). Both groups also demonstrated a statistical tendency for a higher number of fixations on whitespace when the text had null and overt pronouns ($M = 20.03$, $SE = 3.07$) than when it did not ($M = 16.84$, $SE = 2.54$) ($t(50) = 1.75$, $p = 0.085$). These results may denote effort in visual processing (Rodríguez et al., 2025) of texts without pronouns.

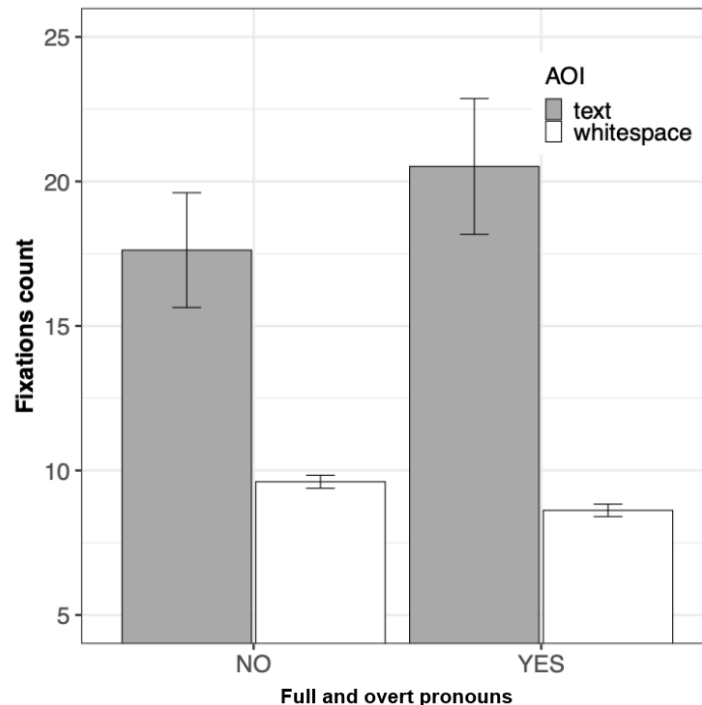


Figure 15 Number of fixations depending on AOI and inclusion of pronouns in Task 1

Bar heights represent mean values of fixation count; whiskers indicate the 95% confidence intervals for the means.

The analysis for average fixation duration as a dependent variable revealed a significant main effect of the group ($F(1,50) = 18.43$, $p < .001$, $\eta^2 = .219$), with longer average fixation duration in the group with ID ($M = 327$ ms., $SE = 12.70$) than in the neurotypical group ($M = 247$ ms., $SE = 13.70$). There was also a statistically significant main effect of AOI ($F(1,50) = 28.82$, $p < .001$, $\eta^2 = .057$), with longer average fixation durations for text ($M = 306$ ms., $SE = 10.50$) than for white space ($M = 269$ ms., $SE = 9.43$). Finally, the interaction effect of the group and AOI was obtained only on the marginally significant level, $F(1,50) = 3.97$, $p = .052$, $\eta^2 = .008$). Pairwise comparison for this effect revealed slightly larger differences in average fixation duration on text ($M = 353$ ms., $SE = 14.30$) and white space ($M = 302$ ms., $SE = 12.80$) in the group with ID than a difference in average fixation duration on text ($M = 259$ ms., $SE = 15.40$) and white space ($M = 235$ ms., $SE = 13.80$) in the neurotypical group, as illustrated in Figure 16.

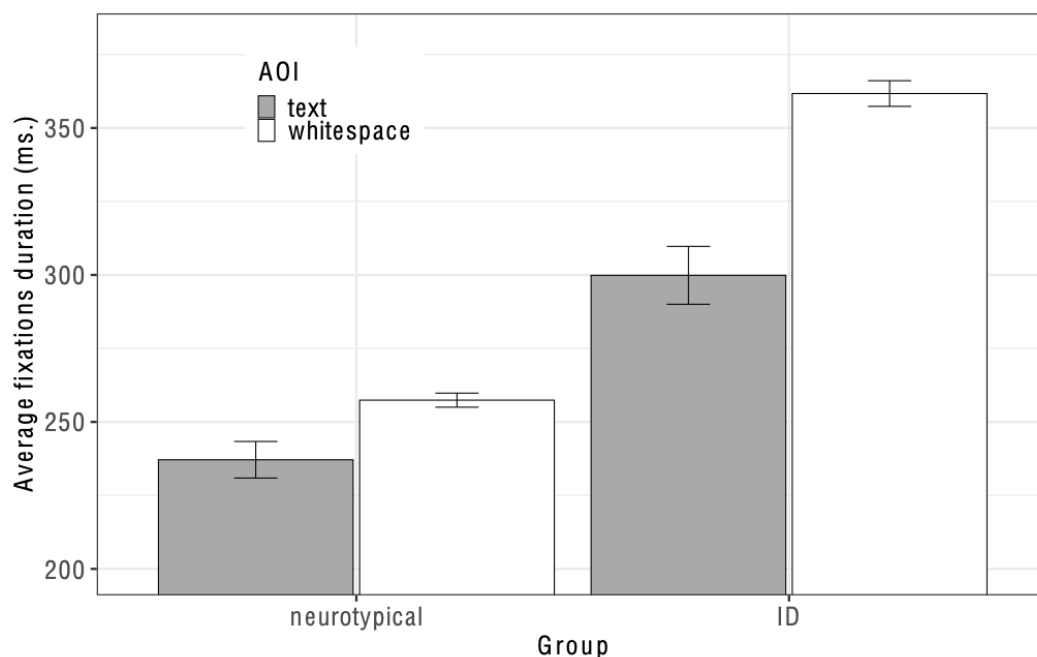


Figure 16 Average fixation duration depending on AOI and group in Task 1

Bar heights represent means; whiskers indicate the 95% confidence intervals for the means.

In summary, the group and AOI type (text vs. whitespace) showed meaningful differences in the number of fixations, and visual attention mode: ambient vs focal. The analysis of ambient and focal attention indicated that when reading text, the group with ID showed more focal attention than the neurotypical group. This effect was independent of the type of text (inclusion of pronouns). We

observed that the inclusion of null and overt pronouns yields more fixations on whitespace, which is one of the indicators of cognitive load.

We demonstrated that participants in the ID group in general exhibited significantly more and longer fixations which might be an indicator of deeper cognitive involvement in task completion in this group. That is especially visible in the analysis of eye movements located on the text.

4.7.3. Task 2: subordinate clauses

The results will be reported following the same structure as for Task 1. Data on the perceived text difficulty was analysed through a two-way ANOVA, with group and text type (with or without subordinate clauses) as independent variables. The group showed a significant effect ($F(1, 308) = 34.977, p < 0.001, \eta^2 = 0.101$). In general, the ID group perceived the texts as more difficult ($M = 1.67, SE = 0.77$) than the neurotypical group ($M = 1.17, SE = 0.35$). The presence of subordinate clauses, on the other hand, showed no significant effect ($F(1, 308) = .274, p = 0.600, \eta^2 = 0.008$); nor did the interaction of both variables ($F(1, 308) = .005, p = .940, \eta^2 < 0.001$).

The participants' preference (between texts with or without subordinate clauses) showed a significant intra-group difference ($F(1, 150) = 73.529, p < 0.001, \eta^2 = 0.100$). All 26 neurotypical participants and most participants with ID (65.4%) expressed no preference.

4.7.3.1. Eye movements

A series of 2 (group: ID vs typical) x 2 (subordinate: included vs omitted) x 2 (AOI type: text vs white space) mixed-design ANOVA was conducted with eye-movement related metrics as dependent variables (K coefficient, number of fixations, and average fixation duration).

Regarding ambient and focal attention, it yielded a significant effect of the group ($F(1, 47) = 27.48, p < .001, \eta^2 = .256$). The ID group was less ambient ($M = -0.197, SE = 0.079$) than the neurotypical group ($M = -0.799, SE = 0.084$). There was also a significant main effect of AOI ($F(1, 47) = 36.14, p < .001, \eta^2 = 0.133$). Both groups were less ambient while reading text ($M = -0.296, SE = 0.053$) than when looking at a whitespace ($M = -0.698, SE = 0.078$). The results corroborate

those from the first task. Interestingly, the analyses revealed marginally significant 3-way interaction of group, AOI and subordinate clauses ($F(1, 47) = 3.30$, $p = .076$, $\eta^2 = 0.008$). The pairwise comparisons showed that the neurotypical group exhibited a significantly higher K coefficient ($M = -0.474$, $SE = 0.079$) when reading text with clauses than text without clauses ($M = -0.631$, $SE = 0.084$). The effect is shown on Figure 17.

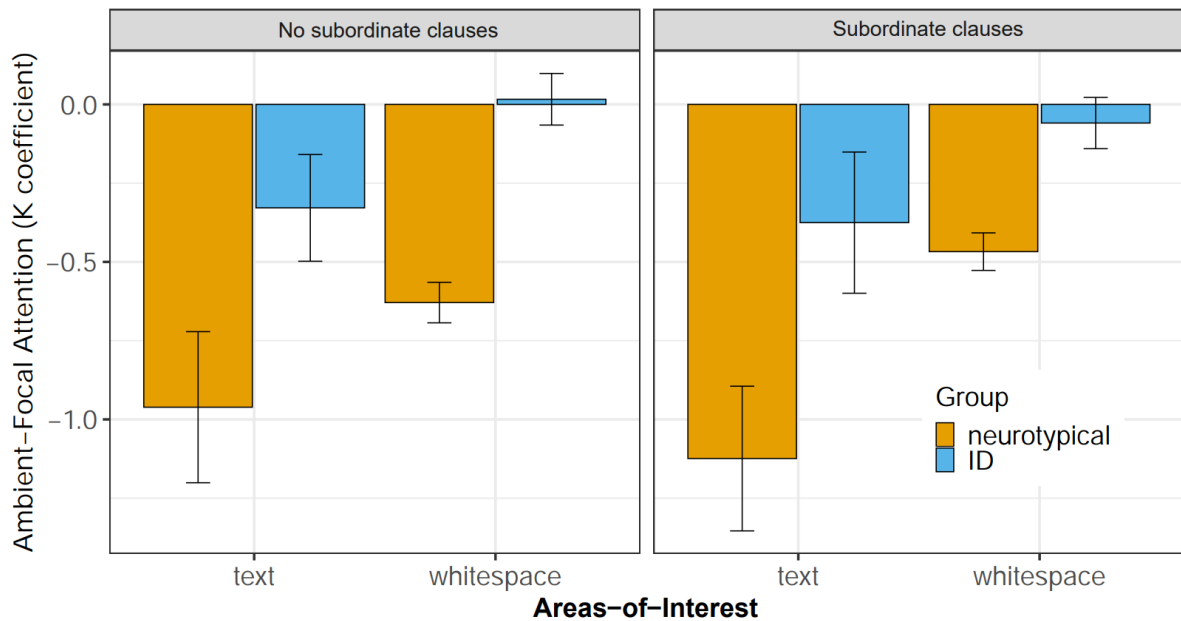


Figure 17 *Ambient/Focal attention while reading text or looking at whitespace*

Bar heights represent mean values of K coefficient; whiskers indicate the 95% confidence intervals for the means.

Next, we analysed the differences in the number of fixations. The analysis revealed that the ID group had more fixations ($M = 217.50$, $SE = 22.50$) than the neurotypical one ($M = 83.20$, $SE = 24.0$), ($F(1, 47) = 16.66$, $p < 0.001$, $\eta^2 = 0.171$).

The group with ID also had a longer average duration of fixations ($M = 442$, $SE = 20.00$) than the neurotypical group ($M = 294$, $SE = 21.3$), ($F(1, 47) = 25.50$, $p < 0.001$, $\eta^2 = .278$). The interaction between AOI type and group indicates that participants with ID had much longer fixations on the text ($M = 499$, $SE = 24.8$) than on whitespace ($M = 384$, $SE = 19.8$), $t(47) = 5.64$, $p < 0.001$. This difference was insignificant for neurotypical participants, ($t(47) = 1.50$, $p = 0.139$) (Fig. 18).

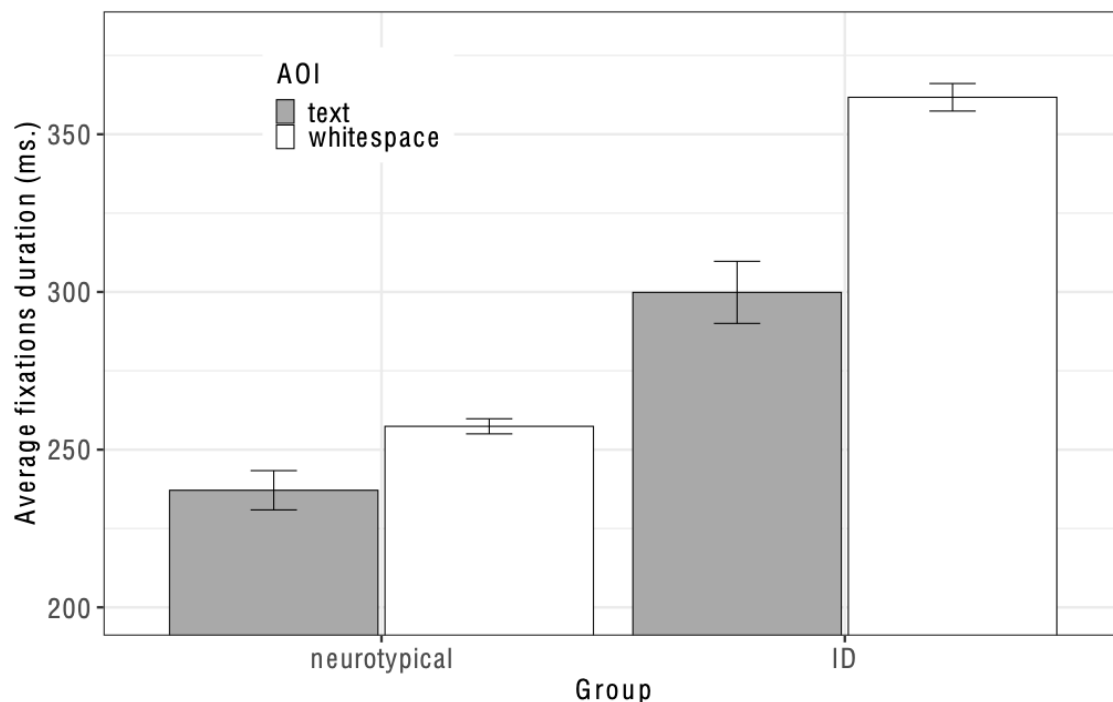


Figure 18 *Average fixation duration results of Task 2*

Bar heights represent mean values of average fixation duration; whiskers indicate the 95% confidence intervals for the means.

In summary, we found systematic differences between participants with ID and their neurotypical counterparts. The group with ID was less ambient and had more frequent and longer fixations while reading the text than the neurotypical group. We did not observe any significant differences due to the presence or absence of subordinate clauses.

4.8. Discussion and conclusions

This study examined linguistic elements often discouraged by EL guidelines. There is ongoing expert debate regarding the effectiveness of these adaptations, as most guidelines are primarily rooted in practice and intuition rather than empirical evidence. The study aims to help bridge this gap. In the following section, we address our hypotheses based on the empirical results of the present study.

H1. The presence of null and overt pronouns makes the text harder to understand for people with ID.

In Task 1, comprehension was assessed through open-ended questions. The results showed that H1 was not supported, as there was no significant effect of null or overt pronouns on comprehension in either the group with ID or the neurotypical group ($F(1, 620) = 0.102, p = 0.337, \eta^2 = 0.001$). Therefore, we cannot conclude that these elements are either detrimental or beneficial for content comprehension in either group. This finding calls into question whether such pronouns could, in fact, be used in Catalan EL texts without impairing comprehension.

H2a. People with ID perceive texts with null and overt pronouns as more difficult to understand and prefer texts without those elements.

H2b. People with ID perceive texts with subordinate clauses as more difficult to understand and prefer texts without those elements.

These aspects were assessed using a Likert scale for perceived difficulty, along with direct preference questions. Hypothesis H2a was not supported: 80.7% of the group with ID showed no preference regarding the inclusion or omission of null and overt pronouns and no significant differences were observed in either group's perception of text difficulty based on the inclusion of these elements ($F(1, 204) = 2.433, p = 0.120, \eta^2 = 0.008$). H2b is also false, as 65.4% of the group with ID showed no preference and the inclusion of subordinate clauses did not significantly affect perceived difficulty in either group ($F(1, 308) = .274, p = 0.600, \eta^2 = 0.008$).

H3a. The presence of null and overt pronouns affects the cognitive effort required for text processing.

H3b. The presence of subordinate clauses affects the cognitive effort required for text processing.

These aspects were evaluated using eye-tracking data, which supported hypothesis H3a by revealing significant differences related to the inclusion of null and overt pronouns. For both groups, texts containing null and overt pronouns elicited more fixations on whitespace ($M = 20.03, SE = 3.07$) than texts without these elements ($M = 16.84, SE = 2.54$), ($t(50) = 1.75, p = 0.085$). Conversely, texts without null or overt pronouns prompted more fixations on the text itself ($M =$

9.39, $SE = 0.641$) compared to texts that included them ($M = 8.58$, $SE = 0.631$), ($t(50) = 3.18$, $p = 0.002$). This indicates that texts without null or overt pronouns require greater cognitive effort to process (Rodríguez et al., 2025), which contradicts the recommendations outlined in EL guidelines. On the other hand, H3b is false because the presence of subordinate clauses had no significant effect on eye movements. Additionally, there were no significant interactions between the linguistic elements and the group.

The study has also provided some relevant findings outside of the scope of our initial hypotheses. To begin with, the group (ID/neurotypical) is the only variable that consistently showed a significant effect on almost all measures, as expected. Regarding ambient-focal attention, while the neurotypical group showed ambient attention in all cases, the group with ID was always more focused on the text. Overall, the group with ID also showed both a greater number of fixations and longer fixations durations.

The study's conclusive findings show no discernible differences regarding the use of subordinate clauses in EL across all aspects analysed. Conversely, the results offer some support for the use of pronouns, aligning with and complementing previous findings in Loureda et al. (2024), which suggested that the presence of null pronouns facilitates reading for neurotypical adults. The findings of the present study contradict established EL guidelines (see § 2.1.3). Specifically, the inclusion of simple sentences had no measurable effect on any variable. Furthermore, the omission of null and overt pronouns was shown to be unfavourable for reading in both groups (prompting more fixations on the text, suggesting a higher cognitive effort), yet this omission did not significantly affect either group's performance on comprehension questions.

Despite the contributions of the present study, several limitations should be acknowledged, that suggest avenues for future research. In Task 2, processing difficulty was measured exclusively through eye-tracking, preference ratings, and perceived difficulty questions, without including comprehension questions. While the choice for this approach is explained in § 4.8, adding comprehension measures could have further enriched the analysis. Another limitation is the relatively small sample size. Ethical constraints regarding participants with ID,

combined with the need for a controlled environment for eye-tracking, required careful planning and extended recruitment time, which limited the number of participants. Future studies should aim to replicate this work with a larger pool of participants. Furthermore, no previous study was fully comparable to the present one, suggesting the need for replication studies both of prior research and of the current study itself. Future research could also explore additional eye-tracking measures and study other features or target users of EL. Comparing results across languages with frequent use of null and overt pronouns and subordinate clauses could provide additional insights. To control for order effects in future studies, the texts should be presented in a randomized text order, addressing a limitation of the current design.

Although we cannot yet draw definitive conclusions regarding specific EL guideline recommendations, the present study underscores the value of empirically testing EL and opens new avenues for research. No clear benefits were observed from following the EL recommendations concerning null and overt pronouns or the use of subordinate clauses. We hope these results inspire much-needed future studies with larger participant samples, examining additional linguistic or graphic elements of EL or different target groups.

- **Conflict of interests and data availability statement**

Authors declare no financial or proprietary interests. The data and analysis scripts related to the reported results are available on OSF: https://osf.io/md6g7/overview?view_only=c90295d6d1cc44708abb3dc4aca762a0

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4.9. References

- Agència de Salut Pública. (2023). *La salut a Barcelona 2022. Lectura fàcil*. <https://www.aspb.cat/wp-content/uploads/2023/12/ASPB-salutbarcelona2022-breu-231211.pdf>
- Alarcon, R., Moreno Lopez, L., Segura-Bedmar, I., & Martínez Fernández, P. (2019). Lexical simplification approach using easy-to-read resources. *Revista de Procesamiento de Lenguaje Natural*, 63. <https://doi.org/10.26342/2019-63-10>
- Allen, S. (2000). A discourse-pragmatic explanation for argument representation in child Inuktitut. *Linguistics*, 38, 483–521. <https://doi.org/10.1515/ling.38.3.483>
- Boland, J. (2004). Linking eye movements to sentence comprehension in reading and listening. In M. Carreiras & C. Clifton Jr. (Eds.), *The on-line study of sentence comprehension* (pp. 51–76). Psychology Press.
- Borghardt, L., Deilen, S., Fuchs, J., Gros, A., Hansen-Schirra, S., Nagels, A., Schiffli, L., & Sommer, J. (2021). Neuroscientific research on the processing of easy language. *Frontiers in Communication*, 6. <https://doi.org/10.3389/fcomm.2021.698044>
- Bruckmaier, G., Binder, K., Krauss, S., & Kufner, H. M. (2019). An eye-tracking study of statistical reasoning with tree diagrams and 2 × 2 tables. *Frontiers in Psychology*, 10, 632. <https://doi.org/10.3389/fpsyg.2019.00632>
- Buell, S., Langdon, P. E., Pounds, G., & Bunning, K. (2020). An open randomized controlled trial of the effects of linguistic simplification and mediation on the comprehension of ‘easy read’ text by people with intellectual disabilities. *Journal of Applied Research in Intellectual Disabilities*, 33(2), 219–231. <https://doi.org/10.1111/jar.12666>
- Chambers, J. M. (1983). *Graphical methods for data analysis* (1st ed.). Chapman and Hall/CRC. <https://doi.org/10.1201/9781351072304>
- Clifton, C., Jr., Staub, A., & Rayner, K. (2007). Eye movements in reading words and sentences. In R. P. G. van Gompel, M. H. Fischer, W. S. Murray, & R. L. Hill (Eds.), *Eye movements: A window on mind and brain* (pp. 341–371). Elsevier. <https://doi.org/10.1016/B978-008044980-7/50017-3>
- Comes, A. (1990). *TLC: Test de lectura comprensiva*. TEA Ediciones.
- Csákvári, J., & Gyori, M. (2015). Applicability of standard eye-tracking technique in people with intellectual disability: Methodological conclusions from a series of studies. *Studies in Health Technology and Informatics*, 217, 63–70. <https://pubmed.ncbi.nlm.nih.gov/26294454/>
- Deilen, S., & Schiffli, L. (2020). Using eye-tracking to evaluate language processing in the easy language target group. In S. Hansen-Schirra & C. Maaß (Eds.), *Easy language research: Text and user perspectives* (pp. 273–281). Frank & Timme.
- Dickinson, K. V., Ortiz-Ramírez, P. A., Arrieta-Zamudio, A., Grinstead, J., & Flores-Ávalos, B. (2023). Overt subject pronoun use in switch-reference contexts in child Spanish developmental language disorder: A discriminant function analysis. *Journal of Speech, Language, and Hearing Research*, 66(2), 605–619. https://doi.org/10.1044/2022_JSLHR-21-00483

- D'Mello, S. K., Southwell, R., & Gregg, J. (2020). Machine-learned computational models can enhance the study of text and discourse: A case study using eye tracking to model reading comprehension. *Discourse Processes*, 57(5–6), 420–440. <https://doi.org/10.1080/0163853X.2020.1739600>
- Duchowski, A. T. (2007). *Eye tracking methodology: Theory and practice*. Springer.
- Ducrot, O., & Todorov, T. (2003). *Diccionario enciclopédico de las ciencias del lenguaje*. Siglo XXI Editores.
- Eisenberg, M. L., & Zacks, J. M. (2016). Ambient and focal visual processing of naturalistic activity. *Journal of Vision*, 16(2). <https://doi.org/10.1167/16.2.5>
- Fajardo, I., Ávila, V., Ferrer, A., Tavares, G., Gómez, M., & Hernández, A. (2014). Easy-to-read texts for students with intellectual disability: Linguistic factors affecting comprehension. *Journal of Applied Research in Intellectual Disabilities*, 27, 212–225. <https://doi.org/10.1111/jar.12065>
- Federal Ministry of Justice and Consumer Protection. (2011). *BITV 2.0: Verordnung zur Schaffung barrierefreier Informationstechnik nach dem Behindertengleichstellungsgesetz (Barrierefreie-Informationstechnik-Verordnung – BITV 2.0)*. http://www.gesetze-im-internet.de/bitv_2_0/BJNR184300011.html
- Ferreira, F., Apel, J., & Henderson, J. M. (2008). Taking a new look at looking at nothing. *Trends in Cognitive Sciences*, 12(11), 405–410. <https://doi.org/10.1016/j.tics.2008.07.007>
- Froncón, C., & Kaakinen, J. (2023). Reading easy language texts written by public authorities: Evidence from eye tracking. *Finnish Journal of Linguistics*, 36, 7–36. <https://doi.org/10.61197/fjl.126062>
- Gelormini-Lezama, C., & Almor, A. (2011). Repeated names, overt pronouns, and null pronouns in Spanish. *Language and Cognitive Processes*, 26(3), 437–454. <https://doi.org/10.1080/01690965.2010.495234>
- González-Sordé, M., & Matamala, A. (2023). Empirical evaluation of Easy Language recommendations: A systematic literature review from journal research in Catalan, English, and Spanish. *Universal Access in the Information Society*. <https://doi.org/10.1007/s10209-023-00975-2>
- Grimm, J., & Grimm, H. (2018). *21 contes dels germans Grimm*. ING Edicions.
- Grinstead, J., Lintz, P., Pratt, A., Vega-Mendoza, M., De la Mora, J., Cantú-Sánchez, M., & Flores-Avalos, B. (2018). Null subject occurrence in monolingual Spanish SLI: A discriminant function analysis. *Languages*, 3(2). <https://doi.org/10.3390/languages3020017>
- Gutermuth, S. (2020). *Leichte Sprache für alle? Eine zielgruppenorientierte Rezeptionsstudie zu Leichter und Einfacher Sprache*. Frank & Timme.
- Hansen-Schirra, S., & Maaß, C. (2020). *Easy language research: Text and user perspectives*. Frank & Timme.

- He, W., Garrido, M. I., Sowman, P. F., Brock, J., & Johnson, B. W. (2015). Development of effective connectivity in the core network for face perception. *Human Brain Mapping*, 36(6), 2161–2173. <https://doi.org/10.1002/hbm.22762>
- Helmert, J. R., Joos, M., Pannasch, S., & Velichkovsky, B. M. (2005). Two visual systems and their eye movements: Evidence from static and dynamic scene perception. *Proceedings of the Annual Meeting of the Cognitive Science Society*, 27. <https://escholarship.org/uc/item/9nv0c661>
- IEC - Institut d'Estudis Catalans. (2022). *Gramàtica essencial de la llengua catalana*. IEC. <https://geiec.iec.cat/inici>
- IFLA - International Federation of Library Associations and Institutions. (2012). *Directrius per a materials de lectura fàcil*. Associació Lectura Fàcil. https://www.lecturafacil.net/media/resources/2012_Directrius_IFLA_Catal%C3%A0.pdf
- ILSMH. (1997). *Make it simple: European guidelines for the production of easy-to-read information for people with learning disability*. Associació Lectura Fàcil. https://repositori.lecturafacil.net/sites/default/files/1998%20EI%20cam%C3%AD%20m%C3%A9s%20f%C3%A1cil%20Directrius%20europees%20per%20gernar%20informaci%C3%B3%20de%20Lectura%20F%C3%A0cil%20ILSMH_ANG.pdf
- ISO - International Organization for Standardization. (2023b). *Information technology — User interfaces — Requirements and recommendations on making written text easy to read and understand*. (ISO Standard No. ISO/IEC 23859).
- Johansson, R., Nyström, M., Dewhurst, R., & Johansson, M. (2022). Eye-movement replay supports episodic remembering. *Proceedings of the Royal Society B*, 298(1977). <https://doi.org/10.1098/rspb.2022.0964>
- Just, M. A., Carpenter, P. A., & Woolley, J. D. (1982). Paradigms and processes in reading comprehension. *Journal of Experimental Psychology: General*, 111(2), 228–238. <https://doi.org/10.1037/0096-3445.111.2.228>
- Kim, S. H., Dong, Z., Xian, H., Upatasing, B., & Yi, J. S. (2012). Does an eye tracker tell the truth about visualizations?: Findings while investigating visualizations for decision making. *IEEE Transactions on Visualization and Computer Graphics*, 18(12), 2421–2430. <https://doi.org/10.1109/TVCG.2012.215>
- Krejtz, I., Szarkowska, A., Krejtz, K., Walczak, A., & Duchowski, A. (2012). Audio description as an aural guide of children's visual attention: Evidence from an eye-tracking study. In *Proceedings of the Symposium on Eye Tracking Research and Applications (ETRA '12)* (pp. 99–106). ACM. <https://doi.org/10.1145/2168556.2168572>
- Krejtz, K., Duchowski, A. T., & Cöltekin, A. (2014). High-level gaze metrics from map viewing: Charting ambient/focal visual attention. In P. Kiefer, I. Giannopoulos, M. Raubal, & A. Krüger (Eds.), *CEUR Workshop Proceedings* (pp. 37–41). CEUR-WS. <http://ceur-ws.org/Vol-1241/>

- Krejtz, K., Duchowski, A. T., Krejtz, I., Kopacz, A., & Chrzastowski-Wachtel, P. (2016). Gaze transitions when learning with multimedia. *Journal of Eye Movement Research*, 9(1). <https://doi.org/10.16910/jemr.9.1.5>
- Lindholm, C., & Vanhatalo, U. (2021). *Handbook of easy languages in Europe*. Frank & Timme.
- Loureda Lama, Ó., Izquierdo Alegria, D., Gelormini-Lezama, C., Hernández Pérez, C., Teucher, M., Cruz Rubio, A., & Julio Vergara, C. (2024). La encapsulación y la correferencia en español mediante pronombres demostrativos y repeticiones léxicas: Una aproximación experimental con eye-tracking. *Revista Signos. Estudios de Lingüística*, 57(114). <https://revistasignos.cl/index.php/signos/article/view/1164>
- Maaß, C. (2020). *Easy language – Plain language – Easy language plus*. Frank & Timme.
- Mayol, L., & Clark, R. (2010). Pronouns in Catalan: Games of partial information and the use of linguistic resources. *Journal of Pragmatics*, 42(3), 629–651. <https://doi.org/10.1016/j.pragma.2009.07.004>
- Mazzaggio, G., & Shield, A. (2020). The production of pronouns and verb inflections by Italian children with ASD: A new dataset in a null subject language. *Journal of Autism and Developmental Disorders*, 50(4), 1425–1433. <https://doi.org/10.1007/s10803-019-04349>
- Merriam-Webster. (n.d.). Subordinate clause. Retrieved from <https://www.merriam-webster.com/dictionary/subordinate%20clause>
- Mézière, D. C., Yu, L., Reichle, E. D., von der Malsburg, T., & McArthur, G. (2023). Using eye-tracking measures to predict reading comprehension. *Reading Research Quarterly*, 58, 425–449. <https://doi.org/10.1002/rrq.498>
- Pappert, S., & Bock, B. M. (2020). Easy-to-read German put to the test: Do adults with intellectual disability or functional illiteracy benefit from compound segmentation? *Reading and Writing: An Interdisciplinary Journal*, 33(5), 1105–1131. <https://doi.org/10.1007/s11145-019-09995-y>
- Perego, E. (2020). *Accessible communication: A cross-country journey*. Frank & Timme.
- Perez, M., & Mestre, R. (2022). *Diccionari de lingüística*. Publicacions de la Generalitat Valenciana.
- R Core Team. (2025). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. <https://cran.r-project.org/doc/manuals/r-release/fullrefman.pdf>
- Raven, J. C. (1998). *Raven's progressive matrices*. Pearson Clinical.
- Rayner, K. (1998). Eye movements in reading and information processing: 20 years of research. *Psychological Bulletin*, 124(3), 372–422. <https://doi.org/10.1037/0033-2909.124.3.372>
- Real, F., & Christiansen, M. H. (2007). Processing of relative clauses is made easier by frequency of occurrence. *Journal of Memory and Language*, 57(1), 1–23. <https://doi.org/10.1016/j.jml.2006.08.014>
- Renkewitz, F., & Jahn, G. (2010). Looking at nothing indicates memory search in multiattribute decision making. *Proceedings of the Annual Meeting of the Cognitive Science Society*, 32.

- Rivero-Contreras, M., Engelhardt, P. E., & Saldaña, D. (2021). An experimental eye-tracking study of text adaptation for readers with dyslexia: Effects of visual support and word frequency. *Annals of Dyslexia*, 71(1), 170–187. <https://doi.org/10.1007/s11881-021-00217-1>
- Rodríguez, K. V., Fonseca, L., Iaconis, F. R., Del-Punta, J., & Gasaneo, G. (2025). Eye tracking studies, a way to understand difficulties in reading processing. *Ocnos*, 24(1). https://doi.org/10.18239/ocnos_2025.24.1.488
- Roland, D., Mauner, G., & Hirose, Y. (2021). The processing of pronominal relative clauses: Evidence from eye movements. *Journal of Memory and Language*, 119. <https://doi.org/10.1016/j.jml.2021.104244>
- Saggion, H., Gómez Martínez, E., Etayo, E., Anula, A., & Bourg, L. (2011). Text simplification in Simplext: Making text more accessible. *Revista de la Sociedad Española Para el Procesamiento del Lenguaje Natural*, 47, 341–342. <http://journal.sepln.org/sepln/ojs/ojs/index.php/pln/article/view/1000>
- Schiffli, L. (2020). Hierarchies in lexical complexity: Do effects of word frequency, word length and repetition exist for the visual word processing of people with cognitive impairments? In S. Hansen-Schirra & C. Maaß (Eds.), *Easy language research: Text and user perspectives* (pp. 227–239). Frank & Timme.
- Schmutz, S., Sonderegger, A., & Sauer, J. (2019). Easy-to-read language in disability-friendly web sites: Effects on nondisabled users. *Applied Ergonomics*, 74, 97–106. <https://doi.org/10.1016/j.apergo.2018.08.013>
- Scholz, A., Klichowicz, A., & Krems, J. F. (2018). Covert shifts of attention can account for the functional role of "eye movements to nothing". *Memory & Cognition*, 46(2), 230–243. <https://doi.org/10.3758/s13421-017-0760-x>
- Serratrice, L., Sorace, A., & Paoli, S. (2004). Crosslinguistic influence at the syntax–pragmatics interface: Subjects and objects in English–Italian bilingual and monolingual acquisition. *Bilingualism: Language and Cognition*, 7, 183–205. <https://doi.org/10.1017/S1366728904001610>
- Southwell, R., Gregg, J., Bixler, R., & D'Mello, S. K. (2020). What eye movements reveal about later comprehension of long connected texts. *Cognitive Science*, 44(10), 1–24. <https://doi.org/10.1111/cogs.12905>
- Staub, A. (2010). Eye movements and processing difficulty in object relative clauses. *Cognition*, 116, 71–86. <https://doi.org/10.1016/j.cognition.2010.04.002>
- Sutherland, R. T., & Isherwood, T. (2016). The evidence for easy-read for people with intellectual disabilities: A systematic literature review. *Journal of Policy and Practice in Intellectual Disabilities*, 12(4), 297–310. <https://doi.org/10.1111/jppi.12201>
- Tiffin-Richards, S. P., & Schroeder, S. (2015). Word length and frequency effects on children's eye movements during silent reading. *Vision Research*, 113, 33–43. <https://doi.org/10.1016/j.visres.2015.05.008>
- Trevarthen, C. B. (1968). Two mechanisms of vision in primates. *Psychologische Forschung*, 31(4), 299–337. <https://doi.org/10.1007/BF00422717>

- UNE - Asociación Española de Normalización. (2018). *Lectura fácil. Pautas y recomendaciones para la elaboración de documentos*. (UNE norm No. 153101:2018 EX).
- van Gog, T., Paas, F., van Merriënboer, J. J. G., & Witte, P. (2005). Uncovering the problem-solving process: Cued retrospective reporting versus concurrent and retrospective reporting. *Journal of Experimental Psychology: Applied*, 11(4), 237–244. <https://doi.org/10.1037/1076-898X.11.4.237>
- Wallot, S., O'Brien, B. A., Haussmann, A., Kloos, H., & Lyby, M. S. (2014). The role of reading time complexity and reading speed in text comprehension. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 40(6), 1745–1765. <https://doi.org/10.1037/xlm0000030>
- Wei, S., Lei, Q., Chen, Y., Xin, Y. P., Kastberg, S., & Kim, S. (2018). Evaluating the effects of highlighting text animations on the attention distribution of students with math learning difficulties. *2018 ASEE Annual Conference & Exposition*.
- White, H., Heck, A., Jubran, R., Chroust, A., & Bhatt, R. S. (2022). Average fixation duration in infancy: Stability and predictive utility. *Infancy*, 27(5), 866–886. <https://doi.org/10.1111/infa.12483>
- Wickham, H., Pedersen, T., & Seidel, D. (2025). *Scales: Scale functions for visualization* (R package version 1.4.0.9000). <https://github.com/r-lib/scales>
- Wolman, C. (1991). Sensitivity to causal cohesion in stories by children with mild mental retardation, children with learning disabilities, and children without disabilities. *The Journal of Special Education*, 25, 135–154. <https://doi.org/10.1177/002246699102500202>
- Yaneva, V., Temnikova, I., & Mitkov, R. (2016). Evaluating the readability of text simplification output for readers with cognitive disabilities. In *Proceedings of the Tenth International Conference on Language Resources and Evaluation (LREC'16)* (pp. 293–299). <https://aclanthology.org/L16-1045/>

CHAPTER 5

5. Summary

Written information often contains long sentences, abstract vocabulary, and visually dense layouts that make it difficult for many people to understand. EL applied to written texts responds to this challenge by reconsidering how information is presented, both in its wording and its design. The aim is to enhance comprehensibility by using straightforward words, organizing ideas in a logical way, and adding supportive visual elements, so that more people can more easily read and use written information on their own.

One limitation of EL is that many of its recommendations are based on practical experience rather than solid empirical evidence. This dissertation addressed this gap by examining how specific features of written EL influence text processing, comprehension, perceived difficulty, and reader preference, with a particular focus on adults with ID. The overarching aim of the dissertation was to assess whether the graphic and linguistic features recommended in EL guidelines effectively support reading and understanding. The focus was also on Catalan EL practice and on elements that are particularly relevant to this language. Specifically, the study examined three features: (1) visual support, (2) null and overt pronouns, and (3) subordinate clauses.

To achieve this goal, the research combined a systematic review of existing empirical studies with two experimental investigations. Using a mixed-method approach, the studies assessed comprehension outcomes, perceived difficulty, and reader preferences through offline methods, as well as text processing through eye-tracking data. By comparing adults with and without ID, the dissertation sought to deepen understanding of how EL features interact with different cognitive profiles and to provide empirical evidence that can inform more flexible and effective EL practices.

The first study, presented in Chapter 2, reviewed the existing empirical research that evaluates recommendations found in EL guidelines in Catalan, English, and Spanish. Through a systematic search across multiple academic databases, a large body of literature was screened, but only a small number of studies met the

criteria for inclusion. The results revealed that empirical research on EL recommendations is extremely limited and methodologically heterogeneous. While some studies provide partial support for specific recommendations, the overall evidence base is weak and often inconclusive. This review highlighted a clear mismatch between the prominence of certain rules in EL guidelines and the extent to which they have been empirically tested, thereby motivating the focus and design of the subsequent experimental studies.

The second study, reported in Chapter 3, investigated the role of visual support in EL texts, a feature that is strongly emphasised in most guidelines. Adults with and without ID read EL texts that either contained (1) no visual support, (2) photographs, or (3) illustrations. Their eye movements were recorded to examine text processing, and comprehension, perceived difficulty, and visual preferences were also assessed through offline methods. The findings show that the presence and type of visual support did not significantly affect comprehension or perceived difficulty in either group. However, clear differences emerged in eye-tracking data: participants with ID spent more time fixating on text and blank areas, whereas neurotypical participants devoted more attention to images, and texts with photographs appeared to require greater cognitive effort than those with illustrations.

The third study, presented in Chapter 4, examined two linguistic features commonly found in standard Catalan texts and discouraged in EL guidelines: subordinate clauses and null and overt pronouns. Using a similar experimental design to the study in Chapter 3, we explored how these features influence perceived difficulty, reader preference, comprehension, and text processing. Eye-tracking data revealed that both linguistic features affect how readers allocate attention and process the text, but they do not significantly influence perceived difficulty or, in the case of null and overt pronouns, comprehension. Notably, the inclusion of subordinate clauses did not result in poorer reading outcomes.

CHAPTER 6



6. Conclusions

Information and communication should be provided in EL, as well as in augmentative and alternative modes and methods (Ley 6/2022, 2022; UN, 2008), in order to be intuitive, easily retrievable, and designed to promote user autonomy. The present dissertation emerges from previous research and professional practice that underscored the need to empirically assess the effectiveness of specific EL features. In particular, there remains a notable gap in studies examining the impact of these features on EL's primary user groups, such as individuals with ID, and through online methods, such as eye tracking (see § 1.2.3.1) (Sutherland & Isherwood, 2016; Chinn & Homeyard, 2017; Rivero & Saldaña, 2020).

In light of this, this dissertation set out to empirically explore how some underresearched EL features influence text processing, text comprehension and other aspects such as preference and perceived difficulty among individuals with ID. In this concluding section, we will revisit the main objective and concomitant aims of our study, evaluating the extent to which they have been achieved and reflecting on the broader implications of our findings.

The main objective of this dissertation is to investigate whether some key features of EL help one of its primary target groups, people with ID, to process and understand texts more easily. To do so, three main aims were addressed:

A1: Review the existing empirical studies in Catalan, English and Spanish on the recommendations in EL guidelines → *Linked to the literature review in Chapter 2*

A2: Assess the effects of visual support and image type in EL texts on comprehension and perception, and on text processing as measured through eye movements, on people with and without ID → *Linked to the study in Chapter 3*

A3: Assess the effects of the exclusion of subordinate clauses, null and overt pronouns in EL texts on comprehension and perception, and on text processing as measured through eye movements, on people with and without ID → *Linked to the study in Chapter 4*

The first step in achieving these aims was to conduct a literature review and the second one, building on its findings, was to perform two empirical studies. Below, we summarize the results for aim and indicate whether it was achieved. This overview draws on the findings presented in Chapters 2–4.

A1) The first aim of this dissertation was to assess the current state of empirical research on EL recommendations. To achieve this, a systematic review of existing studies in Catalan, English and Spanish was conducted, following a methodology similar to previous literature reviews in the field (Hurtado et al., 2014; Sutherland & Isherwood, 2016; Chinn & Homeyard, 2017; Rivero & Saldaña, 2020). The findings largely echoed those of earlier reviews: while a few EL recommendations, such as lexical simplification and visual support inclusion, are partially supported by empirical evidence, this evidence remains inconclusive. Most recommendations, in contrast, are either largely untested, yield inconsistent results across studies, or are partially contradicted by empirical findings, highlighting the ongoing need for further investigation.

Specifically, the review in Chapter 2 found:

Table 17 *Summary of results from the literature review*

The review found empirical evidence on the following aspects:	References, participants	They <u>support</u> EL recommendations in that...	They <u>do not support</u> EL recommendations in that...
(1) Visual support	Rivero-Contreras et al. (2021) 20 university students with dyslexia + 20 neurotypical age-matched people in the control group.	The use of related images supports word processing, prediction of upcoming information, and recognition of semantic content, facilitating lexical access for readers with lower vocabulary and less reading experience.	The use of images does not clearly improve overall text comprehension or reading accuracy for readers with lower vocabulary and less reading experience.
	Schatz et al. (2017) 87 younger participants aged 26–59 without ID + 72 older participants aged 60–81 without ID.	Younger participants comprehended the EL text with images better than the EL version without images. The older participants performed better on the EL version than the standard language one.	Younger participants comprehended the EL text with images just as well as the standard language version.

(2) Linguistic simplification	Buell et al. (2020) 60 people with ID aged 16-75.		Linguistic simplification did not affect comprehension for people with ID.
	Schmutz et al. (2019) 128 university students without ID.	Neurotypical users processed information better when the text was simplified.	Linguistic simplification led to longer reading times and reduced text liking among neurotypical users.
(3) Word frequency	Rivero-Contreras et al. (2021) Participants listed in a cell above.	Participants with lower vocabulary and lower print exposure benefited the most from lexical simplification. High-frequency words showed to result in shorter reading time at text-level and to facilitate (1) overall sentence comprehension and processing, and (2) lexical access to particular words.	
	Fajardo et al. (2013) 19 students with ID with an average age of 19.		High-frequency words do not improve inferential comprehension for people with ID.
	Fajardo et al. (2014) 28 students with ID with an average age of 18.9.		Word frequency did not affect literal or inferential comprehension for people with ID.
(4) Literacy mediation	Buell et al. (2020) Participants listed in a cell above.		Mediation showed to have no effect on the comprehensibility EL texts for people with ID.
	Schmutz et al. (2019) Participants listed in a cell above.		Explaining difficult words will result in longer texts, which can affect comprehension negatively.
(5) Connectives	Fajardo et al. (2013) Participants listed in a cell above.		Connectives had no effects on inferential comprehension for people with ID.
	Fajardo et al. (2014) Participants listed in a cell above.	On readers with ID, a higher number of connectives hinder literal comprehension.	
(6) Co-references	Fajardo et al., (2014) Participants listed in a cell above.	More co-references predicted higher difficulty and lower literal comprehension for people with ID.	
(7) Number of sentences, text length, and word length	Fajardo et al., (2014) Participants listed in a cell above.		A higher number of sentences hinder inferential and literal comprehension for people with ID (<i>as a result of EL adaptations that increase sentence count</i>).
	Schmutz et al. (2019) Participants listed in a cell above.		Neurotypical users took longer to read and liked the text less when it contained more sentences (<i>as a result of EL adaptations that increase sentence count</i>).

The findings, together with previous reviews (Hurtado et al., 2014; Sutherland & Isherwood, 2016; Chinn & Homeyard, 2017; Rivero & Saldaña, 2020), indicate that the existing literature is limited, methodologically heterogeneous, and often non-generalizable due to small and diverse participant samples and a lack of replication. Nevertheless, this review successfully identified which aspects of EL have been empirically investigated and highlighted remaining research gaps. It also pointed out key methodological challenges that need to be addressed to strengthen the field, such as ensuring studies include the primary user group (e.g., people with ID) and incorporating an online method (eye tracking). Therefore, we can conclude that the first aim of our dissertation (A1) has been achieved.

A2) Building on the insights from the review, the second part of this dissertation focused on the graphic or design aspect of EL documents, as visual support is assumed to facilitate comprehension in EL documents (as per guidelines and Schatz et al., 2017). To examine this assumption, we designed an empirical study addressing the following hypotheses, which followed the principles set out in the guidelines, and related research questions.

- *H1*: Visual support of any type has a significant effect on text comprehension for readers with ID.
- *H2*: People with and without ID explore the page differently.
- *Q1*: How does the presence and type of visual support influence the perceived level of text difficulty?
- *Q2*: How does the presence and type of visual support influence the way readers explore the page?

Contrary to H1, our findings revealed that the inclusion of visual support (whether photographs or illustrations) did not significantly affect comprehension accuracy in any participant group. These results challenge one of the most persistent assumptions in EL practice: namely, that adding relevant images necessarily enhances text comprehension. They also contradict previous research (e.g., Jones et al., 2007; Schartz et al., 2017; Wadihah and Fauzi, 2021; Rivero-Contreras, 2022). However, the findings align with studies that question the

effectiveness of visual support in accessible communication. For instance, Hurtado et al. (2014) found no benefits of visual support for comprehension. In fact, adults with intellectual disabilities performed better in a picture-only condition than in a combined text-image format. This finding is particularly relevant to our study, as our test also used a text-image format, which may increase cognitive demands by requiring readers to integrate verbal and visual information (Hurtado et al., 2014).

In contrast, clear group differences emerged regarding H2. Participants with ID showed longer fixation durations and shorter saccades, suggesting higher cognitive effort and a more localized reading strategy. Neurotypical participants, on the other hand, demonstrated broader visual exploration, particularly around images. Moreover, saccades were significantly longer on illustrations than on photographs, especially for the neurotypical group (Q2), indicating greater exploratory behaviour toward more abstract visual material. The differences observed between groups in eye movement patterns support the use of eye-tracking in studies with these participants, as they show that it is possible to gain insights into reading difficulties and information processing challenges.

Interestingly, both groups spent a substantial proportion of fixation time on whitespace areas, particularly the group with ID. This may reflect cognitive pauses during reading or differences in scene integration and visual scanning strategies (Skversky-Blocq et al., 2022). In terms of subjective perception, there were no significant differences between groups in perceived text difficulty.

Preferences regarding image type, however, showed that while most participants expressed no strong preference, neurotypical participants reported a higher preference for illustrations (19.2%) than did participants with ID (3.8%). Some participants with ID expressed discomfort with illustration styles perceived as infantilizing. Adults with visible disabilities, and particularly cognitive conditions that affect communication, are often infantilized (Nario-Redmond et al., 2019; Flynn, 2021), and many of the participants with ID in our study appeared to be aware of that. Additionally, image type did not exert any measurable influence on perceived text difficulty (Q1).

Overall, the results indicate that visual support does not necessarily aid comprehension or processing, nor does it increase liking or perceived ease. In contrast, H2 was supported, confirming that the two groups (ID/neurotypical) read and explored the page differently and that global eye-tracking measures can assess cognitive effort and be valuable tools in EL research.

A3) The third aim of the dissertation explored the linguistic side of EL by empirically testing two features that are discouraged in EL guidelines, but particularly common in Catalan standard language, and that were not assessed by studies in the literature review in Chapter 2.

The following hypotheses were tested:

- *H1*: The presence of null and overt pronouns makes the text harder to understand for people with ID.
- *H2a*: People with ID perceive texts with null and overt pronouns as more difficult and prefer texts without those elements.
- *H2b*: People with ID perceive texts with subordinate clauses as more difficult and prefer texts without those elements.
- *H3a*: The presence of null and overt pronouns has different effects on the cognitive effort of text processing.
- *H3b*: The presence of subordinate clauses has different effects on the cognitive effort of text processing.

H1 was not supported: comprehension was not significantly affected by the presence or absence of pronouns in either group. Similarly, H2a and H2b were not supported, as participants with ID did not perceive texts containing pronouns or subordinate clauses (particularly substantive and relative clauses, as described in §4.2.3) as more difficult, and most reported no clear preference between the different versions.

In contrast, H3a was supported: texts without pronouns elicited a greater number of fixations on textual areas and fewer on whitespace, indicating increased cognitive effort. This result suggests that the elimination of pronouns in favor of

repeated referents may heighten textual density rather than facilitate processing. These findings are consistent with those of Loureda et al. (2024), who reported that null pronouns can, in fact, facilitate reading among neurotypical adults. The present results indicate that a similar effect may also occur in readers with intellectual disabilities (ID). H3b was not supported, as the inclusion of subordinate clauses exerted no significant influence on cognitive processing. Taken together, the results suggest that the omission of pronouns may be counterproductive and that syntactic simplification through the removal of subordination yields little measurable benefit.

Ultimately, the study presented in Chapter 4 demonstrates that removing pronouns or subordinate clauses does not necessarily improve readability and may, in some cases, even hinder text processing. These findings are consistent with Borghardt (2022), who conducted an fMRI study and found no justification for transforming a complex sentence, specifically a causal sentence, into two independent sentences. On the contrary, presenting the information in a single complex sentence sometimes provided processing advantages.

Taken together, the three studies presented in this dissertation offer a comprehensive and empirically informed contribution to the field of EL. The findings provide evidence with potential direct applications for improving EL guidelines and practice, while also opening promising avenues for future research aimed at strengthening the empirical basis of current recommendations.

Through the literature review, this dissertation systematically identified both the scope and limitations of the existing empirical evidence in the field. It became clear that, while some EL guidelines are supported by data, most remain largely speculative and require further validation through focused empirical research. By analysing several under-examined linguistic and visual features of EL, this work has contributed to narrowing the empirical gap highlighted in Chapter 2. The results, discussed earlier in this section, reveal mixed patterns that often contradict existing recommendations or show no measurable effects, thereby calling into question the assumed benefits of some established EL practices.

Find a summary of empirical findings from Test 1 and Test 2 (Chapters 3 and 4) with potential implications for EL guideline recommendations in Table 18:

Table 18 *Summary of findings from the empirical studies (Test 1, Test 2)*

Empirical study <i>Variable studied</i>	Findings that <u>support</u> EL recommendations	Findings that <u>do not support</u> EL recommendations
Test 1 <i>Visual support</i>	- Almost all participants preferred the text to include an image, either a photograph or an illustration, rather than having no visual support.	- Visual support is not related to text comprehension for any of the groups. - Visual support did not affect the perceived difficulty of text for any of the groups.
Test 2a <i>Null and overt pronouns</i>		- Inclusion of null and overt pronouns did not affect text comprehension for either group. - The group with ID showed no preference when choosing between texts with and without null and overt pronouns. - Texts without null or overt pronouns elicited more fixations on the text itself, indicating that such texts require greater cognitive effort to process. - Neither group showed a clear preference for including or excluding those elements.
Test 2b <i>Subordinate clauses</i>		- The inclusion of subordinate clauses did not show any effects on eye movements—that is, on visual or textual processing. - The group with ID showed no preference when choosing between texts with and without subordinate clauses. - Neither group showed a clear preference for including or excluding those elements.

As shown, our findings do not support some of the current EL recommendations concerning visual support and text simplification. If future research confirms these results, some recommendations will necessarily need to be revised, as the aspects analyzed have been strongly challenged by the outcomes of Test 1 and Test 2. It is important to emphasize that a key aim of the analyses was to examine the relationship between the EL aspects assessed, namely visual support, subordinate clauses, and null and overt pronouns, and text comprehension within the primary target group of EL, which in our studies consisted of individuals with intellectual disabilities. Results showed no significant correlation between the inclusion or exclusion of these features, nor between different image types, and comprehension outcomes for either the group with ID or the neurotypical group.

It is also worth noting that if this dissertation had relied solely on offline methods such as comprehension tests, preference ratings, or perceived difficulty questionnaires, many of its most relevant findings would have remained hidden. For instance, comprehension scores did not significantly differ depending on image inclusion, image type, or the presence of subordinate clauses and null versus overt pronouns; however, the eye-tracking data revealed several meaningful effects of these features, indicating differences in textual and visual processing effort. These findings underscore the value of incorporating online data in EL studies to obtain a more detailed understanding of how readers process information in EL.

- *Limitations and future lines of research*

Several limitations of the present work must be acknowledged and point toward productive directions for future research. The literature review revealed considerable challenges in identifying comparable studies, since much of the available research differs substantially in design, population, and conceptual framework. This difficulty limited the extent to which findings could be discussed from a comparative perspective, yet it also underscored the originality and exploratory nature of the present dissertation. It also adopted a deliberately narrow scope, focusing on empirical research explicitly linked to EL recommendations and limited to selected languages and academic databases. As a result, relevant studies published in other languages or formats may not have been included.

The two experimental studies also face methodological constraints. Both relied on relatively small samples, partly due to ethical considerations and the practical demands of conducting eye-tracking research with adults with ID. The use of predominantly global eye-tracking measures somewhat limited the possibility of identifying the specific cognitive processes underlying the observed differences in reading behaviour, and in one of the tasks, comprehension was not directly assessed. Certain design aspects, such as the lack of randomized text order, may also reduce the strength of the conclusions. Moreover, some findings were

unexpected or not inconclusive, and only a limited number of linguistic and graphical EL features were examined. Another methodological limitation is that the study did not focus on a specific type of subordinate clause, which could have introduced a bias toward texts containing certain types over others. Most subordinate clauses that appeared were substantive clauses, but some adverbial clauses were also present, and within the first category there were different types (e.g., relative clauses). Taken together, these aspects suggest that the results should be interpreted with some caution and highlight the value of future studies with larger samples and broader cross-linguistic and population-based perspectives, which are necessary before suggesting any changes in current EL recommendations.

Future research should also explore additional linguistic and graphic features of EL that remain underinvestigated. Beyond the variables examined in this dissertation, it would be valuable to address aspects such as connectors or typography, for example. Future studies should adopt an integrated approach that examines linguistic and graphic aspects within the same experimental context. It is also essential to foster the use of online methods, as discussed in § 1.2.3.1, in order to capture real-time cognitive processes that are often overlooked by offline methods.

Ultimately, this dissertation has been both an academic endeavour and a personal journey toward understanding how accessibility can and should be approached from an empirically grounded perspective. I am now more convinced than ever that accessibility practices must move beyond intuition, tradition, or professional convention and instead be guided by systematic research. Nowadays, promoting communication in EL contributes to a more inclusive society and enhances the quality of life for many individuals, but there is always room for improvement. I believe that, through empirical research, we can develop guidelines that help make these communications even more accessible.

It has also become clear to me that accessibility cannot be achieved in the abstract: communications must be designed with their specific context and

audience in mind, because a text that works well for one group or setting may not work for another (as Bettina Bock [2018] defends). Making information accessible requires understanding how people engage with texts in different ways and how their expectations, needs, and experiences shape the way they interpret information. That is why collaborating directly with the EL target group has been invaluable, as their insights have profoundly shaped this research.

7. Updated bibliography

- Accessible Information Working Group. (2014). *Make it easy: A guideline to preparing Easy to Read information*. WALK. <https://www.walk.ie/userfiles/file/Make%20It%20Easy%20-%20A%20guide%20to%20preparing%20Easy%20to%20Read%20Information.pdf>
- AccessibleEU. (2025). *Understanding EU policies for people with disabilities*. European Parliamentary Research Service. [https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI\(2021\)698811](https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2021)698811)
- Agència de Salut Pública. (2023). *La salut a Barcelona 2022. Lectura fàcil*. <https://www.aspb.cat/wp-content/uploads/2023/12/ASPB-salutbarcelona2022-breu-231211.pdf>
- Alarcon, R., Moreno Lopez, L., Segura-Bedmar, I., & Martínez Fernández, P. (2019). Lexical simplification approach using easy-to-read resources. *Revista de Procesamiento de Lenguaje Natural*, 63. <https://doi.org/10.26342/2019-63-10>
- Allen, S. (2000). A discourse-pragmatic explanation for argument representation in child Inuktitut. *Linguistics*, 38, 483–521. <https://doi.org/10.1515/ling.38.3.483>
- Alwell, M., & Cobb, B. (2009). Functional life skills curricular interventions for youth with disabilities: A systematic review. *Career Development for Exceptional Individuals*, 32(2), 82–93. <https://doi.org/10.1177/0885728809336656>
- Anča, G., & Meļņika, I. (2021). Easy language in Latvia. In C. Lindholm & U. Vanhatalo (Eds.), *Handbook of easy languages in Europe* (pp. 305–325). Frank & Timme.
- Anglin, G. J., Vaez, H., & Cunningham, K. L. (2004). Visual representations and learning: The role of static and animated graphics. In D. H. Jonassen (Ed.), *Handbook of research on educational communications and technology* (pp. 865–916). Lawrence Erlbaum Associates Publishers.
- Antos, G. (2017). Leichte Sprache als Politolekt–Anmerkungen zu den Einflussfaktoren: Verständlichkeit, Fremdheit und Transaktionskosten. In B. M. Bock, U. Fix, & D. Lange (Eds.), *„Leichte Sprache“ im Spiegel theoretischer und angewandter Forschung* (pp. 129–146).
- Arias-Badia, B., & Matamala, A. (2020). Audio description meets easy-to-read and plain language: Results from a questionnaire and a focus group in Catalonia. *Zeitschrift für Katalanistik*, 33, 251–270.
- Associació Lectura Fàcil. (2011). *Resum de les principals pautes de Lectura Fàcil per a elaborar textos narratius*. <https://drive.google.com/file/d/1WmoKoRWIO9B9bmflzSdUBHJc52LgVSIV/view>
- Associació Lectura Fàcil. (n.d.). *Cronologia*. <https://www.lecturafacil.net/info/1-cronologia/>
- Baez-Naghelli, C., Águila, L., Nieves, D., Grande, M., & Mena, T. (2015). *Test Leer para Comprender: Evaluación de la comprensión lectora en educación primaria*. <https://cie.uatx.mx/debates-en-evaluacion-y-curriculum/pdf2015/C036.pdf>

- Basaraba, D., Yovanoff, P., Alonzo, J., & Tindal, G. (2013). Examining the structure of reading comprehension: Do literal, inferential, and evaluative comprehension truly exist? *Reading and Writing: An Interdisciplinary Journal*, 26(3), 349–379. <https://doi.org/10.1007/s11145-012-9372-9>
- Becker, L. (2020). ‘Immigrants’ as recipients of Easy-to-Read in Spain. *Journal of Multilingual and Multicultural Development*, 41(1), 59–71. <https://doi.org/10.1080/01434632.2019.1621874>
- Belinchón, M., Casas, S., Díez, C., & Tamarit, J. (2014). *Accesibilidad cognitiva en los centros educativos*. Ministerio de Educación, Cultura y Deporte. <http://blog.intef.es/cniie/wpcontent/uploads/sites/3/2015/05/ACCESIBILIDAD-COGNITIVA-EN-LOSCENTROS-EDUCATIVOS.pdf>
- Bernabé, R. (2020). New taxonomy of easy-to-understand access services. *MonTi Monografías De Traducción E Interpretación*, (12), 345–380. <https://doi.org/10.6035/MonTI.2020.12.12>
- Beymer, D., Orton, P. Z., & Russell, D. M. (2007). An eye tracking study of how pictures influence online reading. In C. Baranauskas, P. Palanque, J. Abascal, & S. D. J. Barbosa (Eds.), *Human-Computer Interaction – INTERACT 2007* (pp. 3–7). Springer. https://doi.org/10.1007/978-3-540-74800-7_41
- Blythe, H. I., & Joseph, H. S. S. L. (2012). Children's eye movements during reading. In S. P. Liversedge, I. Gilchrist, & S. Everling (Eds.), *The Oxford handbook of eye movements* (pp. 644–662). Oxford University Press.
- Bock, B. M. (2018). *Leichte Sprache – Kein Regelwerk. Sprachwissenschaftliche Ergebnisse und Praxisempfehlungen aus dem LeiSA-Projekt*. Universität Leipzig. <https://ul.qucosa.de/api/qucosa%3A31959/attachment/ATT-0/>
- Bohman, U. (2021). Easy language in Sweden. In C. Lindholm & U. Vanhatalo (Eds.), *Handbook of easy languages in Europe* (pp. 527–567). Frank & Timme.
- Boland, J. (2004). Linking eye movements to sentence comprehension in reading and listening. In M. Carreiras & C. Clifton (Eds.), *The on-line study of sentence comprehension: Eye-tracking, ERP, & beyond* (pp. 51–76). Psychology Press.
- Borghardt, L. (2022). The processing of causal clauses in Easy Language – First evidence. In M. P. Castillo Bernal & M. Estévez Gross (Eds.), *Translation, mediation and accessibility for linguistic minorities* (pp. 145–159).
- Borghardt, L., Deilen, S., Fuchs, J., Gros, A., Hansen-Schirra, S., Nagels, A., Schiffl, L., & Sommer, J. (2021). Neuroscientific research on the processing of easy language. *Frontiers in Communication*, 6. <https://doi.org/10.3389/fcomm.2021.698044>
- Bredel, U., & Maaß, C. (2016). *Leichte Sprache. Theoretische Grundlagen, Orientierung für die Praxis*. Duden, Berlin.

- Bruckmaier, G., Binder, K., Krauss, S., & Kufner, H. M. (2019). An eye-tracking study of statistical reasoning with tree diagrams and 2×2 tables. *Frontiers in Psychology*, 10, 632. <https://doi.org/10.3389/fpsyg.2019.00632>
- Buell, S. (2017). *Health-based information for people with intellectual disabilities: An investigation into the linguistic properties of 'easy read' literature and its contribution to the construction of meaning: The Easy Read Project* [Doctoral thesis, University of East Anglia]. University of East Anglia digital repository. <https://ueaeprints.uea.ac.uk/id/eprint/65618>
- Buell, S., Langdon, P. E., Pounds, G., & Bunning, K. (2020). An open randomized controlled trial of the effects of linguistic simplification and mediation on the comprehension of 'easy read' text by people with intellectual disabilities. *Journal of Applied Research in Intellectual Disabilities*, 33(2), 219–231. <https://doi.org/10.1111/jar.12666>
- Buell, S., Pounds, G., Langdon, P., & Bunning, K. (2024). Easy read health information for people with intellectual disabilities: A linguistic discourse analysis. What happens to language when it is simplified? *Journal of Applied Research in Intellectual Disabilities*, 37(6). <https://doi.org/10.1111/jar.13293>
- Butcher, K. R. (2014). The multimedia principle. In R. E. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (pp. 174–205). Cambridge University Press. <https://doi.org/10.1017/CBO9781139547369.010>
- Callus, A. M., & Cauchi, D. (2020). Ensuring meaningful access to easy-to-read information: A case study. *British Journal of Learning Disabilities*, 48(2), 124–131. <https://doi.org/10.1111/bld.12306>
- Campoverde-Molina, M., Luján-Mora, S., & Valverde, L. (2021). Accessibility of university websites worldwide: A systematic literature review. *Universal Access in the Information Society*, 22, 133–168. <https://doi.org/10.1007/s10209-021-00825-z>
- Carney, R. N., & Levin, J. R. (2002). Pictorial illustrations still improve students' learning from text. *Educational Psychology Review*, 14(1), 5–26. <https://doi.org/10.1023/A:1013176309260>
- Carnine, D. W., Silbert, J., Kame'enui, E. J., & Tarver, S. G. (2010). *Direct instruction reading* (5th ed.). Merrill.
- Caro, R. B., & Orero, P. (2019). Easy to Read as Multimode Accessibility Service. *Hermēneus. Revista de traducción e interpretación*. <https://doi.org/10.24197/her.21.2019.53-74>
- CASP. (2020). *CASP checklists*. Critical Appraisal Skills Programme. <https://casp-uk.net/casp-tools-checklists/>
- Chambers, J. M. (1983). *Graphical methods for data analysis* (1st ed.). Chapman and Hall/CRC. <https://doi.org/10.1201/9781351072304>
- CHANGE. (2016). *How to make information accessible*. <https://www.changepeople.org/images/001-how-to-make-information-accessible.pdf>

- Channel, M. M., Loveall, S. J., & Conners, F. A. (2013). Strengths and weaknesses in reading skills of youth with intellectual disabilities. *Research in Developmental Disabilities, 34*(2), 776–787. <https://doi.org/10.1016/j.ridd.2012.10.010>
- Chhabra, V., & McCardle, P. (2004). Contributions to evidence-based research. In P. McCardle & V. Chhabra (Eds.), *The voice of evidence in reading research* (pp. 3–11). Paul H. Brookes Publishing Co.
- Child, S., Oakhill, J., & Garnham, A. (2020). Tracking your emotions: An eye-tracking study on reader's engagement with perspective during text comprehension. *Quarterly Journal of Experimental Psychology, 73*(6), 929–940. <https://doi.org/10.1177/1747021820905561>
- Chinn, D. (2019). Talking to producers of Easy Read health information for people with intellectual disability: Production practices, textual features, and imagined audiences. *Journal of Intellectual & Developmental Disability, 44*(4), 410–420. <https://doi.org/10.3109/13668250.2019.1577640>
- Chinn, D. (2020). An empirical examination of the use of Easy Read health information in health consultations involving patients with intellectual disabilities. *Journal of Applied Research in Intellectual Disabilities, 33*(2), 232–247. <https://doi.org/10.1111/jar.12657>
- Chinn, D., & Homeyard, C. (2017). Easy read and accessible information for people with intellectual disabilities: Is it worth it? A meta-narrative literature review. *Health Expectations, 20*(6), 1189–1200. <https://doi.org/10.1111/hex.12520>
- Cinková, S., & Latimier, C. (2021). Easy language in Czechia. In C. Lindholm & U. Vanhatalo (Eds.), *Handbook of easy languages in Europe* (pp. 119–147). Frank & Timme.
- Clark, J. M., & Paivio, A. (1991). Dual coding theory and education. *Educational Psychology Review, 3*, 149–210. <https://doi.org/10.1007/BF01320076>
- Clifton, C., Jr., Staub, A., & Rayner, K. (2007). Eye movements in reading words and sentences. In R. P. G. van Gompel, M. H. Fischer, W. S. Murray, & R. L. Hill (Eds.), *Eye movements: A window on mind and brain* (pp. 341–371). Elsevier. <https://doi.org/10.1016/B978-008044980-7/50017-3>
- Comes, A. (1990). *TLC: Test de lectura comprensiva*. TEA Ediciones.
- Conklin, K., Pellicer-Sanchez, A., & Carrol, G. (2018). *Eye-Tracking: A Guide for Applied Linguistics Research*. Cambridge University Press.
- Conners, F. A. (2003). Reading skills and cognitive abilities of individuals with mental retardation. In L. Abbeduto (Ed.), *International Review of Research in Mental Retardation, 27* (pp. 191–229). Academic Press.
- Copeland, L., & Gedeon, T. (2013). Measuring reading comprehension using eye movements. In *4th IEEE International Conference on Cognitive Infocommunications, CogInfoCom 2013 – Proceedings* (pp. 791–796). IEEE. <https://doi.org/10.1109/CogInfoCom.2013.6719207>

- Csákvári, J., & Gyori, M. (2015). Applicability of standard eye-tracking technique in people with intellectual disability: Methodological conclusions from a series of studies. *Studies in Health Technology and Informatics*, 217, 63–70. <https://pubmed.ncbi.nlm.nih.gov/26294454/>
- Cupples, L., & Iacono, T. (2002). The efficacy of whole word' versus analytic' reading instruction for children with Down syndrome. *Reading and Writing*, 15, 549–574. <https://doi.org/10.1023/A:1016385114848>
- Dalton, B., & Proctor, C. P. (2007). Reading as thinking: Integrating strategy instruction in a universally designed digital literacy environment. In D. S. McNamara (Ed.), *Reading comprehension strategies: Theories, interventions, and technologies* (pp. 421–439). Lawrence Erlbaum Associates.
- Deilen, S. (2020). Visual segmentation of compounds in easy language: Eye movement studies on the effects of visual, morphological and semantic factors on the processing of German noun-noun compounds. In S. Hansen-Schirra & C. Maaß (Eds.), *Easy language research: Text and user perspectives* (pp. 241–256). Frank & Timme.
- Deilen, S. (2021). Visual segmentation of compounds in Easy Language: Does the marking of morpheme boundaries reduce cognitive processing costs? In M. P. Castillo Bernal & M. Estévez Gross (Hrsg.), *Translation, mediation and accessibility for linguistic minorities* (pp. 161–174). Berlin: Frank & Timme.
- Deilen, S. (2023). Visual segmentation of compounds in Easy Language: Some evidence of the relationship between facilitating perception and reducing cognitive processing costs. In S. Deilen, S. Hansen-Schirra, S. Hernández Garrido, C. Maaß, & A. Tardel (Hrsg.), *Emerging fields in Easy Language and accessible communication research* (pp. 119–151). Berlin: Frank & Timme.
- Deilen, S., & Schiffli, L. (2020). Using eye-tracking to evaluate language processing in the easy language target group. In S. Hansen-Schirra & C. Maaß (Eds.), *Easy language research: Text and user perspectives* (pp. 273–281). Frank & Timme.
- Deilen, S., Hansen-Schirra, S., & Maaß, C. (2019). Anwendbarkeit der ISO 17100 auf intralinguales Übersetzen in Leichte und Einfache Sprache. *Magazin*, 27, 43–53. <https://doi.org/10.12795/mAGAzin.2020.i28.01>
- Deilen, S., Hansen-Schirra, S., & Nagels, A. (2022). The effect of segmentation signs in compounds on reading behavior: An eye-tracking study. *Lebende Sprachen*, 67(1), 45–99. <https://doi.org/10.1515/les-2022-0003>
- Del Cueto, J., Conte, N. B., Parellada, C., & Roldan, L. A. (2019). Validación de un screening académico para evaluar la comprensión lectora. Estudio piloto. *XI Congreso Internacional de Investigación y Práctica Profesional en Psicología*. Acta Académica. <https://www.aacademica.org/000-111/120>
- Denzen, E. M., Santibáñez, M. E., Moore, H., Foley, A., Gersten, I. D., Gurgol, C., Majhail, N. S., Spellecy, R., Horowitz, M. M., & Murphy, E. A. (2012). Easy-to-read informed consent forms

for hematopoietic cell transplantation clinical trials. *Biology of Blood and Marrow Transplantation*, 18(2), 183–189. <https://doi.org/10.1016/j.bbmt.2011.07.022>

Department of Health. (2010). *Making written information easier to understand for people with learning disabilities: Guidance for people who commission or produce Easy Read information—Revised Edition 2010*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/215923/dh_121927.pdf

Díaz Cintas, J., Orero, P., & Remael, A. (2007). Media for All. *The Journal of Specialised Translation*, 10, 151–154. <https://doi.org/10.26034/cm.jostrans.2008.668>

Díaz-Cintas, J., Matamala, A., & Neves, J. (2010). Media for all: New developments. In J. Díaz-Cintas, A. Matamala, & J. Neves (Eds.), *New insights into audiovisual translation and media accessibility* (pp. 11–22). Rodopi.

Dickinson, K. V., Ortiz-Ramírez, P. A., Arrieta-Zamudio, A., Grinstead, J., & Flores-Ávalos, B. (2023). Overt subject pronoun use in switch-reference contexts in child Spanish developmental language disorder: A discriminant function analysis. *Journal of Speech, Language, and Hearing Research*, 66(2), 605–619. https://doi.org/10.1044/2022_JSLHR-21-00483

D'Mello, S. K., Southwell, R., & Gregg, J. (2020). Machine-learned computational models can enhance the study of text and discourse: A case study using eye tracking to model reading comprehension. *Discourse Processes*, 57(5–6), 420–440. <https://doi.org/10.1080/0163853X.2020.1739600>

Duchowski, A. T. (2007). *Eye tracking methodology: Theory and practice*. Springer.

Ducrot, O., & Todorov, T. (2003). *Diccionario enciclopédico de las ciencias del lenguaje*. Siglo XXI Editores.

Dye, L., Hare, D. J., & Hendy, S. (2004). Capacity to consent to participate in research: A reconceptualisation. *British Journal of Learning Disabilities*, 31, 1–7. <https://doi.org/10.1111/j.1468-3156.2004.00262.x>

Eisenberg, M. L., & Zacks, J. M. (2016). Ambient and focal visual processing of naturalistic activity. *Journal of Vision*, 16(2). <https://doi.org/10.1167/16.2.5>

Everatt, J., & Underwood, G. (1994). Individual differences in reading subprocesses: Relationships between reading ability, lexical access, and eye movement control. *Language and Speech*, 37(3), 283–297. <https://doi.org/10.1177/002383099403700305>

Faber, M., Bixler, R., & D'Mello, S. K. (2018). An automated behavioral measure of mind wandering during computerized reading. *Behavior Research Methods*, 50(1), 134–150. <https://doi.org/10.3758/s13428-017-0857-y>

Fajardo, I., Ávila, V., Delgado, P., Gómez-Merino, N., & Salmerón, L. (2022). Video-blogs and linguistic simplification for students with intellectual disability. *Journal of Applied Research in Intellectual Disabilities: JARID*, 35(5), 1217–1230. <https://doi.org/10.1111/jar.13016>

- Fajardo, I., Ávila, V., Ferrer, A., Tavares, G., Gómez, M., & Hernández, A. (2014). Easy-to-read texts for students with intellectual disability: Linguistic factors affecting comprehension. *Journal of Applied Research in Intellectual Disabilities*, 27, 212–225. <https://doi.org/10.1111/jar.12065>
- Fajardo, I., Tavares, G., Ávila, V., & Ferrer, A. (2013). Towards text simplification for poor readers with intellectual disability: When do connectives enhance text cohesion? *Research in Developmental Disabilities*, 34(4), 1267–1279. <https://doi.org/10.1016/j.ridd.2013.01.006>
- Federal Ministry of Justice and Consumer Protection. (2011). *BITV 2.0: Verordnung zur Schaffung barrierefreier Informationstechnik nach dem Behindertengleichstellungsgesetz (Barrierefreie-Informationstechnik-Verordnung – BITV 2.0)*. http://www.gesetze-im-internet.de/bitv_2_0/BJNR184300011.html
- Federal Ministry of Justice and Consumer Protection. (2011). *BITV 2.0. Verordnung zur Schaffung barrierefreier Informationstechnik nach dem Behindertengleichstellungsgesetz (Barrierefreie-Informationstechnik-Verordnung – BITV 2.0)*. Retrieved from http://www.gesetze-im-internet.de/bitv_2_0/BJNR184300011.html
- Fehlmann, B., Coynel, D., Schick Tanz, N., Milnik, A., Gschwind, L., Hofmann, P., Papassotiropoulos, A., & de Quervain, D. J. (2020). Visual exploration at higher fixation frequency increases subsequent memory recall. *Cerebral Cortex Communications*, 21(1). <https://doi.org/10.1093/texcom/tgaa032>
- Ferreira, F., Apel, J., & Henderson, J. M. (2008). Taking a new look at looking at nothing. *Trends in Cognitive Sciences*, 12(11), 405–410. <https://doi.org/10.1016/j.tics.2008.07.007>
- Ferreres, A., Abusamra, V., Casajús, A., Cartoceti, R., Squillace, M., & Sampedro, B. (2009). Pruebas de screening para la evaluación de la comprensión de textos. *Neuropsicología Latinoamericana*, 1(1), 41–56. https://www.neuropsicolatina.org/index.php/Neuropsicologia_Latinoamericana/article/view/8
- Flynn, R. J. (2021). *Infantilisation in care, community and cognitive disability* [Master thesis, University College Cork]. Cork Open Research Archive. <https://hdl.handle.net/10468/12426>
- Frith, U. (1985). Beneath the surface of developmental dyslexia. In K. Patterson, J. Marshall, & M. Coltheart (Eds.), *Surface dyslexia: Neurological and cognitive studies of phonological reading* (pp. 301–330). Hillsdale, NJ: Lawrence Erlbaum.
- Froncón, C., & Kaakinen, J. (2023). Reading easy language texts written by public authorities: Evidence from eye tracking. *Finnish Journal of Linguistics*, 36, 7–36. <https://doi.org/10.61197/fjl.126062>
- García Muñoz, Ó. (2012). *Lectura fácil: Métodos de redacción y evaluación*. Plena Inclusión. <https://www.plenainclusion.org/sites/default/files/lectura-facil-metodos.pdf>
- García Muñoz, Ó., & Matamala, A. (2021). Easy languages in Spain. In C. Lindholm & U. Vanhatalo (Eds.), *Handbook of easy languages in Europe* (pp. 493–525). Frank & Timme.

- Gelormini-Lezama, C., & Almor, A. (2011). Repeated names, overt pronouns, and null pronouns in Spanish. *Language and Cognitive Processes*, 26(3), 437–454.
<https://doi.org/10.1080/01690965.2010.495234>
- Generalitat de Catalunya. (2023). *DECRET 209/2023, de 28 de novembre, pel qual s'aprova el Codi d'accessibilitat de Catalunya*.
- Generalitat de Catalunya. (2025). *Guia de comunicació clara de la Generalitat de Catalunya*.
- Gillioz, C., & Zufferey, S. (2020). *Introduction to experimental linguistics*. John Wiley & Sons.
- González, I. C. (2022). *Traducción y accesibilidad: el traductor como adaptador a Lectura Fácil* [Bachelor tesis, Universidad de las Palmas de Gran Canaria]. AccedaCRIS.
<https://accedacris.ulpgc.es/handle/10553/118594>
- Gonzalez-Sanchez, J., Baydogan, M., Chavez-Echeagaray, M. E., Atkinson, R., & Burleson, W. (2017). Affect measurement: A roadmap through approaches, technologies, and data analysis. In M. Jeon (Ed.), *Emotions and affect in human factors and human-computer interaction* (pp. 255–288). Elsevier. <https://doi.org/10.1016/B978-0-12-801851-4.00011-2>
- González-Sordé, M., & Matamala, A. (2023). Empirical evaluation of Easy Language recommendations: A systematic literature review from journal research in Catalan, English, and Spanish. *Universal Access in the Information Society*. <https://doi.org/10.1007/s10209-023-00975-2>
- González-Sordé, M., Soler-Vilageliu, O., Krejtz, I., & Krejtz, K. (2026). Null and overt pronouns and subordinate clauses in Catalan Easy Language: An eye-tracking study on adults with and without intellectual disabilities. *Parallèles*, 38(2). <http://dx.doi.org/10.17462/para.2026.02.01>
- González-Sordé, M., Soler-Vilageliu, O., Krejtz, K., & Krejtz, I. (2025). Visual support in easy language: The impact of images on comprehension, perceived difficulty and eye movements. *Language and Cognition*, 17, e87. <https://doi.org/10.1017/langcog.2025.10042>
- Grant, M. J., & Booth, A. (2009). A typology of reviews: An analysis of 14 review types and associated methodologies. *Health Information & Libraries Journal*, 26(2), 91–108.
<https://doi.org/10.1111/j.1471-1842.2009.00848.x>
- Grimm, J., & Grimm, H. (2018). *21 contes dels germans Grimm*. ING Edicions.
- Grinstead, J., Lintz, P., Pratt, A., Vega-Mendoza, M., De la Mora, J., Cantú-Sánchez, M., & Flores-Avalos, B. (2018). Null subject occurrence in monolingual Spanish SLI: A discriminant function analysis. *Languages*, 3(2). <https://doi.org/10.3390/languages3020017>
- Guo, D., McTigue, E. M., Matthews, S. D., & Zimmer, W. (2020). The impact of visual displays on learning across the disciplines: A systematic review. *Educational Psychology Review*, 32, 627–656. <https://doi.org/10.1007/s10648-020-09523-3>
- Gutermuth, S. (2020). *Leichte Sprache für alle? Eine zielgruppenorientierte Rezeptionsstudie zu Leichter und Einfacher Sprache*. Frank & Timme.

- Hannus, M., & Hyönä, J. (1999). Utilization of illustrations during learning of science textbook passages among low- and high-ability children. *Contemporary Educational Psychology*, 24(2), 95–123. <https://doi.org/10.1006/ceps.1998.0987>
- Hansen-Schirra, S., & Gutermuth, S. (2024). Empirical examination of comprehensibility. In C. Maaß & I. Rink (Eds.), *Handbook of Accessible Communication. Easy – Plain – Accessible* (Vol. 15). Frank & Timme. https://doi.org/10.57088/978-3-7929-9120-6_8
- Hansen-Schirra, S., & Maaß, C. (2020). *Easy language research: Text and user perspectives*. Frank & Timme.
- Hansen-Schirra, S., Hansen, S., Wolfer, S., & Konieczny, L. (2009). Fachkommunikation, Popularisierung, Übersetzung: Empirische Vergleiche am Beispiel der Nominalphrase im Englischen und Deutschen. *Linguistik Online*, 39(3). <https://doi.org/10.13092/lo.39.480>
- He, W., Garrido, M. I., Sowman, P. F., Brock, J., & Johnson, B. W. (2015). Development of effective connectivity in the core network for face perception. *Human Brain Mapping*, 36(6), 2161–2173. <https://doi.org/10.1002/hbm.22762>
- Helmert, J. R., Joos, M., Pannasch, S., & Velichkovsky, B. M. (2005). Two visual systems and their eye movements: Evidence from static and dynamic scene perception. *Proceedings of the Annual Meeting of the Cognitive Science Society*, 27. <https://escholarship.org/uc/item/9nv0c661>
- Henderson, L., Snowling, M., & Clarke, P. (2013). Accessing, integrating, and inhibiting word meaning in poor comprehenders. *Scientific Studies of Reading*, 17(3), 177–198. <https://doi.org/10.1080/10888438.2011.652721>
- Hennig, M., & Jacob, J. (2022). Literatur in vereinfachter Sprache: Einfachheit und literarische Ästhetik. *Zeitschrift für Literaturwissenschaft und Linguistik*, 52, 89–121. <https://doi.org/10.1007/s41244-022-00250-6>
- Herber, H. L. (1970). *Teaching reading in the content areas*. Englewood Cliffs, N.J., Prentice-Hall.
- Hibbing, A. N., & Rankin-Erickson, J. L. (2003). A picture is worth a thousand words: Using visual images to improve comprehension for middle school struggling readers. *The Reading Teacher*, 56.
- Hollins, S., Carpenter, B., Bradley, E., & Egerton, J. (2017). Using wordless books to support clinical consultations. *The Journal of Mental Health Training, Education and Practice*, 12(4), 260–271. <https://doi.org/10.1108/JMHTEP-03-2017-0022>
- Hurtado, B., Jones, L., & Burniston, F. (2014). Is easy read information really easier to read? *Journal of Intellectual Disability Research*, 58(9), 822–829. <https://doi.org/10.1111/jir.12097>
- Hyönä, J., & Kaakinen, J. K. (2019). Eye movements during reading. In C. Klein & U. Ettinger (Eds.), *Eye movement research*. Springer. https://doi.org/10.1007/978-3-030-20085-5_7
- Idescat. (2018). *Usos lingüístics de la població. Coneixement de llengües: català, castellà, anglès i francès*. Retrieved from <https://www.idescat.cat/indicadors/?id=basics&n=10367&t=201800>

- IEC - Institut d'Estudis Catalans. (2022). *Gramàtica essencial de la llengua catalana*. IEC.
<https://geiec.iec.cat/inici>
- IFLA - International Federation of Library Associations and Institutions. (2012). *Directrius per a materials de lectura fàcil*. Associació Lectura Fàcil.
https://www.lecturafacil.net/media/resources/2012_Directrius_IFLA_Catal%C3%A0.pdf
- ILSMH. (1997). *Make it simple: European guidelines for the production of easy-to-read information for people with learning disability*. Associació Lectura Fàcil.
https://repositori.lecturafacil.net/sites/default/files/1998%20El%20cam%C3%AD%20m%C3%A9s%20f%C3%A1cil%20Directrius%20europees%20per%20gernar%20informaci%C3%B3%20de%20Lectura%20F%C3%A0cil%20ILSMH_ANG.pdf
- ILSMH. (1998a). *El Camí Més Fàcil: Directrius Europees per Generar Informació de Lectura Fàcil*. Associació Lectura Fàcil. http://www.lecturafacil.net/media/resources/ILSMH_catal%C3%A0.pdf
- ILSMH. (1998b). *El Camino Más Fácil: Directrices Europeas para Generar Información de Fácil Lectura*. Associació Lectura Fàcil.
<http://www.lecturafacil.net/media/resources/ILSMHcastell%C3%A0.pdf>
- Inclusion Europe. (2009). *Information for all: European standards for making information easy to read and understand*. https://www.inclusion-europe.eu/wp-content/uploads/2017/06/EN_Information_for_all.pdf
- Inhoff, A. W., & Rayner, K. (1986). Parafoveal word processing during eye fixations in reading: Effects of word frequency. *Perception & Psychophysics*, 40(6), 431–439.
<https://doi.org/10.3758/BF03208203>
- ISO - International Organization for Standardization. (2016). *Assistive products for persons with disabilities—Classification and terminology*. ISO. (ISO Standard No. ISO 9999:2016).
- ISO - International Organization for Standardization. (2020). *Cognitive accessibility—Part 1: General guidelines*. (ISO Standard No. ISO 21801-1:2020).
- ISO - International Organization for Standardization. (2023a). *Plain language—Part 1: Governing principles and guidelines*. ISO. (ISO Standard No. ISO 24495-1:2023).
- ISO - International Organization for Standardization. (2023b). *Information technology — User interfaces — Requirements and recommendations on making written text easy to read and understand*. (ISO Standard No. ISO/IEC 23859).
- Jakobson, R. (1959). On linguistic aspects of translation. In R. Brower (Ed.), *On translation* (pp. 232–239). Harvard University Press.
- Johanna Briggs Institute. (2017). *Checklist for systematic reviews and research syntheses*.
https://jbi.global/sites/default/files/2019-05/JBI_Critical_Appraisal-Checklist_for_Systematic_Reviews2017_0.pdf
- Johansson, R., Nyström, M., Dewhurst, R., & Johansson, M. (2022). Eye-movement replay supports episodic remembering. *Proceedings of the Royal Society B*, 298(1977).
<https://doi.org/10.1098/rspb.2022.0964>

- Jones, F. W., Long, K., & Finlay, W. M. L. (2007). Symbols can improve the reading comprehension of adults with learning disabilities. *Journal of Intellectual Disability Research*, 51(7), 545–550. <https://doi.org/10.1111/j.1365-2788.2006.00926.x>
- Just, M. A., & Carpenter, P. A. (1980). A theory of reading: From eye fixations to comprehension. *Psychological Review*, 87(4), 329–354. <https://doi.org/10.1037/0033-295X.87.4.329>
- Just, M. A., Carpenter, P. A., & Woolley, J. D. (1982). Paradigms and processes in reading comprehension. *Journal of Experimental Psychology: General*, 111(2), 228–238. <https://doi.org/10.1037/0096-3445.111.2.228>
- Justino, J., & Kolinsky, R. (2023). Eye movements during reading in beginning and skilled readers: Impact of reading level or physiological maturation? *Acta Psychologica*, 236. <https://doi.org/10.1016/j.actpsy.2023.103927>
- Kazem, A. M., Alzubiadi, A. S., Yousif, Y. H., Aljamali, F. A., Al-Mashhdany, S. I., Alkharusi, H. A., Al-Busaidi, O. B., Alsarmi, A. M., Al-Bulushi, S. S., Al-Bahrani, W. A., & Al-Fori, S. M. (2007). Psychometric properties of Raven's Colored Progressive Matrices for Omani children aged 5 through 11 years. *Social Behavior and Personality*, 35(10), 1385–1398. <https://doi.org/10.2224/sbp.2007.35.10.1385>
- Kim, S. H., Dong, Z., Xian, H., Upatising, B., & Yi, J. S. (2012). Does an eye tracker tell the truth about visualizations?: Findings while investigating visualizations for decision making. *IEEE Transactions on Visualization and Computer Graphics*, 18(12), 2421–2430. <https://doi.org/10.1109/TVCG.2012.215>
- Kintsch, W. (1998). *Comprehension: A paradigm for cognition*. Cambridge University Press.
- Kintsch, W. (2018). Revisiting the Construction–Integration Model of text comprehension and its implications for instruction. In M. Sailors & D. E. Alvermann (Eds.), *Theoretical models and processes of literacy*. Routledge.
- Kintsch, W., & Rawson, K. A. (2005). Comprehension. In M. J. Snowling & C. Hulme (Eds.), *The science of reading: A handbook* (pp. 209–226). Blackwell Publishing.
- Köksal, O., & Zorlu-Kale, B. N. (2023). A review study on the latest trends in translation studies. In *Proceedings of the 3rd International Congress of Language and Translation Studies*. Selçuk University.
- Krejtz, I., Szarkowska, A., Krejtz, K., Walczak, A., & Duchowski, A. (2012). Audio description as an aural guide of children's visual attention: Evidence from an eye-tracking study. In *Proceedings of the Symposium on Eye Tracking Research and Applications (ETRA '12)* (pp. 99–106). ACM. <https://doi.org/10.1145/2168556.2168572>
- Krejtz, K., Duchowski, A. T., & Cöltekin, A. (2014). High-level gaze metrics from map viewing: Charting ambient/focal visual attention. In P. Kiefer, I. Giannopoulos, M. Raubal, & A. Krüger (Eds.), *CEUR Workshop Proceedings* (pp. 37–41). CEUR-WS. <http://ceur-ws.org/Vol-1241/>

- Krejtz, K., Duchowski, A. T., Krejtz, I., Kopacz, A., & Chrzastowski-Wachtel, P. (2016). Gaze transitions when learning with multimedia. *Journal of Eye Movement Research*, 9(1). <https://doi.org/10.16910/jemr.9.1.5>
- Larraz Istúriz, C. (2015). *Reto 10. Accesibilidad cognitiva*. Imsero.
- Larreina, M. E., & Mangiron, C. (2025). Advancing game accessibility with audio description: User perspectives and recommendations. *Journal of Audiovisual Translation*, 8(2), 1–23. <https://doi.org/10.47476/jat.v8i8.2025.355>
- Lenček, M., & Kuvač Kraljević, J. (2021). Easy language in Croatia. In C. Lindholm & U. Vanhatalo (Eds.), *Handbook of easy languages in Europe* (pp. 92–118). Frank & Timme.
- León, J. A., & León-López, A. (2019). Reading performance in adults with intellectual and developmental disability (IDD) when they read different kinds of texts. *Psychology in Russia: State of the Art*, 12(4). <http://doi.org/10.11621/pir.2019.0409>
- Leskelä, L., Mustajoki, A., & Piehl, A. (2022). Easy and plain languages as special cases of linguistic tailoring and standard language varieties. *Nordic Journal of Linguistics*, 45(2), 194–213. <https://doi.org/10.1017/S0332586522000142>
- Levie, W. H., & Lentz, R. (1982). Effects of text illustrations: A review of research. *Educational Technology Research and Development*, 30, 195–232. <https://doi.org/10.1007/BF02765184>
- Ley 6/2022, de 31 de marzo. *Boletín Oficial del Estado*, 78, de 1 de abril de 2022.
- Linares-Espinós, E., Hernández, V., Domínguez-Escrig, J. L., Fernández-Pello, S., Hevia, V., Mayor, J., Padilla-Fernández, B., & Ribal, M. J. (2018). Metodología de una revisión sistemática. *Actas Urológicas Españolas*, 42(8), 499–506.
- Lindholm, C., & Vanhatalo, U. (2021). *Handbook of easy languages in Europe*. Frank & Timme.
- Loureda Lama, Ó., Izquierdo Alegría, D., Gelormini-Lezama, C., Hernández Pérez, C., Teucher, M., Cruz Rubio, A., & Julio Vergara, C. (2024). La encapsulación y la correferencia en español mediante pronombres demostrativos y repeticiones léxicas: Una aproximación experimental con eye-tracking. *Revista Signos. Estudios de Lingüística*, 57(114). <https://revistasignos.cl/index.php/signos/article/view/1164>
- Louwerse, M. M. (2004). Un modelo conciso de cohesión en el texto y coherencia en la comprensión. *Revista Signos: Estudios de Lingüística*, 37(56), 41–58. <https://doi.org/10.4067/S0718-09342004005600004>
- Maaß, C. (2015). *Leichte Sprache. Das Regelbuch*. LIT Verlag.
- Maaß, C. (2020). *Easy language – Plain language – Easy language plus*. Frank & Timme.
- Maaß, C., & Hernández Garrido, S. (2020). Easy and Plain Language in Audiovisual Translation. In S. Hansen-Schirra, C. Maaß (Eds.), *Easy Language Research: Text and User Perspectives* (pp. 131–161). Frank & Timme. <https://doi.org/10.25528/043>
- Maaß, C., & Rink, I. (2017). Leichte Sprache: Verständlichkeit ermöglicht Gesundheitskompetenz. *Public Health Forum*, 25(1), 50–53. <https://doi.org/10.1515/pubhef-2016-2148>

- Maaß, C., Rink, I., & Hansen-Schirra, S. (2021). Easy languages in Germany. In C. Lindholm & U. Vanhatalo (Eds.), *Handbook of easy languages in Europe* (pp. 191–218). Frank & Timme.
- Machuca, M. J., & Matamala, A. (2025). Easy Audios: from Readability to Listenability. *Journal of Audiovisual Translation*, 8(1), 1–19. <https://doi.org/10.47476/jat.v8i1.2025.345>
- Marinis, T. (2010). Using on-line processing methods in language acquisition research. In E. Blom & S. Unsworth (Eds.), *Experimental methods in language acquisition research* (pp. 139–162). John Benjamins. <https://doi.org/10.1075/llt.27.09mar>
- Matamala, A. (2022). Easy-to-understand language in audiovisual translation and accessibility: State of the art and future challenges. *XLinguae*, 15(2), 130–144. <https://doi.org/10.18355/XL.2022.15.02.10>
- Matamala, A., & Orero, P. (2018). Standardising accessibility: Transferring knowledge to society. *Journal of Audiovisual Translation*, 1(1), 139–154. <https://doi.org/10.47476/jat.v1i1.49>
- Matamala, A., Orero, P., & Oncins, E. (2021). EASIT: Formació per a nous perfil professionals en serveis d'accessibilitat fàcils de comprendre. *Revista del Congrés Internacional de Docència Universitària i Innovació*, 5. <https://raco.cat/index.php/RevistaCIDUI/article/view/377503>
- Mayer, R. E. (Ed.). (2014). *The Cambridge handbook of multimedia learning* (2nd ed.). Cambridge University Press.
- Mayol, L., & Clark, R. (2010). Pronouns in Catalan: Games of partial information and the use of linguistic resources. *Journal of Pragmatics*, 42(3), 629–651. <https://doi.org/10.1016/j.pragma.2009.07.004>
- Mazzaggio, G., & Shield, A. (2020). The production of pronouns and verb inflections by Italian children with ASD: A new dataset in a null subject language. *Journal of Autism and Developmental Disorders*, 50(4), 1425–1433. <https://doi.org/10.1007/s10803-019-04349>
- Medina Reguera, A., & Balaguer Girón, P. (2022). Textos cognitivamente accesibles: Lectura fácil y Leichte Sprache en contraste. *Magazin*, 29. <https://doi.org/10.12795/mAGAzin.2021.i29.05>
- Mencap. (2013). *Make it clear*. Inclusion Ireland. <https://inclusionireland.ie/wp-content/uploads/2020/10/makeitclearapr09.pdf>
- Merriam-Webster. (n.d.). Subordinate clause. Retrieved from <https://www.merriam-webster.com/dictionary/subordinate%20clause>
- Mézière, D. C., Yu, L., Reichle, E. D., von der Malsburg, T., & McArthur, G. (2023). Using eye-tracking measures to predict reading comprehension. *Reading Research Quarterly*, 58, 425–449. <https://doi.org/10.1002/rrq.498>
- Miesenberger, K., & Petz, A. (2014). Easy-to-read on the web: State of the art and needed research. In K. Miesenberger, D. Fels, D. Archambault, P. Peñáz, & W. Zagler (Eds.), *ICCHP 2014. LNCS, 8547* (pp. 161–168). https://doi.org/10.1007/978-3-319-08596-8_25
- Ministerio de Derechos Sociales, Consumo y Agenda 2030. (2024). *Proyecto de Real Decreto por el que se aprueba el Reglamento sobre las condiciones básicas de accesibilidad cognitiva*.

- Moreno, L., Petrie, H., Martínez, P., et al. (2024). Designing user interfaces for content simplification aimed at people with cognitive impairments. *Universal Access in the Information Society*, 23, 99–117. <https://doi.org/10.1007/s10209-023-00986-z>
- Morton, J. (1969). Interaction of information in word recognition. *Psychological Review*, 76(2), 165–178. <https://doi.org/10.1037/h0027366>
- Nario-Redmond, M. R., Kemerling, A. A., & Silverman, A. (2019). Hostile, benevolent, and ambivalent ableism: Contemporary manifestations. *Journal of Social Issues*, 75(3), 674–692. <https://doi.org/10.1111/josi.12337>
- Nash, H., & Heath, J. (2011). The role of vocabulary, working memory and inference making ability in reading comprehension in Down syndrome. *Research in Developmental Disabilities*, 32(5), 1782–1791. <https://doi.org/10.1016/j.ridd.2011.03.007>
- Nomura, M., Nielsen, G., & Tronbacke, B. (2010). *Guidelines for easy-to-read materials (IFLA Professional Reports 120)*. IFLA.
- Oliva-Zamora, M. Á., & Mangiron, C. (2025). How to create video games with cognitive accessibility features: A literature review of recommendations. *Universal Access in the Information Society*, 24, 2805–2818. <https://doi.org/10.1007/s10209-025-01231-5>
- Oliver, M., & Sapey, B. (2006). *Social work with disabled people* (3rd ed.). Palgrave Macmillan.
- Oncins, E., & Orero, P. (2021). Pongamos en práctica la estandarización: Servicios de accesibilidad e interacción. *Hikma*, 20(1). <https://doi.org/10.21071/hikma.v20i1.12886>
- Orduna-Hospital, E., Hernández-Aranda, D., & Sanchez-Cano, A. (2023). Ocular motility patterns in intellectual disability: Insights from the developmental eye movement test. *Life*, 13(12). <https://doi.org/10.3390/life13122360>
- Orero, P., Delgado, C., & Matamala, A. L. (2020). Easy to read standardisation. Some steps towards an international standard. *DSAI 2020: 9th International Conference on Software Development and Technologies for Enhancing Accessibility and Fighting Info-exclusion*, 44–46. <https://doi.org/10.1145/3439231.3440605>
- Orero, P., Oncins, E., & Matamala, A. (2021). Web accessibility for all: Learning materials towards the new EU standard. *Revista CIDUI*, 5. <https://raco.cat/index.php/RevistaCIDUI/article/view/377519>
- Paeye, C., & Madelain, L. (2011). Reinforcing saccadic amplitude variability. *Journal of the Experimental Analysis of Behavior*, 95(2), 149–162. <https://doi.org/10.1901/jeab.2011.95-149>
- Pappert, S., & Bock, B. M. (2020). Easy-to-read German put to the test: Do adults with intellectual disability or functional illiteracy benefit from compound segmentation? *Reading and Writing: An Interdisciplinary Journal*, 33(5), 1105–1131. <https://doi.org/10.1007/s11145-019-09995-y>
- Perego, E. (2020). *Accessible communication: A cross-country journey*. Frank & Timme.
- Perego, E. (2023). Spoken easy language for social inclusion: Needs & resource mapping [Conference abstract]. In *Proceedings of the 3rd KLAARA Conference*.

- Perez, M., & Mestre, R. (2022). *Diccionari de lingüística*. Publicacions de la Generalitat Valenciana.
- Perfetti, C., & Helder, A. (2022). Progress in reading science: Word identification, comprehension, and universal perspectives. In M. J. Snowling, C. Hulme, & K. Nation (Eds.), *The science of reading: A handbook* (2nd ed., pp. 5–35). Wiley Blackwell.
<https://doi.org/10.1002/9781119705116.ch1>
- Plena Inclusión Madrid. (n.d.). *Train2Validate*. <https://plenainclusionmadrid.org/train2validate/>
- Plena Inclusión. (2021). ¿Cómo usamos las imágenes en la lectura fácil?
<https://www.plenainclusion.org/noticias/como-usamos-las-imagenes-en-la-lectura-facil/>
- Poncelas, A., & Murphy, G. (2007). Accessible information for people with intellectual disabilities: Do symbols really help? *Journal of Applied Research in Intellectual Disabilities*, 20(5), 466–474. <https://doi.org/10.1111/j.1468-3148.2006.00334.x>
- Przybyła-Wilkin, A. (2021). Easy language in Poland. In C. Lindholm & U. Vanhatalo (Eds.), *Handbook of easy languages in Europe* (pp. 401–412). Frank & Timme.
- Pujadas-Farreras, M., & Matamala, A. (2026). Creation and translation of audiovisual content in oral Easy-to-Understand Language: insights from interviews with professionals. *Hermēneus. Revista de traducción e interpretación*. <https://doi.org/10.24197/2jbfgs25>
- Queiroz-Garcia, I., Espirito Santo, H., & Pires, C. (2021). Propriedades psicométricas da forma geral das Matrizes Progressivas de Raven numa amostra portuguesa. *Revista Portuguesa de Investigação Comportamental e Social*, 7(1), 84–101.
<https://doi.org/10.31211/rpics.2021.7.1.210>
- R Core Team. (2025). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. <https://cran.r-project.org/doc/manuals/r-release/fullrefman.pdf>
- Rastelli, S. (2024). *Plain language: A psycholinguistic approach* (1st ed.). Routledge.
<https://doi.org/10.4324/9781003492368>
- Rastelli, S. (2025). Calibrating the passive: An experimental approach to plain language rules. *Lebende Sprachen*, 70(1), 230–254. <https://doi.org/10.1515/les-2024-0035>
- Ratz, C., & Lenhard, W. (2013). Reading skills among students with intellectual disabilities. *Research in Developmental Disabilities*, 34(5), 1740–1748.
<https://doi.org/10.1016/j.ridd.2013.01.021>
- Raven, J. C. (1998). *Raven's progressive matrices*. Pearson Clinical.
- Rayner, K. (1983). Eye movements, perceptual span, and reading disability. *Annals of Dyslexia*, 33, 163–173. <https://doi.org/10.1007/BF02648003>
- Rayner, K. (1992). *Eye movements and visual cognition: Scene perception and reading*. Springer-Verlag Publishing. <https://doi.org/10.1007/978-1-4612-2852-3>
- Rayner, K. (1998). Eye movements in reading and information processing: 20 years of research. *Psychological Bulletin*, 124(3), 372–422. <https://doi.org/10.1037/0033-2909.124.3.372>

- Rayner, K., & Castelhana, M. S. (2008). Eye movements during reading, scene perception, visual search, and while looking at print advertisements. In M. Wedel & R. Pieters (Eds.), *Visual marketing: From attention to action* (pp. 9–42). Taylor & Francis.
- Rayner, K., Chace, K. H., Slattery, T. J., & Ashby, J. (2006). Eye movements as reflections of comprehension processes in reading. *Scientific Studies of Reading*, 10(3), 241–255.
https://doi.org/10.1207/s1532799xssr1003_3
- Rayner, K., Pollatsek, A., Ashby, J., & Clifton, C. (2011). *Psychology of reading*. Psychology Press.
- Rayner, K., Slattery, T. J., & Bélanger, N. N. (2010). Eye movements, the perceptual span, and reading speed. *Psychonomic Bulletin & Review*, 17(6), 834–839.
<https://doi.org/10.3758/PBR.17.6.834>
- Real, F., & Christiansen, M. H. (2007). Processing of relative clauses is made easier by frequency of occurrence. *Journal of Memory and Language*, 57(1), 1–23.
<https://doi.org/10.1016/j.jml.2006.08.014>
- Reichle, E. D., Liversedge, S. P., Drieghe, D., Blythe, H. I., Joseph, H. S., White, S. J., & Rayner, K. (2013). Using EZ Reader to examine the concurrent development of eye-movement control and reading skill. *Developmental Review*, 33(2), 110–149.
<https://doi.org/10.1016/j.dr.2013.03.001>
- Renkewitz, F., & Jahn, G. (2010). Looking at nothing indicates memory search in multiattribute decision making. *Proceedings of the Annual Meeting of the Cognitive Science Society*, 32.
- Rica Peromingo, J. P., & Saenz Herrero, A. (2025). Accessibility and audiovisual language in early twentieth century-films. *Estudis filològics i de traducció*, 2, 93–114.
<https://doi.org/10.7203/efit.2.30320>
- Richart-Marset, M., & Calamita, F. (2020). El gran reto de la traducción y la accesibilidad audiovisual en los medios de comunicación. *MonTI: Monografías de Traducción e Interpretación*, 12, 29–52. <https://doi.org/10.6035/MonTI.2020.12.01>
- Riffo, B., Rojas, C., Helo, A., Véliz, M., Urzúa, P., Gutierrez, G., & Guerra, E. (2025). Reading comprehension in older adults—Effects of age, educational level, and reading habits. *Journal of Intelligence*, 13(1), 4. <https://doi.org/10.3390/jintelligence13010004>
- Rivero Contreras, M. (2022). *Apoyo visual, simplificación léxica y comprensión lectora* [Doctoral Thesis, Universidad de Sevilla]. IdUS. <https://hdl.handle.net/11441/140371>
- Rivero Contreras, M., Engelhardt, P. E., & Saldaña Sage, D. (2023). Do easy-to-read adaptations really facilitate sentence processing for adults with a lower level of education? An experimental eye-tracking study. *Learning and Instruction*, 84.
<https://doi.org/10.1016/j.learninstruc.2022.101731>
- Rivero-Contreras, M., & Saldaña, D. (2020). ¿Legibilidad es sinónimo de comprensión en Lectura Fácil? Una revisión de estudios sobre comprensión lectora en textos adaptados o simplificados y su calidad metodológica. In A. E. Díez Mediavilla & R. Gutiérrez Fresneda (Coords.), *Lectura y dificultades lectoras en el siglo XXI* (pp. 714–728). Octaedro.

- Rivero-Contreras, M., Engelhardt, P. E., & Saldaña, D. (2021). An experimental eye-tracking study of text adaptation for readers with dyslexia: Effects of visual support and word frequency. *Annals of Dyslexia*, 71(1), 170–187. <https://doi.org/10.1007/s11881-021-00217-1>
- Rodríguez, K. V., Fonseca, L., Iaconis, F. R., Del-Punta, J., & Gasaneo, G. (2025). Eye tracking studies, a way to understand difficulties in reading processing. *Ocnos*, 24(1). https://doi.org/10.18239/ocnos_2025.24.1.488
- Roland, D., Mauner, G., & Hirose, Y. (2021). The processing of pronominal relative clauses: Evidence from eye movements. *Journal of Memory and Language*, 119. <https://doi.org/10.1016/j.jml.2021.104244>
- Saggion, H., Gómez Martínez, E., Etayo, E., Anula, A., & Bourg, L. (2011). Text simplification in Simplext: Making text more accessible. *Revista de la Sociedad Española Para el Procesamiento del Lenguaje Natural*, 47, 341–342. <http://journal.sepln.org/sepln/ojs/ojs/index.php/pln/article/view/1000>
- Saletta, M., Kaldenberg, E., Rivera, K., & Wood, A. (2019). Do illustrations promote reading comprehension in adults with intellectual or developmental disabilities? *Education and Training in Autism and Developmental Disabilities*, 54(3), 225–236. <https://doi.org/10.1177/215416471905400303>
- Salvador, E. (1999). *Materials de lectura fàcil: Anàlisi, directrius internacionals i proposta per a elaborar aquests materials a Catalunya*. FUS, Grup de Fundacions.
- Schatz, T., Haberstroh, J., Bindel, K., Oswald, P., Pantel, J., Paulitsch, M., Konopik, N., & Knopf, M. (2017). Improving comprehension in written medical informed consent procedures. *GeroPsych: Journal of Gerontopsychology and Geriatric Psychiatry*, 30(3), 97–108. <https://doi.org/10.1024/1662-9647/a000169>
- Schiffli, L. (2020). Hierarchies in lexical complexity: Do effects of word frequency, word length and repetition exist for the visual word processing of people with cognitive impairments? In S. Hansen-Schirra & C. Maaß (Eds.), *Easy language research: Text and user perspectives* (pp. 227–239). Frank & Timme GmbH.
- Schmalhofer, F., McDaniel, M. A., & Keefe, D. (2002). A unified model for predictive and bridging inferences. *Discourse Processes*, 33(2), 105–132. https://doi.org/10.1207/S15326950DP3302_01
- Schmutz, S., Sonderegger, A., & Sauer, J. (2019). Easy-to-read language in disability-friendly websites: Effects on nondisabled users. *Applied Ergonomics*, 74, 97–106. <https://doi.org/10.1016/j.apergo.2018.08.013>
- Scholz, A., Klichowicz, A., & Krems, J. F. (2018). Covert shifts of attention can account for the functional role of "eye movements to nothing". *Memory & Cognition*, 46(2), 230–243. <https://doi.org/10.3758/s13421-017-0760-x>
- Serratrice, L., Sorace, A., & Paoli, S. (2004). Crosslinguistic influence at the syntax–pragmatics interface: Subjects and objects in English–Italian bilingual and monolingual acquisition. *Bilingualism: Language and Cognition*, 7, 183–205. <https://doi.org/10.1017/S1366728904001610>

- Sevcik, R. A., Barton-Hulsey, A., Walters, C., & Ronski, M. (2019). Reading interventions for individuals with intellectual and developmental disabilities: A review. In R. M. Hodapp & D. J. Fidler (Eds.), *International review of research in developmental disabilities* (pp. 81–118). Elsevier Academic Press. <https://doi.org/10.1016/bs.irrdd.2019.08.001>
- Skversky-Blocq, Y., Shmuel, S., Cohen, O., & Shechner, T. (2022). Looking fear in the face: Adults but not adolescents gaze at social threat during observational learning. *International Journal of Psychophysiology*, 182, 240–247. <https://doi.org/10.1016/j.ijpsycho.2022.11.004>
- Social Care Institute for Excellence. (2005). *How to produce information in an accessible way (Social Care Accessibility Guidelines)*. <https://web.archive.org/web/20220119220308/https://www.scie.org.uk/publications/misc/accessguidelinespublications.asp>
- Southwell, R., Gregg, J., Bixler, R., & D'Mello, S. K. (2020). What eye movements reveal about later comprehension of long connected texts. *Cognitive Science*, 44(10), 1–24. <https://doi.org/10.1111/cogs.12905>
- Staub, A. (2010). Eye movements and processing difficulty in object relative clauses. *Cognition*, 116, 71–86. <https://doi.org/10.1016/j.cognition.2010.04.002>
- Subiela-Hernández, B. J., & Gómez-Company, A. (2018). Influencia del diseño periodístico en la comprensión de la información. *Profesional de la Información*, 27(1), 115–123. <https://doi.org/10.3145/epi.2018.ene.11>
- Šumskienė, E., & Baltrūnaitė, M. (2021). Easy language in Lithuania. In C. Lindholm & U. Vanhatalo (Eds.), *Handbook of easy languages in Europe* (pp. 327–344). Frank & Timme.
- Sung, E., & Mayer, R. E. (2012). When graphics improve liking but not learning from online lessons. *Computers in Human Behavior*, 28(5), 1618–1625. <https://doi.org/10.1016/j.chb.2012.03.026>
- Sutherland, R. T., & Isherwood, T. (2016). The evidence for easy-read for people with intellectual disabilities: A systematic literature review. *Journal of Policy and Practice in Intellectual Disabilities*, 12(4), 297–310. <https://doi.org/10.1111/jppi.12201>
- Sweller, J., van Merriënboer, J. J. G., & Paas, F. G. W. C. (1998). Cognitive architecture and instructional design. *Educational Psychology Review*, 10, 251–296. <https://doi.org/10.1023/A:1022193728205>
- Taylor, C., & Perego, E. (2020). New approaches to accessibility and audio description in museum environments. In S. Braun & K. Starr (Eds.), *Innovation in audio description research* (pp. 97–120). Routledge. <https://doi.org/10.4324/9781003052968>
- Tiffin-Richards, S. P., & Schroeder, S. (2015). Word length and frequency effects on children's eye movements during silent reading. *Vision Research*, 113, 33–43. <https://doi.org/10.1016/j.visres.2015.05.008>
- Trevarthen, C. B. (1968). Two mechanisms of vision in primates. *Psychologische Forschung*, 31(4), 299–337. <https://doi.org/10.1007/BF00422717>

- Trevisan, P., & Brumen, D. (2023). Translating standard language into easier varieties in Italy: Mapping needs and strategies for spoken easy language. *Rivista Internazionale di Tecnica della Traduzione / International Journal of Translation*, 25, 57–72.
<https://doi.org/10.13137/2421-6763/35508>
- Turnpenny, A., Caiels, J., Whelton, B., Richardson, L., Beadle-Brown, J., Crowther, T., Forder, J., Apps, J., & Rand, S. (2018). Developing an easy read version of the adult social care outcomes toolkit (ASCOT). *Journal of Applied Research in Intellectual Disabilities*, 31(1), e36–e48. <https://doi.org/10.1111/jar.12294>
- UNE - Asociación Española de Normalización. (2018). *Lectura fácil. Pautas y recomendaciones para la elaboración de documentos*. (UNE norm No. 153101:2018 EX).
- UNESCO Institute for Statistics. (2017). *Literacy rates continue to rise from one generation to the next*. https://www.uis.unesco.org/sites/default/files/medias/fichiers/2025/04/fs45-literacy-rates-continue-rise-generation-to-next-en-2017_0.pdf
- van den Bos, K. P., Nakken, H., Nicolay, P. G., & van Houten, E. J. (2007). Adults with mild intellectual disabilities: Can their reading comprehension ability be improved? *Journal of Intellectual Disability Research*, 51(11), 835–849. <https://doi.org/10.1111/j.1365-2788.2006.00921.x>
- van der Schuit, M., Segers, E., van Balkom, H., & Verhoeven, L. (2011). How cognitive factors affect language development in children with intellectual disabilities. *Research in Developmental Disabilities*, 32(5), 1884–1894. <https://doi.org/10.1016/j.ridd.2011.03.015>
- Van Gog, T., Ericsson, K. A., & Rikers, R. M. J. P. (2005). Instructional design for advanced learners: Establishing connections between the theoretical frameworks of cognitive load and deliberate practice. *Educational Technology Research and Development*, 53, 73–81. <https://doi.org/10.1007/BF02504799>
- van Gog, T., Paas, F., van Merriënboer, J. J. G., & Witte, P. (2005). Uncovering the problem-solving process: Cued retrospective reporting versus concurrent and retrospective reporting. *Journal of Experimental Psychology: Applied*, 11(4), 237–244. <https://doi.org/10.1037/1076-898X.11.4.237>
- van Gompel, R. P. G. (2013). Sentence processing: An introduction. In R. P. G. van Gompel (Ed.), *Sentence processing* (pp. 1–20). Psychology Press.
- van Tilborg, A., Segers, E., van Balkom, H., & Verhoeven, L. (2014). Predictors of early literacy skills in children with intellectual disabilities: A clinical perspective. *Research in Developmental Disabilities*, 35(7), 1674–1685. <https://doi.org/10.1016/j.ridd.2014.03.025>
- Vanhatalo, U., & Lindholm, C. (2023). Simplifying phrases in depression screens: Interpreters' views on usefulness in six languages. *PLOS ONE*, 18(12).
<https://doi.org/10.1371/journal.pone.0292365>

- Vidal, L. (2021). *La mirada tàctil. Versió LF: Llocs d'interès de Rupit i Pruit*. Oficina de Patrimoni Cultural, Diputació de Barcelona & Ajuntament de Rupit i Pruit.
- Vollenwyder, B., Schneider, A., Krueger, E., & Brühlmann, F. (2018). How to use plain and easy-to-read language for a positive user experience on websites. In K. Miesenberger & G. Kouroupetroglou (Eds.), *Computers helping people with special needs: 16th International Conference, ICCHP 2018* (pp. 514–522). Springer.
- W3C - World Wide Web Consortium. (2021). *Techniques for the Cognitive and Learning Disabilities Accessibility Task Force (COGA)*. <https://w3c.github.io/coga/techniques/index.html>
- W3C - World Wide Web Consortium. (2022). *W3C accessibility standards overview: Accessibility guidelines*. <https://www.w3.org/WAI/standards-guidelines/#guidelines>
- Wadihah, H., & Fauzi, A. (2021). Using image media on reading text to improve reading comprehension of students with intellectual disabilities. *Jurnal Asesmen dan Intervensi Anak Berkebutuhan Khusus*, 21(1).
- Wallot, S., O'Brien, B. A., Haussmann, A., Kloos, H., & Lyby, M. S. (2014). The role of reading time complexity and reading speed in text comprehension. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 40(6), 1745–1765. <https://doi.org/10.1037/xlm0000030>
- Wang, Y., & Sparks, B. A. (2016). An eye-tracking study of tourism photo stimuli: Image characteristics and ethnicity. *Journal of Travel Research*, 55(5), 588–602. <https://doi.org/10.1177/0047287514564598>
- Warburg, M. (2001). Visual impairment in adult people with intellectual disability: Literature review. *Journal of Intellectual Disability Research*, 45(5), 424–438. <https://doi.org/10.1046/j.1365-2788.2001.00348.x>
- Wei, S., Lei, Q., Chen, Y., Xin, Y. P., Kastberg, S., & Kim, S. (2018). Evaluating the effects of highlighting text animations on the attention distribution of students with math learning difficulties. *2018 ASEE Annual Conference & Exposition*.
- Wengelin, Å. (2015). Mot en evidensbaserad språkvård? En kritisk granskning av några svenska klarspråksråd i ljuset av forskning om läsbarhet och språkbearbetning. *Sakprosa*, 7(2), 17. <https://doi.org/10.5617/sakprosa.983>
- Whaley, C. P. (1978). Word-nonword classification time. *Journal of Verbal Learning and Verbal Behavior*, 17(2), 143–154. [https://doi.org/10.1016/S0022-5371\(78\)90110-X](https://doi.org/10.1016/S0022-5371(78)90110-X)
- White, H., Heck, A., Jubran, R., Chroust, A., & Bhatt, R. S. (2022). Average fixation duration in infancy: Stability and predictive utility. *Infancy: The Official Journal of the International Society on Infant Studies*, 27(5), 866–886. <https://doi.org/10.1111/infa.12483>
- Wickham, H., Pedersen, T., & Seidel, D. (2025). *Scales: Scale functions for visualization* (R package version 1.4.0.9000). <https://github.com/r-lib/scales>
- Wolman, C. (1991). Sensitivity to causal cohesion in stories by children with mild mental retardation, children with learning disabilities, and children without disabilities. *The Journal of Special Education*, 25, 135–154. <https://doi.org/10.1177/002246699102500202>

- Yaneva, V., Temnikova, I., & Mitkov, R. (2016a). Accessible texts for autism: An eye-tracking study. *ASSETS 2015, the 17th International ACM SIGACCESS Conference of Computer and Accessibility*, 49–57. <https://doi.org/10.1145/2700648.2809852>
- Yaneva, V., Temnikova, I., & Mitkov, R. (2016b). Evaluating the readability of text simplification output for readers with cognitive disabilities. *Proceedings of the Tenth International Conference on Language Resources and Evaluation (LREC'16)*, 293–299. <https://aclanthology.org/L16-1045/>
- Zhao, F., Schnotz, W., Wagner, I., & Gaschler, R. (2014). Eye tracking indicators of reading approaches in text-picture comprehension. *Frontline Learning Research*, 2(5), 46–66. <https://doi.org/10.14786/flr.v2i4.98>

ANNEXES

Annex 1. Summary of results from the studies in Chapters 3 and 4 in EL

❖ **Lectura Fàcil** (Catalan Easy Language)

Aquest document presenta els resultats
de 3 estudis sobre Lectura Fàcil.

Volem explicar els resultats de manera fàcil
i donar les gràcies a tots els participants.

Qui hi ha participat?

- Un grup de 26 persones amb discapacitat intel·lectual,
de SOM Fundació
i del Taller Jeroni de Moragas.
- Un grup de 26 persones sense discapacitat intel·lectual.

Què hem estudiat?

El primer experiment ha estudiat
si és més fàcil llegir i entendre un text
quan hi ha imatges.

També hem estudiat si és millor
fer servir fotografies o dibuixos.

El segon experiment ha estudiat
si és més fàcil llegir i entendre un text
quan repetim la informació.

El tercer experiment ha estudiat
si és més fàcil llegir i entendre un text
quan hi ha frases senzilles.

Com hem fet els experiments?

Els participants han llegit textos en Lectura Fàcil.
Amb una màquina que es diu “eye-tracker”
hem pogut saber on miraven
i com llegien.

També els hem preguntat:

- què expliquen els textos, i
- quins textos els agraden més.

Què hem descobert?

Hem descobert:

- Quins textos s’entenen millor.
- Quins textos agraden més als participants.

Quins textos s'entenen més bé?

En el nostre experiment
els textos amb imatge s'entenen igual
que els textos sense imatge.

Els textos amb un dibuix s'entenen igual
que els textos amb una fotografia.

Els textos on es repeteix informació s'entenen igual
que els textos on no es repeteix la informació.

Quins textos agraden més?

Als participants amb discapacitat intel·lectual
els agraden les fotografies
i no els agraden els dibuixos.

Als participants sense discapacitat intel·lectual
els agraden els dibuixos
i també les fotografies.

Als participants sense discapacitat intel·lectual
els agraden els textos
que no repeteixen informació.

Als participants amb discapacitat intel·lectual
els agraden més els textos
que sí que repeteixen informació.

Els textos amb frases simples agraden igual
que els textos amb frases més complicades.

Haurem de fer més estudis
per veure si altres persones pensen el mateix.

❖ **Easy Language** (literal translation from Catalan Easy Language)

This document presents the results
of 3 studies about Easy Language.

We want to explain the results in an easy way
and thank all the participants.

Who participated?

- A group of 26 people with intellectual disabilities,
from SOM Fundació
and from Taller Jeroni de Moragas.
- A group of 26 people without intellectual disabilities.

What did we study?

The first experiment studied
if it is easier to read and understand a text
when there are images.

We also studied if it is better
to use photographs or drawings.

The second experiment studied
if it is easier to read and understand a text
when we repeat the information.

The third experiment studied

if it is easier to read and understand a text
when there are simple sentences.

How did we do the experiments?

The participants read texts in Easy Language.

With a machine called "eye-tracker"

we could know where they looked
and how they read.

We also asked them:

- what the texts explain, and
- which texts they like the most.

What did we discover?

We discovered:

- Which texts the participants understand better.
- Which texts the participants like more.

Which texts are understood better?

In our experiment

texts with images are understood the same
as texts without images.

Texts with a drawing are understood the same
as texts with a photograph.

Texts where information is repeated are understood the same as texts where information is not repeated.

Which texts are liked most?

Participants with intellectual disabilities
like photographs
and do not like drawings.

Participants without intellectual disabilities
like drawings and photographs.

Participants without intellectual disabilities
like texts that do not repeat information.

Participants with intellectual disabilities
like more the texts
that do repeat information.

Texts with simple sentences are liked the same
as texts with more complicated sentences.

We will need to do more studies
to see if other people think the same.

Annex 2. Data from studies in Chapters 3 and 4

[Link](#) to the data from study in Chapter 3 (from article *Visual support in Easy Language: The impact of images on comprehension, perceived difficulty and eye movements*).

[Link](#) to the data from study in Chapter 4 (from article *Null and overt pronouns and subordinate clauses in Catalan Easy Language: An eye-tracking study on adults with and without intellectual disabilities*).

Annex 3. Stimuli from study in Chapter 3

See the stimuli in full size [here](#).

1) Instructions		
 L'estudi comença a la pàgina següent. Llegeix els textos en silenci. Quan hagis acabat de llegir el text, pots parlar i fer preguntes. La investigadora també et farà preguntes a tu.		
2a) Text 1, illustration	2b) Text 1, no visual support	2c) Text 1, photograph
 Vila de Rupit Rupit és un poble de la comarca d'Osona. El seu nom significa 'roca'. Fa molts anys, la família Cardona va construir un castell a sobre d'una gran roca. A partir d'aquest castell es va crear el poble. Anys més tard, el poble es va buidar a causa de les pestes i els terratrèmols. Avui en dia, el castell ja no hi és i només en queden ruïnes.	Vila de Rupit Rupit és un poble de la comarca d'Osona. El seu nom significa 'roca'. Fa molts anys, la família Cardona va construir un castell a sobre d'una gran roca. A partir d'aquest castell es va crear el poble. Anys més tard, el poble es va buidar a causa de les pestes i els terratrèmols. Avui en dia, el castell ja no hi és i només en queden ruïnes.	 Vila de Rupit Rupit és un poble de la comarca d'Osona. El seu nom significa 'roca'. Fa molts anys, la família Cardona va construir un castell a sobre d'una gran roca. A partir d'aquest castell es va crear el poble. Anys més tard, el poble es va buidar a causa de les pestes i els terratrèmols. Avui en dia, el castell ja no hi és i només en queden ruïnes.
3) Perceived difficulty Likert scale		
Has trobat aquest text difícil de llegir? 1 2 3 4 Gens, ha estat fàcil. No gaire. M'ha costat una mica. M'ha costat molt.		
4a) Text 2, illustration	4b) Text 2, no visual support	4c) Text 2, photograph
 Pont penjat Rupit està envoltat per una riera. L'any 1945, els ferraers del poble, Francesc i Pere Rovira; el paleta, Salvi Vila, i Joaquim Marsal, de la fonda, van construir un pont penjat per tenir un camí directe al poble. La riera de Rupit desemboca al pantà de Susqueda. Per la zona hi ha moltes fonts, molins i salts d'aigua. El salt d'aigua més alt és el salt de Sallent.	Pont penjat Rupit està envoltat per una riera. L'any 1945, els ferraers del poble, Francesc i Pere Rovira; el paleta, Salvi Vila, i Joaquim Marsal, de la fonda, van construir un pont penjat per tenir un camí directe al poble. La riera de Rupit desemboca al pantà de Susqueda. Per la zona hi ha moltes fonts, molins i salts d'aigua. El salt d'aigua més alt és el salt de Sallent.	 Pont penjat Rupit està envoltat per una riera. L'any 1945, els ferraers del poble, Francesc i Pere Rovira; el paleta, Salvi Vila, i Joaquim Marsal, de la fonda, van construir un pont penjat per tenir un camí directe al poble. La riera de Rupit desemboca al pantà de Susqueda. Per la zona hi ha moltes fonts, molins i salts d'aigua. El salt d'aigua més alt és el salt de Sallent.
5) Perceived difficulty Likert scale (same as above)		
6a) Text 3, illustration	6b) Text 3, no visual support	6c) Text 3, photograph
 Els oficis del poble Fa anys, Rupit era un poble molt important i amb molta activitat. Moltes cases encara tenen el nom dels oficis que hi havia. Antigament, al poble hi havia oficis com el de sastre o el de teixidor. L'ofici de farmacèutic era un dels més prestigiosos. L'antiga casa del farmacèutic de Rupit té inscrita a la porta una frase en llatí. La frase diu que Déu va crear els medicaments.	Els oficis del poble Fa anys, Rupit era un poble molt important i amb molta activitat. Moltes cases encara tenen el nom dels oficis que hi havia. Antigament, al poble hi havia oficis com el de sastre o el de teixidor. L'ofici de farmacèutic era un dels més prestigiosos. L'antiga casa del farmacèutic de Rupit té inscrita a la porta una frase en llatí. La frase diu que Déu va crear els medicaments.	 Els oficis del poble Fa anys, Rupit era un poble molt important i amb molta activitat. Moltes cases encara tenen el nom dels oficis que hi havia. Antigament, al poble hi havia oficis com el de sastre o el de teixidor. L'ofici de farmacèutic era un dels més prestigiosos. L'antiga casa del farmacèutic de Rupit té inscrita a la porta una frase en llatí. La frase diu que Déu va crear els medicaments.

7) Perceived difficulty Likert scale (same as above)

8a) Text 4, illustration

**Les rutes guiades**

A la primavera i a l'estiu,
Rupit organitza diverses rutes guiades
per conèixer el poble.
Una de les rutes porta fins al salt de Sallent.
La ruta passa pels boscos del voltant del poble.
Pel camí, podem veure antics molins abandonats,
gorgs, salts d'aigua i fonts.
Al final de la ruta, arribem al salt de Sallent.
La riera de Rupit acaba en aquest salt.

8b) Text 4, no visual support

Les rutes guiades

A la primavera i a l'estiu,
Rupit organitza diverses rutes guiades
per conèixer el poble.
Una de les rutes porta fins al salt de Sallent.
La ruta passa pels boscos del voltant del poble.
Pel camí, podem veure antics molins abandonats,
gorgs, salts d'aigua i fonts.
Al final de la ruta, arribem al salt de Sallent.
La riera de Rupit acaba en aquest salt.

8c) Text 4, photograph

**Les rutes guiades**

A la primavera i a l'estiu,
Rupit organitza diverses rutes guiades
per conèixer el poble.
Una de les rutes porta fins al salt de Sallent.
La ruta passa pels boscos del voltant del poble.
Pel camí, podem veure antics molins abandonats,
gorgs, salts d'aigua i fonts.
Al final de la ruta, arribem al salt de Sallent.
La riera de Rupit acaba en aquest salt.

9) Perceived difficulty Likert scale (same as above)

10a) Text 5, illustration

**Molí d'en Marandes**

Al llarg de la riera de Rupit hi ha diferents molins.
Alguns dels molins són molt antics.
Abans, els molins molien blat, blat de moro, farinetes...
Molts dels molins es van destruir amb unes riudes
i van deixar de funcionar.
Avui en dia, l'edifici del molí més gran és residencial
i hi viuen diverses persones.
El molí conserva un soterrani, la planta baixa i dos pisos.

10b) Text 5, no visual support

Molí d'en Marandes

Al llarg de la riera de Rupit hi ha diferents molins.
Alguns dels molins són molt antics.
Abans, els molins molien blat, blat de moro, farinetes...
Molts dels molins es van destruir amb unes riudes
i van deixar de funcionar.
Avui en dia, l'edifici del molí més gran és residencial
i hi viuen diverses persones.
El molí conserva un soterrani, la planta baixa i dos pisos.

10c) Text 5, photograph

**Molí d'en Marandes**

Al llarg de la riera de Rupit hi ha diferents molins.
Alguns dels molins són molt antics.
Abans, els molins molien blat, blat de moro, farinetes...
Molts dels molins es van destruir amb unes riudes
i van deixar de funcionar.
Avui en dia, l'edifici del molí més gran és residencial
i hi viuen diverses persones.
El molí conserva un soterrani, la planta baixa i dos pisos.

11) Perceived difficulty Likert scale (same as above)

12a) Text 6, illustration

**Dos miradors**

A Rupit, hi ha dos miradors destacables.
El primer mirador es troba al mateix poble.
Aquest mirador té vistes del poble de Rupit,
de les cases dels voltants
i de l'Aguilola, que és una roca molt gran.
La forma d'aquesta roca és curiosa
i sembla que algú l'hagi tallat amb un ganivet.
El segon mirador es troba a la carretera de Pruit.
Aquest mirador té vistes dels Pirineus.

12b) Text 6, no visual support

Dos miradors

A Rupit, hi ha dos miradors destacables.
El primer mirador es troba al mateix poble.
Aquest mirador té vistes del poble de Rupit,
de les cases dels voltants
i de l'Aguilola, que és una roca molt gran.
La forma d'aquesta roca és curiosa
i sembla que algú l'hagi tallat amb un ganivet.
El segon mirador es troba a la carretera de Pruit.
Aquest mirador té vistes dels Pirineus.

12c) Text 6, photograph

**Dos miradors**

A Rupit, hi ha dos miradors destacables.
El primer mirador es troba al mateix poble.
Aquest mirador té vistes del poble de Rupit,
de les cases dels voltants
i de l'Aguilola, que és una roca molt gran.
La forma d'aquesta roca és curiosa
i sembla que algú l'hagi tallat amb un ganivet.
El segon mirador es troba a la carretera de Pruit.
Aquest mirador té vistes dels Pirineus.

13) Perceived difficulty Likert scale (same as above)

14) Visual suport preference question

Quina d'aquestes pàgines t'agrada més? Per què?



Annex 4. Stimuli from study in Chapter 4

See the full-size stimuli for the null and overt pronouns and the subordinate clauses tests [here](#). Note that the changes in the stimuli are purely textual rather than design-related, and that all texts are in Catalan.

Annex 5. Demographic form, consent forms and information sheets

❖ Demographic form

1. Codi del test

...

2. Codi del participant

3. Gènere

- ☐ Dona
- ☐ Home
- ☐ No binari
- ☐ M'estimo més no dir-ho

4. Edat

5. Tens algun problema de visió greu no corregit?

- ☐ Sí
- ☐ No
- ☐ No ho sé

6. Acostumes a llegir continguts en Lectura Fàcil?

- ☐ Sí
- ☐ No
- ☐ No coneixia la Lectura Fàcil

❖ Information sheet and consent form

1. FULL INFORMATIU

Aquest estudi és part d'una investigació sobre la Lectura Fàcil.

La investigació la fa la Mariona González.

La Mariona és de la Universitat Autònoma de Barcelona.

Amb aquest estudi volem saber si un text és fàcil de comprendre.

Volem trobar maneres de fer els textos més comprensibles.

Mesurarem els teus moviments oculars.

També et farem algunes preguntes.

Aquest estudi durarà uns 60 minuts.

Et demanarem informació sobre tu.

Pots fer qualsevol pregunta a la Mariona González.

Ara llegeix el consentiment informat.

El consentiment informat és un document

en què dius que vols participar en l'estudi.

CONSENTIMENT INFORMAT

Participes en aquest estudi perquè tu vols.

Pots parar quan vulguis

i sense donar explicacions.

Està bé parar en qualsevol moment.

Les dades seran confidencials.

Això significa que no utilitzarem el teu nom.

La persona responsable de l'estudi és la Mariona González.

Si vols saber més sobre el projecte,

pots escriure a la Mariona González.

El seu correu electrònic és: mariona.gonzalez@uab.cat

Política de dades

Si dones dades personals,

l'Anna Matamala serà la responsable de guardar-les.

Les dades personals són el teu nom i correu electrònic.

D'aquí a 5 anys,

esborrarem totes les dades personals.

Seguirem les normes europees que protegeixen les teves dades personals.

No donarem les teves dades a cap altra persona, empresa o organització.

Pots demanar a l'Anna Matamala

- una còpia de les teves dades personals,
- que esborri les teves dades personals,
- que canviï les teves dades personals.

Pots escriure un correu a l'Anna Matamala.

El seu correu electrònic és: anna.matamala@uab.cat

També pots escriure a qui s'encarrega de les dades personals

a la Universitat Autònoma de Barcelona.

El seu correu electrònic és: proteccio.dades@uab.cat

Si les frases següents són verdaderes,

marca la casella "Acceptar" i escriu el teu nom:

- He llegit la informació o algú me l'ha explicat de manera fàcil de comprendre.
- He pogut fer preguntes.
- Vull participar en l'estudi.

*

☐ Acceptar

2. Nom i cognoms tutor/a *

Escriuiu la vostra resposta.

3. Nom i cognoms participant *

Escriuiu la vostra resposta.

Annex 6. Ethics committee report



Comisión de Ética en la Experimentación Animal y Humana (CEEAH)

Universitat Autònoma de Barcelona
08193 Bellaterra (Cerdanyola del Vallès)

La Comisión de Ética en la Experimentación Animal y Humana (CEEAH) de la Universitat Autònoma de Barcelona, reunida el día **21-02-2022**, acuerda informar favorablemente el proyecto con número de referencia **CEEAH CA40** y que tiene por título **"Easy Language: empirical evaluations"** presentado por **Mariona González Sordé**

Elaborado:	Aprobado:
Nombre: Nuria Perez Pastor Cargo: Secretària de la CEEA de la UAB Fecha:  2022.02.2 5 10:39:22 +01'00' Universitat Autònoma de Barcelona Núria Pérez Pastor Secretària de la CEEAH Comissió d'Ètica en Experimentació Animal i Humana	Nombre: José Luis Molina González Cargo: President de la CEEAH de la UAB Fecha: JOSE LUIS MOLINA GONZALEZ - DNI 36561625C Fecha: 2022.02.25 12:47:06 +01'00'

Annex 7. Published articles within this dissertation: Article 1

Screen reader users, please refer to Chapter 2.



Empirical evaluation of Easy Language recommendations: a systematic literature review from journal research in Catalan, English, and Spanish

Mariona González-Sordé¹ · Anna Matamala¹

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Abstract

Easy Language is a language variety that aims to make information more comprehensible and, ultimately, more accessible. Content in this variety is written and designed following a set of recommendations that have been published in different guidelines. However, it remains uncertain to what extent these recommendations are backed up by empirical research. The aim of this study is to review the existing literature that evaluates current recommendations in Easy Language guidelines, on the basis of the following research questions: (a) is there empirical research that evaluates current international Easy Language recommendations? and, (b) if so, what current international Easy Language recommendations are supported by empirical research and what results were obtained? To this end, we conducted a systematic literature review based on journal articles in three languages: Catalan, English, and Spanish. First, a systematic search was designed and performed in 10 databases of different fields of science. Then, we reviewed every article that resulted from the search and found that 6 publications out of the initial 617 met the inclusion criteria and could be considered relevant for the study. Based on the data extracted from the included publications, and after an overall review of our systematic search results, we safely state that there is indeed empirical research on some current Easy Language recommendations. Nevertheless, empirical research in the field (at least in the publication format and languages considered in our study) is not enough in terms of the number of publications, and the findings obtained are far from generalisable. Our literature review suggests future lines of research, and we hope that it fosters empirical studies in the field that help support the existing findings.

Keywords Easy Language · Easy-to-understand language · Accessible information · Systematic review · Literature review

1 Introduction

Reaching accessible information and communication requires eliminating linguistic, sensory, and cognitive barriers [1]. Audio description (AD) and subtitling for the deaf and hard-of-hearing (SDH) may be the best-known modalities, but accessible communication can be reached by means of different access services, relates to various types of media, and targets different groups of people. Making information more accessible and communicating easier for everyone is

the shared goal of many different practices, one of them being Easy-to-understand Language.

The ISO standard on making written texts easier to read and understand defines “Easy-to-understand language” as “any language variety which enhances comprehensibility” [2, p. 1]. “Easy-to-understand language” has been used as an umbrella term for different simplified language varieties, among which we find Plain Language (less-simplified language) and Easy Language (more-simplified language) [3]. Maaß [4] defends that Plain Language is less perceptible and comprehensible, more acceptable and avoids stigmatisation, whereas Easy Language does the opposite: it is more perceptible and comprehensible, less acceptable and can lead to stigmatisation. This article will focus on Easy Language, the most simplified functional variety of Easy-to-understand Language.

Easy Language is defined in the ISO standard [2, p. 2] as a “language variety in which a set of recommendations

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regarding wording, structure, design and evaluation are applied to make information accessible to persons with reading comprehension difficulties for any reason". But an official definition of the term is yet to be set [5], and researchers and professionals of the field are yet to reach a consensus on one consolidated term. Today, Easy Language is also referred to as "Easy-to-read" and "Easy Read" [6–10], among other less-popular terms. We decided to consistently use the term "Easy Language" in our paper on account of its recent extended usage by experts [4, 5, 11] and because, contrary to the terms "Easy Read" and "Easy-to-read", it does not denote that the variety is limited to written text [2, p. 2] or content intended to be read.

Easy Language deviates from standard use in specific aspects related to content, vocabulary, and structure [5, 7, 12], as well as in paratextual elements, like the use of illustrations as visual support, the design, or the layout of the documents [7].

Any person who finds it hard to understand standard language at any level is a target user of Easy Language [5]. A very heterogeneous group of people can experience comprehension barriers: low levels of literacy, intellectual disabilities, dyslexia, aphasia, advanced age, or limited language skills (a frequent characteristic of second-language learners or immigrants) can all be the cause of experiencing comprehension difficulties or declined reading abilities [7, 13, 14], alongside contextual circumstances. After all, literacy is not a native ability but rather acquired and dependant on many factors [14]. It is estimated that nowadays a total of 750 million adults around the world [15] and a third of the population in Spain [11] could benefit from accessible communication and Easy Language. Ultimately, since Easy Language can serve everyone [5, 16], everyone should be able to choose between information in Easy Language and standard language [5].

The reality and practice of Easy Language is different from one country to another and from one language to another. This paper adopts a European point of view, as well as having a special focus on Spain and Catalonia, which is the context the authors are more familiar with and in which Spanish and Catalan, languages that are in our inclusion criteria for publications (see Sect. 2.1.1), are official.

Many researchers state that current recommendations lack empirical support (see Sect 1.2), and both professionals and academics manifest that more research on the field is needed [17, 18]. A 2020 literature review from Rivero-Contreras and Saldaña [19] assessed the existing research that evaluates the effects of Easy Language on comprehensibility. An earlier review by Sutherland and Isherwood [18] also searched for evidence related to different characteristics of Easy Language (e.g. symbols, photographs) and their effects on comprehension. Finally, Chinn and Homeyard [20] performed a meta-narrative literature review centred on the

impact of accessible health information for people with intellectual disabilities.

These studies resulted, in the most part, in finding no conclusive evidence to support the alleged positive effect on the reader's comprehension of Easy Language. Our review is the first to set the Easy Language recommendations as the focus and starting point of the search, although we also acknowledge the limitations of our search (see Sect. 4.3) in terms of language and publication outlet choices. Naturally, the results of all these reviews (including ours) are meant to complement each other.

Our main aim is to review the existing literature that evaluates current recommendations in Easy Language guidelines in three languages and discover if these recommendations have empirical support, and if further research would be needed. More specifically, our research questions are the following: (a) is there empirical research that evaluates current international Easy Language recommendations? and (b) if so, what current international Easy Language recommendations are supported by empirical research and what results were obtained?

The article presents, firstly, an overview of the main guidelines and standards, and references to research performed on the field. Then, the methodology is set forth, followed by the main results of our systematic literature review. Finally, we will discuss the results and arrive at conclusions.

1.1 Easy Languages: existing guidelines and research

The main guidelines on Easy Language will be presented in this section, focusing on international and Spanish guidelines. Recommendations on other languages and on other easy-to-understand language varieties are outside the scope of this article, although a few can be mentioned.

1.1.1 Guidelines and standards

In 1997, the International Federation of Library Associations and Institutions (IFLA) published their first Easy Language guidelines. An updated version was published in 2010 [7]. Adaptations of the latter have become the main guidelines for Easy Language practice in a few countries, like Croatia or Sweden [21, 22].

Inclusion Europe (an association that was called International League of Societies for Persons with Mental Handicap-European Association until 2000) also published some guidelines in 1998 [23], which were updated in 2009 [24]. These guidelines have been translated and adapted to various European languages and have become the most popular—and, in some cases, the first—guidelines for Easy Language in many countries (e.g. Latvia, Lithuania, Poland, Czech Republic) [25–28].

An International Organization for Standardization (ISO) project has recently been working on composing and publishing the first international standard for writing in Easy Language [2]. This ISO project has taken inspiration from previous sources, including the first-ever—and so far the only—Easy Language standard, the UNE 153,101:2018 EX [29], published in 2018 in Spain, which presents some specificities from the Spanish language [13, 29]. The UNE standard is currently the main guide for Easy Language practice in Spain. That being said, there are several handbooks with recommendations on how to create and evaluate content in Easy Language available in Spanish [11, 30], and a few international guidelines have been translated into Spanish, Catalan, and other co-official languages of Spain. Inclusion Europe had its first Easy Language guidelines from 1998 [23] translated into Catalan and Spanish [31, 32] and its 2009 guidelines [24] translated into the same languages in 2016. The 2010 IFLA guidelines [7] were also translated into Catalan and Spanish in 2012.

Guidelines can include language-independent as well as language-specific rules, but the recommendations in international Easy Language guidelines like the ones by Inclusion Europe [24] or IFLA [7] are not focused on language-specific requirements and provide mainly generalisable recommendations instead. Easy Language is language-dependant [14], but language-independent guidelines can function as a source of standard, replicable recommendations to be later reviewed, questioned, and adjusted into language-specific rules or practices.

Easy Language guidelines can include recommendations related to not only linguistic aspects of the text, but also to the paratextual aspects of it, like the need for visual support or the communication channels that can be used. Most guidelines will include recommendations on both types of elements, with a few exceptions. The publication *Make it easy. A guide to preparing Easy-to-read* guidelines, published in 2011 by the Accessible Information Working Group [33], for example, presents a set of recommendations that go scarcely over the linguistic aspects of Easy Language only to focus on other aspects of the text (e.g. graphic and stylistic elements).

Finally, guidelines can be designed for different uses and can be generic or case-specific. A few guidelines for making accessible content were designed to be relevant and applicable to one specific context. One example of this is the W3C Accessibility Guidelines (WCAG) 3.0 that include a set of recommendations for “making web content more accessible to users with disabilities” [34] in which writing in Plain Language is recommended. The Techniques for the Cognitive and Learning Disabilities Accessibility Task Force (COGA) [35] also give designers some corresponding recommendations to make sites more usable for people with cognitive and learning disabilities, although Easy Language is not

mentioned. Another example of case-specific accessibility guideline is *Resum de les principals pautes de Lectura Fàcil per a elaborar textos narratius* [30], a set of recommendations for writing prose fiction in Easy Language.

1.1.2 Guidelines and research

Easy Language guidelines and standards may not suffice “neither for consistent text practice nor for research purposes” [4: 78], but “they show good intuition as to what makes information easier to understand [...] [and] it is interesting to see where those rules overgeneralise or underspecify” [4, p. 78]. These statements sprout from a lack of evidence supporting Easy Language recommendations, an issue that has been outlined by many authors [5, p. 15, 18, pp. 297–298, 20, p. 2]. As a matter of fact, even if there was existing evidence to support certain recommendations, it would be very hard to know, since most of the existing guidelines do not reference previous studies [18, p. 298]. It is difficult to trace each recommendation back to the study that might assess it [36] and, therefore, it could not be easy to understand why and how the adaptation of the text following certain recommendations makes the text more accessible—that is, why they should be included in Easy Language guidelines. In a recent literature review by Sutherland and Isherwood [18, p. 308], it is determined that “aside from the simplified written text, it is not clear from the current paucity of experimental research whether other aspects of [Easy Language] such as symbols, pictures (line drawings), or photographs necessarily enhance understanding [...] Overall, there is little supporting evidence in the literature for the recommendations contained in many [Easy Language] design guidelines.” Rivero-Contreras and Saldaña [19, p. 726] also concluded in their review that “it seems like the adaptation of written content facilitates reading, [...] but, in general, it does not allow a better comprehension of the information” (“*Parece ser que la adaptación del material escrito facilita la lectura, [...] pero, en general, no permite una mayor comprensión de la información*”). On account of this, Chinn [8] mentions that the process of producing Easy Language resources is still unclear, and “rationales for design decisions are lacking” [8, p. 411]. Thereby, without evidence to base the creation of guidelines on, no hierarchy of recommendations has yet been set, and a few inconsistencies between different publications can be found [18]. For example, in García Muñoz [13, p. 76], it is recommended to always indicate the picture’s copyright (“*Señalar el copyright de la foto*”), with no further instruction given. This instruction could give the reader the idea that the copyright should be placed under the image, but at the same time, the UNE standard [29, p. 31] specifies the

following: “copyright information should not accompany the image. It should be placed on a different section or a credits section” (“*La información sobre derechos de uso de imagen no debe incorporarse junto a ella. Se debería situar en un apartado de créditos o en otro apartado*”). Another inconsistency would be the placement of images, with instructions to place them on the left of the text [37], as well as on the right [38].

In 2015, Wengelin [39] pointed out that, until then, only a few studies had provided supporting evidence for Easy Language guidelines, and that the results of these studies were mostly outdated. In 2021, Lindholm and Vanhatalo [5] defended that systematic research on Easy Language was incipient in most countries, and the existing studies often referred to specific applications of Easy Language (e.g. online content and websites [6, 10, 40], health and social care [41, 42]), or to certain target groups (e.g. people with autism [42, 43] or intellectual disabilities [41, 44]). In a related manner, Miesenberger and Petz presented a state of the art of website content in Easy Language and pointed out the need for research in that specific field back in 2013 [6].

German-speaking countries (and, specially, Germany) are an encouraging exception because of their recently increasing research on Easy Language [5, 17]. It is also remarkable that Easy German does have scientifically based rulebooks, in addition to practical guidelines, the first dating back to 2015 [45]. All scientifically based rulebooks have been developed at the University of Hildesheim in Germany [46], but even these guidelines are supported by previous non-specific research (studies that were not related to or focused on Easy Language). As Maaß [4] defends, more studies that clearly evaluate Easy Language recommendations, as well as more studies performed with the primary users of Easy Language, are necessary to back up the guidelines. One main limitation of this paper is that, due to the language barrier, publications written in German will not be included in our review (see Sects. 2.2.1, 2.2.2 and 4.3).

2 Methods

Our systematic literature review followed two different complementary processes: first, an identification of Easy Language recommendations shared across guidelines that would become the focus of our research, and second, the actual systematic literature review of possible research supporting these recommendations. Section 2.1 provides an overview of the methodology followed for the first goal, and Sect. 2.2 reports on the methodology of the later review.

2.1 Step 1: selecting Easy Language recommendations

Defining the Easy Language guidelines—and, consequently, the recommendations—that were to be taken into consideration in our study helped us later sort and analyse the results of our literature review.

As has been partially exposed in Sect. 1.1.1, numerous guidelines with different characteristics and target audiences have been published. In the following section, we will present the criteria used to select the included guidelines and standards, as well as the procedure followed to extract and classify the recommendations in each one.

2.1.1 Selection criteria

We selected recent guidelines and standards written in English, Spanish, and Catalan that met the selection criteria in Table 1. The initial bibliography of guidelines had been built over the previous months, based on read literature on Easy Language and the guidelines and standards referred in them. The initial bibliography included a total of 23 publications (see Appendix 1).

After applying the set criteria (see Table 1), 8 guidelines and standards were selected:

- (1) Guidelines for easy-to-read materials [7],
- (2) Information for all [24],
- (3) ISO/IEC DIS 23859–1 [2],
- (4) Lectura

Table 1 Criteria for including and excluding guidelines

Inclusion criterion	Published in the last 15 years (2006 or later) Written in English, Spanish, or Catalan Not a translation or adaptation of a different guideline Guidelines to produce written content in Easy Language Majority of recommendations are language-independent
Exclusion criterion	Published in 2005 or earlier Written in a language other than English, Spanish, or Catalan Translation or adaptation from a different guideline Guidelines to produce a type of content other than written text Sets out a specific context of application (e.g. websites) Majority of recommendations are dependent to one language

fácil: Métodos de redacción y evaluación [13], (5) UNE 153,101:2018 EX [15], (6) How To Make Information Accessible [47], (7) Make it easy: A guideline to preparing Easy-to-read [33], and (8) Make It Clear [48].

2.1.2 Data extraction and synthesis

Recommendations were manually extracted from the selected documents. Our classification system was shaped by the categories in the guidelines by García-Muñoz [13], which were adapted by the authors to fit this study and its data specifically (see Table 2). Extracting and classifying the recommendations in a systematic way helped us obtain comparable data.

For each recommendation, the following information was noted: type of recommendation, category, subcategory, source, year of publication, author, country of publication, language of publication, page in the source document that

the recommendation appears in, examples or additional notes provided for it, and keywords.

Figure 1 depicts the information noted for each recommendation in the guidelines.

Keywords were added for each entry in order to create relationships of closeness or correspondence between different recommendations. Keywords included terms that appeared in the recommendation or that were related to either the recommendation itself or the category it was included in. The list of keywords already in use was consulted for each new entry to make sure that consistency was kept. Every time that a new keyword needed to be included, this was added to the list.

2.2 Easy Language recommendations literature

In the following subsections, we present the criteria and the methodology followed in our literature review. All the steps and decisions along this procedure were taken keeping

Table 2 Classification of guideline recommendations

Type of recommendation	Category	Subcategory
Language	Orthography and writing	Capitalisation
		Punctuation
		Other punctuation marks and diacritics
		Numbers
		Time and date
	Grammar	Verbs
		Parts of the sentence
		Sentences
	Vocabulary	Complexity of the vocabulary
		Lexical units
		Semantic aspects
	Style	
Design and Layout	Images	Semantic features
		Technical aspects
		Layout on the page
	Font	
	Layout	Lines
		Paragraphs
		Page layout
		Presenting lists
	Pagination	
	Other graphic aspects	
	Paratextual elements	Table of contents
		Glosses and glossaries
		Summaries
		Maps
		Graphics

Type of suggestion	Category	Subcategory	Suggestion	Guideline	Year of publication	Authors	Country of publication	Language of publication	Page	Examples provided	Additional notes	Keywords
Language	Grammar	Sentences	Be concise. Avoid several actions in a single sentence.	Guidelines for easy-to-read materials	2010	International Federation of Library Association and Institutions	The Netherlands	English	11			sentence, sentence structure
Design and layout	Images	Layout on the page	Illustrations should [...] be placed in direct connection to the text.	Guidelines for easy-to-read materials	2010	International Federation of Library Association and Institutions	The Netherlands	English	13			image, layout, page

Fig. 1 Sample of data extracted from Easy Language guidelines

into consideration that our search and review had to be systematic.

2.2.1 Search strategy

With the aim of detecting studies that potentially provided evidence to support Easy Language recommendations, we systematically searched for publications on the following electronic databases: Scopus, Web of Science, ERIC (Education Resources Information Center), JSTOR (Journal STORage), DOAJ (Directory of Open Access Journals), PubMed, Helka, DiVA (*Digitala Vetenskapliga Arkivet* ["Digital Scientific Archive"]), APA PsychInfo and MLA International Bibliography. Easy Language may be of interest for professionals and researchers in many fields, hence searching on multiple databases that encompass different fields of science gave us a higher chance to find relevant publications. This search strategy entails a notable limitation: these databases mostly list academic journals, and other types of relevant publications may be missed. This will be discussed in Sect. 4.3.

In the systematic searches, we used various sets of keywords that were linked to different aspects relevant for our review: (1) Easy Language recommendations and guidelines and (2) the type of studies that we were aiming to retrieve (see the different sets of keywords as [A], [B], [C] and [D] on Table 3).

Our searches were designed to include the following:

- (A) Keywords that refer to Easy Language guidelines;
- (B) Keywords that refer to Easy Language;
+ keywords that refer to the empirical aspect of searched publications;
- (C) Keywords that refer to Easy Language;
+ keywords related to guidelines and recommendations;
- (D) Keywords that refer to Easy Language;
+ keywords that refer to specific Easy Language guidelines or standards

It has to be noted that the search engines in the databases explored do not discriminate between a word with accent marks and the same word without them; hence, the text in Table 3 does not consider these marks. These search engines do not restrict based on capitalisation either.

We made sure to include the most common terms used to refer to "Easy Language", as well as to search all terms in all the languages considered in the inclusion criteria of our study (Tables 1 and 4). The keywords were searched for in abstracts, in the keywords of publications, and/or in the full texts, depending on the more or less precise search options, and on the information that was included in the indexed entries for each database.

Because of these differences between the database search options, a few of them (DOAJ, JSTOR and Web of Science) would not allow combining two or more strings of keywords. For these, searches [B], [C], and [D] presented in Table 3 could not be performed, and each independent set of keywords needed to be searched for separately. In these cases, results were filtered manually applying the selection criteria in Sect. 2.2.2.

The systematic searches resulted in a total of 617 publications.

2.2.2 Selection criteria

The 617 retrieved publications were reviewed and filtered manually using the criteria in Table 4.

First, titles and abstracts were reviewed for all 617 publications. Some articles were excluded because they addressed topics that were not relevant for our review (e.g. publications related to chemical processes, programming language, or mechanics). The authors also excluded publications that mentioned or were focused on Easy Language, but that did not perform evaluations or empirical studies (e.g. non-empirical, descriptive studies; studies on the promotion of Easy Language). A few other results were discarded because, although having gone through the language filter of the database, they were written in a language other than

Table 3 Database search keywords

(A) "Information for all" OR "UNE 153101:2018 EX." OR "AENOR" OR "ISO/IEC DIS 23859-1" OR "Lectura facil: Metodos de redaccion y evaluacion" OR "Guidelines for easy-to-read materials" OR "Garcia Muñoz" OR "International Organization for Standardization" OR "IFLA" OR "Asociacion Española de Normalizacion" OR "Inclusion Europe"		
(B), (C), (D) "easy-to-read" OR "easy to read" OR "easy read" OR "easy reading" OR "lectura facil" OR "easy to understand language" OR "E2U"		
		
"empirical" OR "empiric" OR "empirico"	"guideline" OR "recommendation" OR "recomendacion" OR "recomendaciones" OR "recomanacio" OR "recomanacions" OR "guia" OR "guies" OR "standard" OR "norma" OR "norm"	"Information for all" OR "UNE 153101:2018 EX." OR "AENOR" OR "ISO/IEC DIS 23859- 1" OR "Lectura facil: Metodos de redaccion y evaluacion" OR "Guidelines for easy-to-read materials" OR "Garcia Muñoz" OR "ISO" OR "IFLA" OR "UNE" OR "International Organization for Standardization" OR "International Federation of Library Associations and Institutions" OR "Asociacion Española de Normalizacion" OR "Inclusion Europe"

Table 4 Criteria for including and excluding publications

Inclusion criterion	Published in the last 15 years (2006 or later) Written in English, Spanish, or Catalan The research puts a focus on Easy Language Provides evidence to support or evaluate Easy Language guidelines recommendations
Exclusion criterion	Published in 2005 or earlier Written in a language other than English, Spanish, or Catalan The research is not focused on Easy Language Does not provide evidence to support or evaluate Easy Language guidelines recommendations

English, Spanish, or Catalan (see the limitation this entails in Sect. 4.3). Finally, some results, like news or informational pamphlets, were excluded because of their format, in addition to their content (e.g. medical pamphlets). This first selection step resulted in the exclusion of 597 publications that did not meet the inclusion criteria. Figure 2 presents a summary of the selection process.

The next step taken was to fully review the remaining 20 publications. In the end, only 6 of them met the pre-set criteria and were included in our study. All 6 of these

studies provided empirical findings directly linked to Easy Language recommendations. The studies that were excluded after being fully reviewed resulted to finally be (a) not directly related to Easy Language, (b) not mentioning Easy Language recommendations or guidelines, and/or (c) not providing empirical findings related to Easy Language recommendations. Consequently, criteria for inclusion were not completely met in these cases, and 14 more publications had to be excluded.

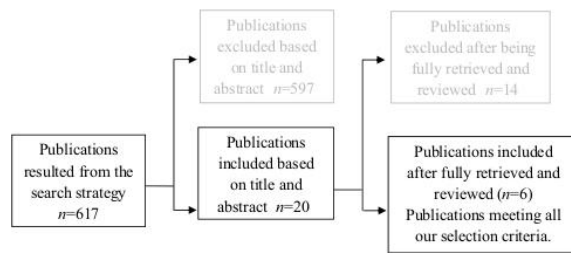


Fig. 2 Publications selection process

2.2.3 Data extraction and synthesis

To analyse the 6 included publications, we created a matrix including the following data: aims, design, participants, Easy Language recommendations that are evaluated, findings, and limitations. The data extracted will be presented and discussed in Sect. 3.

2.2.4 Quality appraisal

In literature reviews, a quality appraisal assessment should be performed on the selected publications [18, 49]. Numerous academic institutions and scientific organisations have created quality appraisal checklists to perform these assessments, but most target health science studies (this is the case for some of the main providers of quality appraisal tools: Critical Appraisal Skills Program [CASP], the Johanna Briggs Institute, the Centre for Evidence Based Medicine of Oxford University or the Scottish Intercollegiate Guidelines Network) or a specific study design (e.g. randomised controlled trials, case control studies).

For that reason, we created a list of general quality indicators that could be applicable to the studies included in our review and that were based on the quality indicators in checklists of CASP [50], Johanna Briggs Institute [51], as well as the indicators in Sutherland and Isherwood [18].

All six publications included in our analysis passed the assessment.

3 Results

The findings retrieved from the review of studies are grouped according to the linguistic aspect they evaluate. Our literature review found studies that evaluated (1) visual support, (2) linguistic simplification, (3) word frequency, (4) literacy mediation, (5) connectives, (6) co-references, and (7) number of sentences, text length, and word length.

In Sect. 4.2, we will present the relationship between these aspects and Easy Language recommendations.

3.1 Visual support

Visual support and, specifically, the use of pictures and vignettes to enhance comprehension are evaluated in Rivero-Contreras et al. [52] and Schatz et al. [53].

Rivero-Contreras et al. [52] performed an eye-tracking study on 20 university students with dyslexia (7 males and 13 females) and 20 chronological age-matched controls. The aim of this study was to evaluate the influence of visual representation and word frequency both on processing and on readers with dyslexia. For this, they designed a test where participants read 60 sentences: half the sentences contained an image, and the other half did not. At the same time, half contained a low-frequency word and half a high-frequency word. In this study, Rivero-Contreras et al. [52] found that, for people with lower vocabulary and less reading experience, the use of images related to the information in the text helps with the initial processing of words in the sentence and with the prediction of upcoming information, as well as with the recognition of semantic content in the text, which facilitates lexical access. However, it is not clear that the use of images helps with overall comprehension of the text, neither that it affects reading accuracy for this group of users [52].

Schatz et al. [53] performed an online study with 159 adults who were presented simulated medical informed consent procedures. Researchers aimed to determine the effects that the use of pictures and the different varieties of Easy-to-understand languages (that is, their different levels of language simplification) might have on comprehension. Participants were randomly assigned to one of the five ways of presenting information: standard version (with or without visual support), Easy-to-Read Language (with or without visual support), or Elaborated Plain Language. After each section, participants were directly asked comprehension questions. Schatz et al. [53] also found that, for young participants without intellectual disabilities, vignettes supporting Easy Language texts yielded no significant benefit in comprehension. This group of participants performed better when the Easy Language version was accompanied by images than when it was not, but not better than with the standard language version. The Easy Language version with visual support just compensated the negative effect of the Easy Language version without visual support and showed similar comprehensibility than the standard version [53]. Therefore, this study found no benefits of using Easy Language with images rather than standard language with young participants without intellectual disabilities.

3.2 Linguistic simplification

Linguistic simplification on a general, textual level is evaluated in Buell et al. [9] and Schmutz et al. [10].

Buell et al. [9] performed a test on 60 adults with intellectual disabilities. Participants had to read a text that could be linguistically simple or complex and come with or without mediation. Conditions were allocated randomly, and participants were later asked questions that assessed reading comprehension and that were formulated to tap recall and the inferential application of information from the text. The aim of this study was to investigate how extrinsic (linguistic complexity of the text and literacy mediation) and intrinsic (participants' receptive vocabulary and reading comprehension abilities) factors affect the understanding of Easy Language material.

Schmutz et al. [10] aimed to examine the consequences of Easy Language as a web accessibility criterion for users with no disabilities. In their study, 128 participants that were mainly psychology students needed to solve tasks in a website that was either in Easy Language or in standard language (conditions were assigned randomly). Participants also filled in questionnaires to evaluate the website and had to answer free-recall, recognition of content, and true/false tasks.

In Buell et al. [9], linguistic simplification was found to not have any significant effect on comprehension for people with intellectual disabilities. The repetition of vocabulary only reinforced certain concepts but failed in improving comprehension for this group of users. On the other hand, Schmutz et al. [10] found that users in the control group processed information better when reading a simplified text.

Schmutz et al. [10] found that linguistic simplification also showed an increase in reading time [10] (due to the fact that text simplification resulted in more characters), as well as a decrease in text liking for the control group users. Users performed better when the text was simplified, but still showed a preference for the standard text [10].

Finally, Buell et al. [9] suggest that adjusting the linguistic complexity of the text may have less impact on required cognitive effort than the presence of familiar, frequent vocabulary.

3.3 Word frequency

Lexical simplification using high-frequency words is evaluated in Rivero-Contreras et al. [52], Fajardo et al. [36], and Fajardo et al. [54].

Rivero-Contreras et al. [52, p. 182] (design and characteristics of the study were discussed in Sect. 3.1) found that “participants with lower vocabulary and lower print exposure [which are common characteristics of people with dyslexia] benefited the most from lexical simplification”. High-frequency words showed to result in shorter reading time at text-level and to facilitate overall sentence comprehension and processing [52]. Their presence was also found to be beneficial to lexical access to particular words [52].

Fajardo et al. [54] studied the effects of word frequency and connectives on reading comprehension in a 2013 study. Two experiments were performed: in the first one, participants read four versions of Spanish journalistic texts and answered literal and inferential comprehension questions after each one. Word frequency and connectives were adapted and measured. In the second experiment, participants performed a Text Cohesion Task, in which they were “asked to read sentences that are missing a connective [...] and choose the connective that makes the most contextual sense from three choices” [54, p. 1274].

Fajardo et al. [36] performed a study in 2014 that aimed to assess the comprehensibility levels of different Easy Language texts and to examine the relationships between reading comprehension and various linguistic features of this type of texts. The participants were 16 students with intellectual disability, and each week, for a period of 16 weeks, they had to read three pieces of news in Easy Language and complete a reading comprehension test. For each text, different levels of linguistic variables were measured.

The findings in Fajardo et al. [54] indicate that the inclusion of high-frequency words does not improve inferential comprehension for people with intellectual disability. Opposing this statement, no correlation was found between word frequency and literal or inferential comprehension scores for people with intellectual disability in Fajardo et al. [36].

3.4 Literacy mediation

In Buell et al. [9], literacy mediation is evaluated through testing the effects of (1) structured summaries, (2) explanations of the text, (3) clarification of points, (4) examples of inferential information, (5) explanations to make inferences explicit, (6) the reinforcement of keywords and their corresponding images through pointing, and (7) the use of gestures with people with intellectual disabilities. In Buell et al. [9], no specific results are given of the effect of each one of these separate items, but rather of the effect of the mediation resource in general.

Mediation showed to have no effect on the comprehensibility of Easy Language texts (nor in standard language texts) for people with intellectual disabilities [9]. Mediation only showed to be beneficial for comprehension when the influence of receptive vocabulary was controlled [9]. This literacy mediation in the study by Buell et al. [9] was based on auditory-verbal-gestural repetition of the content, and the participants showed an extraordinarily passive response to the intervention.

Finally, Schmutz et al. [10] mention that it should always be considered that explaining difficult words will result in

longer texts which, as shown in findings in Sect. 3.1.6, can affect comprehension negatively.

3.5 Connectives

The presence of connectives is evaluated in Fajardo et al. [36] and Fajardo et al. [54] with people with intellectual disabilities.

Fajardo et al. [36] showed that the number of connectives is negatively correlated with literal comprehension. When it comes to inferential comprehension, connectives proved to produce no improvements in Fajardo et al. [54]. To try to explain the latter finding, Fajardo et al. [54] also tested the role of connective familiarity and its interaction with connective type, which showed that performance in both nondisabled participants and participants with intellectual disabilities was indeed affected by the type of connective and its familiarity: low familiar additive connectives and contrastive connectives resulted in lower comprehension scores, while low familiar temporal and causal connectives showed higher comprehension scores [54].

Finally, Fajardo et al. [36] suggest that the negative effect connectives showed on literal comprehension can be linked to the fact that sentences with more connectives tend to be longer and contain more ideas that require to be integrated.

3.6 Co-references

Fajardo et al. [36] found that the number of co-references has a negative relationship with literal comprehension in people with intellectual disabilities: that is, a higher number of co-references predicted higher difficulty and lower literal comprehension. The authors suggest that this negative effect can be linked to the fact that sentences with a high number of co-references tend to be longer (the same factor that could explain the negative effect on comprehension that the number of connectives showed [36] [see Sect. 3.1.4]) and the fact that the grammar in these sentences tends to be more complex and unnatural [36].

No other reviewed publications studied the effects of co-references.

3.7 Number of sentences, text length, and word length

Fajardo et al. [36] found that word length had no effect on comprehension for people with intellectual disabilities. On the other hand, they found that the number of sentences in the text had a negative relationship with inferential comprehension for the same group. The authors argue that, since individuals with intellectual disabilities tend to have problems with retaining information from memory, a higher

number of information units logically results in the participants showing higher difficulty in the process of “making inferences between parts of the text or between the text and prior knowledge” [36, p. 18].

Fajardo et al. [36] also suggest that the length of the text can affect self-efficacy and motivation. Higher sentence and text length was also suggested as the reason for a decrease in literal comprehension when there is a high presence of co-references and connectives in the text [36].

Finally, Schmutz et al. [10] link the increase in reading time and the users liking Easy Language texts less than those in standard language to the fact that following the tested recommendation of “making only one statement per sentence” [11, 29] results in a higher number of sentences.

4 Discussion

The information discussed in this section is a synthesis of the evidence found in the studies included in our review. Upcoming statements are not conclusive and, therefore, should be delicately considered.

One consistently evaluated variable throughout the included studies is comprehension. Based on the evidence in these studies, it is unclear if both visual support and linguistic simplification affect comprehension in any way. Lexical simplification using high-frequency words showed a positive effect on literal comprehension, but its effect on inferential comprehension remains unclear.

Mediation resources and word length did not show any effects on comprehension. On the contrary, the number of both connectives and co-referents present in the text showed to be linked to a decrease in comprehension. The number of sentences in the text and text length also caused a decrease in inferential comprehension, specifically, and connectives showed different effects on comprehension depending on their type.

Finally, in Schmutz et al. [10], some subjective user reactions were also evaluated. In their study, centred on linguistic simplification, a decrease in text liking was observed when the Easy Language texts with these adaptations were presented to people without disabilities.

After having summarised the findings, we will now go over our research questions and answer them based on the results of our literature review.

Q1. Is there empirical research that evaluates current international Easy Language recommendations?

Our research has proven that there are empirical findings that evaluate multiple Easy Language recommendations. However, although we cannot deny that there is research being done on the field, the number of publications resulting from our systematic literature review exhibits the small

extent of empirical evidence in academic journals and in the languages chosen. See this item discussed in Sect. 4.1, and the limitations of this statement in 4.3.

Q2. If so, what current international Easy Language recommendations are supported by empirical research and what results were obtained?

Our literature review found studies that evaluated (1) visual support, (2) linguistic simplification, (3) word frequency, (4) literacy mediation, (5) connectives, (6) co-references, and (7) number of sentences, text length, and word length (see the results in Sect. 3).

Although all the aspects evaluated are directly linked to recommendations in the reviewed Easy Language guidelines (see this correlation evidenced in Sect. 4.2), not all the empirical findings turned out to be conclusive, and we did not find evaluations of all Easy Language recommendations. This is also discussed in Sect. 4.2.

4.1 Results of the literature search

Although the search strategy was pre-set as a first filter to aim for relevant results, the retrieved publications were mainly unrelated to Easy Language and, therefore, not relevant to our study. Only 20 publications were considered to possibly meet the inclusion criteria after their titles and abstracts were reviewed (that is 3.24% of the total of initial results), and only 6 of them were finally considered relevant, after being fully reviewed (that is 0.97% of the initial results).

The fact that only 6 studies were included in our review is telling of the incipient state of empirical research on Easy Language guideline recommendations, although it must be pointed out that a total of 102 publications (16.53% of the initial results) were marked as related to linguistics when their title and abstracts were read (of which 82 were discarded because of the study being descriptive or focusing on aspects not relevant to our review). Although this will be discussed in Sect. 4.3, it is important to keep in mind that our search was performed on databases that mostly listed academic journals and their articles, and that other type of publications would have been missed.

As already mentioned, Sutherland and Isherwood [18] also performed a literature review on the evidence for Easy Language and specifically for people with intellectual disabilities. In their review, they finally included only 11 studies from the initial 8063 publications retrieved. Rivero-Contreras and Saldaña [19] included 13 publications in their review, from the initial 235 retrieved. Taking this into account, we can suggest that the incipient state of empirical research is extensive to Easy Language in general—not only to Easy Language recommendations.

Finally, the results of our review manifest that only some recommendations in Easy Language guidelines have been empirically evaluated in academic journals written in English, Spanish, and Catalan. Nevertheless, even the recommendations that have been assessed could use complementary or reviewing research, given that the evidence in the retrieved studies is inconclusive (see Sect. 4.2).

4.2 Empirical findings on Easy Language recommendations

The relevant findings in the reviewed publications were grouped according to the linguistic aspects that they evaluated. At the same time, these linguistic aspects are all explicitly linked to Easy Language recommendations. Ultimately, the empirical findings in these articles can all be directly linked to Easy Language recommendations. See the recommendations that relate to each evaluated linguistic aspect in Appendix 2.

With that being said, the empirical data found in our review are not sufficient: most findings are not comparable or complementary, and none of the results is decisive enough to be able to drive us to conclusive statements.

For instance, in Buell et al. [9] and Schmutz et al. [10], we find evaluations of “linguistic simplification”, a non-concrete concept which is not broken down into more specific measures or explained in detail. This makes it difficult to determine to what extent the results of these evaluations would be comparable to other findings.

In some cases, we encountered results that go against the statements in Easy Language recommendations, but since the evidence is not generalisable or conclusive, this is not enough to re-evaluate Easy Language guidelines—although it does highlight issues to revise and perform research on.

The findings in Rivero-Contreras et al. [52] and Schatz et al. [53] related to visual support are a clear example. These studies found some benefits in using images to support the text, but did not lead to an improvement on comprehension, while the 1998 guidelines by Inclusion Europe [23, 31, 32] and the ISO standard [2] precisely state the opposite: that the use of images enhances comprehension. These findings should be carefully considered and investigated. Rivero-Contreras et al. [52] and Schatz et al. [53] themselves state that their results may not be representative or generalisable. Again, future research should corroborate their findings.

Another example of findings that are contrary to Easy Language recommendations is those in Schmutz et al. [10] and Fajardo et al. [36], which showed that including a high number of sentences in the text has a negative effect on inferential comprehension, increases reading time, and decreases

acceptability. These statements oppose the ISO standard [2] and guidelines by García Muñoz [13] and Asociación Española de Normalización [29], which defend that Easy Language texts should express only one idea per sentence. Following this recommendation would normally result in longer texts with a higher number of sentences. It is uncertain if the possible benefits on comprehension of expressing one idea per sentence compensates for the negative effects that the higher number of sentences presumably has on inferential comprehension, reading time and acceptability. Once again, further research would be necessary to ponder this topic and possibly revise Easy Language guidelines accordingly.

4.3 Limitations

The results of our literature search and review lead to mostly case-specific conclusions and can only be generalised to some degree. The research questions and systematic search were designed to find focused and specific results: we aimed to review the literature that included empirical research on Easy Language that was explicitly related to its recommendations. We acknowledge that empirical findings in missed publications from other fields of research may have evaluated linguistic aspects intrinsic to some Easy Language recommendations. Nevertheless, we intentionally opted for a more focused search to review the state of the empirical research on Easy Language, rather than *associated with* Easy Language. With that being said, we suspect that more results would have come up if a more generic search was made—that is, if the results were not as restricted by the very specific keyword search that was performed.

As Grant and Booth [55] mention, there are no methods for literature reviews to ensure that all the literature is considered, no matter the topic. For that reason, this is considered an inherent limitation of this type of study, as was also encountered by Campoverde-Molina et al. [56], Chinn and Homeyard [20], and Sutherland and Isherwood [18]. As Chinn and Homeyard [20, p. 9] state in their meta-narrative literature review, “[these studies] regard intuition, personal and professional knowledge and networks, and serendipity as resources available to reviewers, although at the expense of the replicability of the review. [...] Other reviewers might well identify different groupings of studies and highlight different themes”.

In addition to that, some relevant publications surely may have not been retrieved and, therefore, not reviewed because of the databases we perform our search in. As stated earlier in the paper, the design of our systematic review only contemplated the pool of publications available in online databases. Easy Language is a new, largely unexplored field of science, and it is very probable that relevant results in handbooks, congress publications, monographical work, or even grey literature have not been considered, as normally

only academic journals are listed in the searched online databases. For instance, a seminal book such as the one edited by Lindholm and Vanhatalo [5], or the book on theoretical and empirical perspectives on Easy Language research edited by Hansen-Schirra and Maaß [17], are not included. This limitation is one that we fully acknowledge and the results in this literature review should be considered relevant only according to our research scope.

Finally, the languages considered in our inclusion criteria for both guidelines and publications (English, Spanish, and Catalan) (see Sect. 2) also entailed a big limitation for this review. As explained in Sect. 1.1.2, German-speaking countries are in the lead when it comes to both the creation of Easy Language guidelines and research on the field. Therefore, several publications (like journal articles by Deilern et al. [57], Hansen-Schirra et al. [58] or Maaß and Rink [59]) might have been relevant and have most probably been missed due to the language barrier.

5 Conclusion

We fulfilled the aims of our study and can state that there is empirical evidence for some of the recommendations in current Easy Language guidelines. Our systematic literature search showed that the studies performed on that specific topic are scarce, and the later review of the results showed that the empirical findings in the studies are also non-conclusive and non-generalisable. Nevertheless, as stated in Sect. 4.3, our search results were limited to academic journals in three languages and, therefore, these statements are only conclusive to that extent.

The studies included in our review had different numbers and types of participants and used very different methodologies in their research. This made it difficult to know if the resulting data were comparable or generalisable. Performing more research on Easy Language recommendations could (1) determine if the data in these studies are anecdotal or can be conclusive, and (2) create a pool of complementary data large enough to allow researchers to make outright statements, and to evaluate and possibly redesign the current Easy Language guidelines based on it.

This review ultimately aims to act as a portrayal of the current state of empirical research on Easy Language recommendations to a certain extent and to foster future research in the field. We would suggest research to focus either on the recommendations that are missing empirical evaluation, on complementing previous studies, or on balancing out the limitations in these. As Rivero-Contreras and Saldaña [19] defend, we need more research in the field, but we need to especially foster new research of high methodological quality.

This is a call to join forces towards effective, optimal and scientifically based guidelines, which would ultimately entail effective and optimal Easy Language content.

Appendix 1

1. A brief guide to easy read (Scottish Accessible Information Forum, 2014)
2. A guide to producing written information in easy read (North Yorkshire County Council, 2021)
3. Basic guidelines for people who commission Easy Read information (Department of Health, 2009)
4. Finestra Oberta: Materials de Lectura-fàcil, anàlisi, directrius internacionals i proposta per a elaborar aquests materials a Catalunya (Mayol & Salvador, 1999)
5. Guía de lectura fácil: normas e recomendacións (Down Galicia, 2017)
6. Guía para validar textos en lectura fácil (Jareño Galán, 2018)
7. Guide to Making Information Accessible for People with a Learning Disability (NHS England, 2018)
8. Guidelines for easy-to-read materials (ILFA, 2010)
9. Guidelines for writing and translating into Easy Read Welsh (Learning Disability Wales & Mencap Cymru, 2012)
10. How to use Easy Words and Pictures (Disability Rights Commission, 2006)
11. Information for all: European standards for making information easy to read and understand (Inclusion Europe, 2009)
12. ISO/IEC DIS 23859–1. Guidance on making written text easy to read and easy to understand (International Organization for Standardization, 2021)
13. Kent County Council Easy Read Guidelines (Kent County, 2010)
14. Lectura fácil: Métodos de redacción y evaluación (García Muñoz, 2012)
15. LF, una necessitat per a la inclusió de l'alumnat nouvingut d'ESO (Serra Milà, 2008)
16. Make it easy: A guideline to preparing Easy-to-read (Accessible Information Working Group, 2014)
17. Make it Simple: European Guidelines for the Production of Easy-to-Read Information (Inclusion Europe/ILSMH, 1998)
18. Making written information easier to understand for people with learning disabilities (Department of Health, 2010)
19. How To Make Information Accessible (CHANGE, 2016)
20. Mencap's Make it clear: A guide to making easy read information (Mencap, 2013)
21. Resum de les principals pautes de Lectura Fàcil per a elaborar textos narratius (Associació Lectura Fàcil, 2011)
22. UNE 153,101 EX. Lectura Fácil: Pautas y recomendaciones para la elaboración de documentos (Asociación Española de Normalización, 2018)
23. Validación de textos en lectura fácil: aspectos prácticos y sociolaborales (Plena Inclusión Madrid, 2018)

Appendix 2

Easy Language recommendations that are evaluated on the reviewed publications.

- (1) Visual support
- (2) Linguistic simplification
- (3) Word frequency
- (4) Literacy mediation
- (5) Connectives
- (6) Co-references
- (7) Number of sentences, text length, and word length

	Category	Recommendation
(1)	Images	Easy-to-read materials with pictograms help persons with intellectual and cognitive disabilities understand content. [7, p. 13]
(1)	Images	Many people find it hard to read text. To help them understand your text, you should put images next to it to describe what it is about. Images are things like photographs, drawings, or symbols. [24, p. 20]
(1)	Images	Images can be used to enhance comprehension. [2: 18]

	Category	Recommendation
(1)	Images	Non-verbal paratextual elements such as images and other graphical elements can enhance comprehension. [2, p. 17]
(2)	Vocabulary > Complexity of the vocabulary	Avoid difficult words but use language that is adult and dignified. [7, p. 11]
(2), (4)	Grammar > Parts of the sentence	It is OK to repeat important information. It is OK to explain difficult words more than once. [24, p. 11]
(2), (3)	Vocabulary > Complexity of the vocabulary	Use easy-to-understand that people will know well. [24: 10]
(2)	Vocabulary > Complexity of the vocabulary	Do not use difficult words. [24, p. 15]
(2)	Vocabulary > Complexity of the vocabulary	When writing information in easy read it is not enough to avoid jargon words. Your text should also be free of any hard words. Hard words are words that are not generally used in everyday conversation. [47, p. 8]
(2)	Vocabulary > Complexity of the vocabulary	Try to write your information in short, clear sentences. Do not use complicated words, words that are hard to understand or jargon words. [47, p. 28]
(2), (4)	Vocabulary > Complexity of the vocabulary	Do not use difficult words. If you need to use difficult words, make sure you always explain them clearly. [24, p. 10]
(2), (3), (4)	Vocabulary > Complexity of the vocabulary	Avoid difficult or unfamiliar words. If you do need to use one, put the difficult or unfamiliar word in bold and explain it. If it is an abstract concept, try to explain it with a clear, practical example. Some people will find a word list or glossary useful. [33, p. 17]
(2), (4)	Vocabulary > Complexity of the vocabulary	Simplify complex information and explain it using examples from everyday life. [47, p. 9]
(2), (3)	Vocabulary > Complexity of the vocabulary	Vocabulary should be suitable for the intended target reader. Some words are more difficult to understand than others. Unusual words are more likely to be difficult to understand. Therefore, one should use simple, frequent, and every-day vocabulary. [2, p. 10]
(2), (3)	Vocabulary > Complexity of the vocabulary	<i>Se debe utilizar un lenguaje sencillo y de uso frecuente.</i> [29, p. 18] ("Simple, frequently used language should be used. [29, p. 18]")
(2), (3), (7)	Vocabulary > Complexity of the vocabulary	<i>Utilizar palabras sencillas expresadas de forma simple. Utilizar vocablos cortos, con el menor número de sílabas y con las sílabas menos complejas (es decir, utilizar las sílabas de mayor frecuencia de uso en el castellano). Utilizar vocablos de alta frecuencia léxica (de uso cotidiano) y cercanos al lenguaje hablado, que utilice el público objetivo del texto.</i> [13, p. 70] ("Use simple words expressed in a simple way. Use short words, with the least number of syllables and with the least complex syllables (that is, use the syllables with the highest frequency of use in Spanish). Use words of high lexical frequency (everyday use) and close to spoken language, used by the target audience of the text. [13, p. 70]")
(3)	Vocabulary > Complexity of the vocabulary	Non-frequent forms of verbs should be avoided. [2, p. 12]
(3)	Vocabulary > Complexity of the vocabulary	Use words that we use all the time. [48, p. 3]

	Category	Recommendation
(3)	Grammar > Verbs	<i>Se deberían evitar los tiempos verbales compuestos o poco frecuentes y el uso de los condicionales y subjuntivos.</i> [29, p. 22] ("Compound or infrequent tenses and the use of conditionals and subjunctives should be avoided. [29, p. 22]")
(3), (4)	Vocabulary > Complexity of the vocabulary	Foreign language words should be avoided unless they are well established in the source language or explained. [2, p. 11]
(4)	Vocabulary > Lexical units	The meaning of non-frequent acronyms should be explained the first time they are used. [2, p. 12]
(4), (2)	Paratextual elements > Summaries	Repeating or summarizing content allows the reader to remember relevant information. This is called redundancy and it increases comprehension. It is especially important in long content. [2, p. 19]
(4), (2)	Paratextual elements > Summaries	<i>Repetir y resumir las ideas principales. Aunque el resumen final del contenido es importante, todavía lo es más el tema central del documento, es decir, la información que se transmite a lo largo del mismo. El resumen se puede presentar en las páginas centrales en un formato de papel más amplio.</i> [13, p. 73] ("Repeat and summarise the main ideas. Although the final summary of the content is important, the central theme of the document is even more important, that is, the information that is transmitted throughout it. The abstract can be presented on the central pages in a larger paper format. [13, p. 73]")
(4), (2)	Paratextual elements > Summaries	<i>La repetición de información debería aparecer cuando se requiera que el lector recuerde un contenido necesario para comprender el texto de la página que está leyendo y que fue abordado con anterioridad en el documento.</i> [29, p. 36] ("The repetition of information should appear when the reader is required to remember content that is necessary to understand the text of the page they are reading and that was addressed earlier in the document. [29, p. 36]")
(4)	Paratextual elements	Use examples to explain things. Try to use examples that people will know from their everyday lives. [24, p. 10]
(4)	Paratextual elements	Where possible, explain the words at the time you are using them. In written documents, you could also have a list of useful words at the end of the document. [24, p. 15]
(4)	Paratextual elements	If you must use a hard word or a jargon word, make sure you explain it clearly in easy words. If you do not have room to explain the word in the paragraph, it is best to create a paragraph below that defines the word with easy words and pictures. Or you could try an illustrated word bank. [47, p. 27]
(4)	Vocabulary > Complexity of the vocabulary	Technical terms used in a specific context can also be difficult to understand for a lay person. Abstract, technical, and complex terms should be avoided when addressing a lay audience. If they cannot be avoided, they should be explained. [2, p. 11]
(4)	Vocabulary > Complexity of the vocabulary	<i>Evitar tecnicismos, jergas y xenismos, aunque se debe explicar el significado si se usan.</i> [13, p. 71] ("Avoid technical terms, jargon and xenisms; but their meaning should be explained if they are used. [13, p. 71]")
(4)	Vocabulary > Complexity of the vocabulary	<i>Explicar las palabras menos comunes o complejas a través de la contextualización, el apoyo en imágenes y la explicación del significado. Para esto último, es conveniente destacarlas en negrita o subrayadas la primera vez que aparecen y explicar al margen o en un glosario final su significado. Hay que señalar que no todo se puede contar con un léxico básico: habrá objetos, situaciones, hechos, características de los personajes y ambientes, lugares desconocidos para el lector que deben introducirse, pero favorecerá la ampliación del vocabulario.</i> [13, p. 70] ("Explain less common or complex words through contextualisation, support with images and explanation of meaning. For the latter, it is convenient to highlight them in bold or underlined the first time they appear and explain their meaning in the margin or in a final glossary. It should be noted that not everything can be explained with a basic lexicon: there will be objects, situations, facts, characteristics of the characters and environments, places unknown to the reader, etc., that must be introduced, but it will favour the expansion of vocabulary. [13, p. 70]")
(4)	Vocabulary > Lexical units	<i>Se pueden utilizar acrónimos cuando su uso esté extendido en el idioma. No obstante, la primera vez que se utilicen se debería explicar su significado.</i> [29, p. 20] ("Acronyms can be used when their use is widespread in the language. However, the first time they are used, their meaning should be explained. [29: 20]")

	Category	Recommendation
(3)	Grammar > Verbs	<i>Se deberían evitar los tiempos verbales compuestos o poco frecuentes y el uso de los condicionales y subjuntivos.</i> [29, p. 22] ("Compound or infrequent tenses and the use of conditionals and subjunctives should be avoided. [29, p. 22]")
(3), (4)	Vocabulary > Complexity of the vocabulary	Foreign language words should be avoided unless they are well established in the source language or explained. [2, p. 11]
(4)	Vocabulary > Lexical units	The meaning of non-frequent acronyms should be explained the first time they are used. [2, p. 12]
(4), (2)	Paratextual elements > Summaries	Repeating or summarizing content allows the reader to remember relevant information. This is called redundancy and it increases comprehension. It is especially important in long content. [2, p. 19]
(4), (2)	Paratextual elements > Summaries	<i>Repetir y resumir las ideas principales. Aunque el resumen final del contenido es importante, todavía lo es más el tema central del documento, es decir, la información que se transmite a lo largo del mismo. El resumen se puede presentar en las páginas centrales en un formato de papel más amplio.</i> [13, p. 73] ("Repeat and summarise the main ideas. Although the final summary of the content is important, the central theme of the document is even more important, that is, the information that is transmitted throughout it. The abstract can be presented on the central pages in a larger paper format. [13, p. 73]")
(4), (2)	Paratextual elements > Summaries	<i>La repetición de información debería aparecer cuando se requiera que el lector recuerde un contenido necesario para comprender el texto de la página que está leyendo y que fue abordado con anterioridad en el documento.</i> [29, p. 36] ("The repetition of information should appear when the reader is required to remember content that is necessary to understand the text of the page they are reading and that was addressed earlier in the document. [29, p. 36]")
(4)	Paratextual elements	Use examples to explain things. Try to use examples that people will know from their everyday lives. [24, p. 10]
(4)	Paratextual elements	Where possible, explain the words at the time you are using them. In written documents, you could also have a list of useful words at the end of the document. [24, p. 15]
(4)	Paratextual elements	If you must use a hard word or a jargon word, make sure you explain it clearly in easy words. If you do not have room to explain the word in the paragraph, it is best to create a paragraph below that defines the word with easy words and pictures. Or you could try an illustrated word bank. [47, p. 27]
(4)	Vocabulary > Complexity of the vocabulary	Technical terms used in a specific context can also be difficult to understand for a lay person. Abstract, technical, and complex terms should be avoided when addressing a lay audience. If they cannot be avoided, they should be explained. [2, p. 11]
(4)	Vocabulary > Complexity of the vocabulary	<i>Evitar tecnicismos, jergas y xenismos, aunque se debe explicar el significado si se usan.</i> [13, p. 71] ("Avoid technical terms, jargon and xenisms; but their meaning should be explained if they are used. [13, p. 71]")
(4)	Vocabulary > Complexity of the vocabulary	<i>Explicar las palabras menos comunes o complejas a través de la contextualización, el apoyo en imágenes y la explicación del significado. Para esto último, es conveniente destacarlas en negrita o subrayadas la primera vez que aparecen y explicar al margen o en un glosario final su significado. Hay que señalar que no todo se puede contar con un léxico básico: habrá objetos, situaciones, hechos, características de los personajes y ambientes, lugares desconocidos para el lector que deben introducirse, pero favorecerá la ampliación del vocabulario.</i> [13, p. 70] ("Explain less common or complex words through contextualisation, support with images and explanation of meaning. For the latter, it is convenient to highlight them in bold or underlined the first time they appear and explain their meaning in the margin or in a final glossary. It should be noted that not everything can be explained with a basic lexicon: there will be objects, situations, facts, characteristics of the characters and environments, places unknown to the reader, etc., that must be introduced, but it will favour the expansion of vocabulary. [13, p. 70]")
(4)	Vocabulary > Lexical units	<i>Se pueden utilizar acrónimos cuando su uso esté extendido en el idioma. No obstante, la primera vez que se utilicen se debería explicar su significado.</i> [29, p. 20] ("Acronyms can be used when their use is widespread in the language. However, the first time they are used, their meaning should be explained. [29: 20]")

	Category	Recommendation
(4)	Vocabulary > Lexical units	<i>Evitar abreviaturas, acrónimos y siglas, aunque se pueden utilizar si son muy conocidas o necesarias, explicando el significado la primera vez que aparezcan. [13, p. 71]</i> ("Avoid abbreviations, acronyms and initialisms, although they can be used if they are well known or necessary, explaining their meaning the first time they appear. [13, p. 71]")
(4)	Vocabulary > Semantic aspects	<i>Evitar conceptos abstractos e ilustrarlos con ejemplos concretos y comparaciones, ejemplos prácticos y de la vida diaria. No obstante, es difícil evitarlos totalmente, por lo que se pueden utilizar los de fácil comprensión y uso habitual, apoyados en una construcción semántica sencilla y no introduciendo más de un término abstracto por oración. [13, p. 71]</i> ("Avoid abstract concepts and illustrate them with concrete examples and comparisons, practical examples and examples from daily life. However, it is difficult to avoid them completely, so those that are easy to understand and frequently used can be used if supported by a simple semantic construction and not introducing more than one abstract term per sentence. [13, p. 71]")
(4)	Vocabulary > Semantic aspects	<i>Se debería evitar el uso de enunciados con sentido figurado (frases hechas o refranes, ironías, metáforas o semejantes). En caso de que su inclusión sea necesaria para mantener la viveza del texto o enriquecerlo se debe incluir una explicación con su significado. [29, p. 20]</i> ("The use of statements with a figurative meaning [set phrases or proverbs, ironies, metaphors or the like] should be avoided. In case its inclusion is necessary to maintain the vividness of the text or to enrich it, an explanation with its meaning must be included. [29, p. 20]")
(5)	Vocabulary > Lexical units	<i>Utilizar las preposiciones y conjunciones más habituales y actuales, puesto que dan información determinante para la comprensión del sintagma que antecede. La coherencia del bloque de oraciones o párrafos se produce por elementos de enlace y de transición que ofrecen un mensaje ágil. Estos marcadores discursivos actúan como conectores y facilitan la introducción de un orden lógico. [13, p. 71]</i> ("Use the most common and current prepositions and conjunctions since they provide decisive information for understanding the preceding phrase. The coherence of the block of sentences or paragraphs is produced by linking and transition elements that offer an agile message. These discourse markers act as connectors and facilitate the introduction of a logical order. [13, p. 71]")
(5)	Grammar > Sentences	<i>Se debería evitar el uso de conectores complejos entre oraciones, como "por lo tanto", "no obstante", "por consiguiente" o "sin embargo". [29, p. 24]</i> ("The use of complex connectors between sentences, such as 'therefore', 'however', 'consequently' or 'however', should be avoided. [29, p. 24]")
(6)	Grammar > Parts of the sentence	<i>Evitar la elisión del sujeto. Es preferible repetir el sujeto a elidirlo o sustituirlo por un pronombre para reiterar el protagonista de la acción y facilitar la comprensión. Se acepta como excepción la elisión o su sustitución por un pronombre, si el referente contextual es muy claro. [13, p. 69]</i> ("Avoid elision of the subject. Repeating the subject is preferable to eliding it or replacing it with a pronoun to reiterate the protagonist of the action and facilitate understanding. Elision or its replacement by a pronoun is accepted as an exception if the contextual referent is very clear. [13, p. 69]")
(6)	Grammar > Parts of the sentence	<i>No se debería utilizar elipsis. Se debería evitar que el lector tenga que hacer inferencias. En todo caso, hay que procurar que las omisiones sean mínimas y garantizar la identificación referencial. [29, p. 23]</i> ("Ellipses should not be used. The reader should be prevented from having to make inferences. In any case, it is necessary to ensure that omissions are minimal and guarantee referential identification. [29, p. 23]")
(6)	Grammar > Parts of the sentence	<i>Se debería evitar que el lector tenga que realizar inferencias para comprender el texto. [29, p. 24]</i> ("The reader should be prevented from having to make inferences to understand the text. [29, p. 24]")
(6)	Grammar > Parts of the sentence	Be careful when you use pronouns. Pronouns are words like "I", "him" or "it" that you use instead of the actual person or thing you are talking about. Make sure it is always clear who or what the pronoun is talking about. If it is not clear, then use the proper name instead. [24, p. 15]
(6)	Grammar > Parts of the sentence	Information should be explicitly formulated. Implied meaning and omissions should be avoided if they make understanding difficult for the target reader. [2, p. 13]
(7)	Vocabulary > Lexical units	In alphabetical languages, long words are more likely to be difficult to understand and should be avoided where possible. [2, p. 11]
(7)	Vocabulary > Lexical units	<i>Se debería evitar el uso de palabras muy largas o que contengan sílabas complejas. [29, p. 19]</i> ("The use of very long words or those containing complex syllables should be avoided. [29, p. 19]")
(7)	Grammar > Sentences	Be concise. Avoid several actions in a single sentence. [7, p. 11]
(7)	Grammar > Sentences	<i>No se deben presentar más de dos ideas en una misma frase. [29: 24]</i> ("No more than two ideas should be presented in the same sentence. [29, p. 24]")

	Category	Recommendation
(7)	Grammar > Sentences	<i>Se deberían utilizar frases sencillas y evitar las oraciones complejas. Si no se pueden evitar en algún caso, conviene separar las ideas en distintas líneas.</i> [29, p. 22] ("Simple phrases should be used, and complex sentences should be avoided. If they cannot be avoided in some case, it is convenient to separate the ideas in different lines. [29, p. 22]")
(7)	Grammar > Sentences	Always keep your sentences short. [24, p. 11]
(7)	Grammar > Sentences	Keep your sentences short. You could do this by writing only 1 idea per sentence or using a full stop before starting a new idea, instead of using a comma or an "and". [24, p. 17]
(7)	Grammar > Sentences	Unnecessary long sentences should be avoided. It is recommended to include one idea per sentence. It is also recommended to vary the length of the sentences. [2, p. 13]
(7)	Grammar > Sentences	In easy language, if it is not possible to avoid a complex sentence, ideas should be separated in different lines. [2, p. 13]
(7)	Grammar > Sentences	Complex sentences with many subordinate clauses should be avoided. It is recommended to write different sentences instead. [2, p. 13]
(7)	Grammar > Sentences	<i>Utilizar oraciones simples cortas, con la estructura «sujeto + verbo + complementos». Esta estructura puede sufrir algunas modulaciones, como la posposición del sujeto en el caso del discurso directo y en discursos de contenido informativo o la dislocación del objeto directo al inicio de la frase.</i> [13, p. 69] ("Use short simple sentences, with the structure 'subject + verb + complements'. This structure can undergo some modulations, such as the postposition of the subject in the case of direct speech and in speeches with informative content, or the dislocation of the direct object at the beginning of the sentence. [13, p. 69]")
(7)	Vocabulary > Semantic aspects	Expressions which make the written text longer and do not add information should be avoided. [2, p. 11]
(7)	Vocabulary > Semantic aspects	<i>Se debería evitar el uso de palabras que no aportan información al texto y alargan su lectura.</i> [29, p. 19] ("The use of words that do not add information to the text and lengthen its reading should be avoided. [29, p. 19]")

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Data availability Data generated or analysed during this study are included in this published article and its supplementary information files. Any additional data can be made available upon reasonable request.

Declarations

Conflicts of interests The authors declare that there are no conflicts of financial or non-financial interest.

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References

1. Richart-Masset, M., Calamita, F.: El gran reto de la traducción y la accesibilidad audiovisual en los medios de comunicación. *MonTI: Monogr. de Trad. e Interpret.* **12**, 29–52 (2020). <https://doi.org/10.6035/MonTI.2020.12.01>
2. International Organization for Standardization (ISO): ISO/IEC DIS 23859-1:2021(E): Information technology—User interfaces—Requirements and recommendations on making written text easy to read and understand, 2021–09-13. International Organization for Standardization, Geneva (2021)
3. Matamala, A.: Easy-to-understand language in audiovisual translation and accessibility: state of the art and future challenges.

- XLinguae: Eur. Sci. Lang. J. **15**(2), 130–144 (2022). <https://doi.org/10.18355/XL.2022.15.02.10>
4. Maaß, C.: Easy Language—Plain Language—Easy Language Plus. Frank & Timme, Berlin (2020)
5. Lindholm, C., Vanhatalo, U.: Handbook of Easy Languages in Europe. Frank & Timme, Berlin (2021)
6. Miesenberger, K., Petz, A.: Easy-to-Read on the Web: State of the Art and Needed Research. In: Miesenberger, K., Fels, D., Archambault, D., Peñáz, P., Zagler, W. (ed.) ICCHP 2014. LNCS 8547, pp. 161–168 (2014). https://doi.org/10.1007/978-3-319-08596-8_25
7. Nomura, M., Nielsen, G., Tronbacke, B. on behalf of IFLA/Library Services to People with Special Needs Section: *Guidelines for easy-to-read materials (IFLA Professional Reports 120)*. IFLA, The Hague (2010)
8. Chinn, D.: Talking to producers of Easy Read health information for people with intellectual disability: production practices, textual features, and imagined audiences. J. Intellect. Dev. Disabil. **44**(4), 410–420 (2019). <https://doi.org/10.3109/13668250.2019.1577640>
9. Buell, S., Langdon, P.E., Pounds, G., Bunning, K.: An open randomized controlled trial of the effects of linguistic simplification and mediation on the comprehension of “easy read” text by people with intellectual disabilities. J. Appl. Res. Intellect. Disabil. **33**(2), 219–231 (2020). <https://doi.org/10.1111/jar.12666>
10. Schmutz, S., Sonderegger, A., Sauer, J.: Easy-to-read language in disability-friendly web sites: effects on nondisabled users. Appl. Ergon. **74**, 97–106 (2019). <https://doi.org/10.1016/j.apergo.2018.08.013>
11. García Muñoz, Ó., Matamala, A.: Easy Languages in Spain. In: Lindholm, C., Vanhatalo, U. (eds.) Handbook of Easy Languages in Europe, pp. 493–525. Frank & Timme, Berlin (2021)
12. Bernabé, R.: New taxonomy of easy-to-understand access services. In: Richart-Marset, M., Calamita, F. (eds.) Traducción y Accesibilidad en los medios de comunicación: de la teoría a la práctica. MonTI, vol. 12, pp. 345–380 (2020). <https://doi.org/10.6035/MonTI.2020.12.12>
13. García Muñoz, Ó.: Lectura fácil: Métodos de redacción y evaluación. <https://www.plenainclusion.org/sites/default/files/lectura-facil-metodos.pdf> (2012). Accessed 1 Oct 2021
14. Orero, P., Delgado, C., Matamala, A.L.: Easy to read standardisation. Some steps towards an international standard. In: DSAI 2020: 9th International Conference on Software Development and Technologies for Enhancing Accessibility and Fighting Info-exclusion, pp. 44–46 (2020). <https://doi.org/10.1145/3439231.3440605>
15. UNESCO Institute for Statistics: Literacy Rates Continue to Rise from One Generation to the Next. <http://uis.unesco.org/sites/default/files/documents/fs45-literacy-rates-continue-rise-generation-to-next-en-2017.pdf> (2017). Accessed 11 Dec 2021
16. Dalton, B., Proctor, C.P.: Reading as thinking: integrating strategy instruction in a universally designed digital literacy environment. In: McNamara, D.S. (ed.) Reading Comprehension Strategies: Theories, Interventions, and Technologies, pp. 421–439. Lawrence Erlbaum Associates, Hillsdale (2007)
17. Hansen-Schirra, S., Maaß, C.: Easy Language Research: Text and User Perspectives. Frank & Timme, Berlin (2020)
18. Sutherland, R.T., Isherwood, T.: The evidence for easy-read for people with intellectual disabilities: a systematic literature review. J. Policy Pract. Intell. Disabil. **12**(4), 297–310 (2016). <https://doi.org/10.1111/jppi.12201>
19. Rivero-Contreras, M., Saldaña, D.: ¿Legibilidad es sinónimo de comprensión en Lectura Fácil? Una revisión de estudios sobre comprensión lectora en textos adaptados o simplificados y su calidad metodológica. In: Díez Mediavilla, A.E., Gutiérrez Fresneda, R. (coord.) Lectura y dificultades lectoras en el siglo XXI. Octaedro, Barcelona, pp. 714–728 (2020)
20. Chinn, D., Homeyard, C.: Easy read and accessible information for people with intellectual disabilities: Is it worth it? A meta-narrative literature review. Health Expect. Int. J. Public Particip. Health Care Health Policy **20**(6), 1189–1200 (2017). <https://doi.org/10.1111/hex.12520>
21. Bohman, U.: Easy Language in Sweden. In: Lindholm, C., Vanhatalo, U. (eds.) Handbook of Easy Languages in Europe, pp. 527–567. Frank & Timme, Berlin (2021)
22. Lenček, M., Kuvač Kraljević, J.: Easy Language in Croatia. In: Lindholm, C., Vanhatalo, U. (eds.) Handbook of Easy Languages in Europe, pp. 92–118. Frank & Timme, Berlin (2021)
23. ILSMH European Association: Make It Simple: European Guidelines for the Production of Easy-to-Read Information for People with Learning Disability. https://repositori.lecturafacil.net/sites/default/files/1998%20El%20cam%C3%AD%20m%C3%A9s%20f%C3%A1cil%20Directrius%20Europees%20per%20gernar%20informaci%C3%B3%20de%20Lectura%20F%C3%A0cil%20ILSMH_ANG.pdf (1998). Accessed 10 Oct 2021
24. Inclusion Europe: Information for all: European standards for making information easy to read and understand. https://www.inclusion-europe.eu/wp-content/uploads/2017/06/EN_Information_for_all.pdf (2009). Accessed 10 Oct 2021
25. Anča, G., Melņika, I.: Easy Language in Latvia. In: Lindholm, C., Vanhatalo, U. (eds.) Handbook of Easy Languages in Europe, pp. 305–325. Frank & Timme, Berlin (2021)
26. Cinková, S., Latimier, C.: Easy Language in Czechia. In: Lindholm, C., Vanhatalo, U. (eds.) Handbook of Easy Languages in Europe, pp. 119–147. Frank & Timme, Berlin (2021)
27. Przybyła-Wilkin, A.: Easy language in Poland. In: Lindholm, C., Vanhatalo, U. (eds.) Handbook of Easy Languages in Europe, pp. 401–412. Frank & Timme, Berlin (2021)
28. Šumskienė, E., Baltrūnaitė, M.: Easy Language in Lithuania. In: Lindholm, C., Vanhatalo, U. (eds.) Handbook of Easy Languages in Europe, pp. 327–344. Frank & Timme, Berlin (2021)
29. Asociación Española de Normalización: UNE 153101:2018 EX: Lectura Fácil. Pautas y recomendaciones para la elaboración de documentos (2018)
30. Associació Lectura Fácil: Resum de les principals pautes de Lectura Fácil per a elaborar textos narratius. https://xarxanet.org/sites/default/files/Resum_pautes_LF_per_a_textos_narratius.pdf (2011). Accessed 22 Nov 2021. Accessed 8 Oct 2021
31. Associació Europea ILSMH: El Camí Més Fácil: Directrius Europees per Generar Informació de Lectura Fácil. http://www.lecturafacil.net/media/resources/ILSMH_catal%C3%A0.pdf (1998). Accessed 10 Oct 2021
32. Asociación Europea ILSMH: El Camino Más Fácil: Directrices Europeas para Generar Información de Fácil Lectura. <http://www.lecturafacil.net/media/resources/ILSMHcastell%C3%A0.pdf> (1998). Accessed 10 Oct 2021
33. Accessible Information Working Group: Make it easy: a guideline to preparing Easy to Read information. <https://www.walk.ie/userfiles/file/Make%20it%20Easy%20-%20A%20guide%20to%20preparing%20Easy%20to%20Read%20Information.pdf> (2014). Accessed 18 Nov 2021
34. World Wide Web Consortium (W3C): W3C Accessibility Standards Overview: Accessibility Guidelines. <https://www.w3.org/WAI/standards-guidelines/#guidelines> (2022). Accessed 1 Feb 2022
35. World Wide Web Consortium (W3C): Techniques for the Cognitive and Learning Disabilities Accessibility Task Force (COGA). <https://w3c.github.io/coga/techniques/index.html> (2021). Accessed 1 Feb 2022
36. Fajardo, I., Ávila, V., Ferrer, A., Tavares, G., Gómez, M., Hernández, A.: Easy-to-read texts for students with intellectual disability:

- linguistic factors affecting comprehension. *J. Appl. Res. Intell. Disabil.* **27**, 212–225 (2014). <https://doi.org/10.1111/jar.12065>
37. Department of Health: Making written information easier to understand for people with learning disabilities: Guidance for people who commission or produce Easy Read information—Revised Edition 2010. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/215923/dh_121927.pdf (2010). Accessed 1 Nov 2021
 38. Social Care Institute for Excellence: How to produce information in an accessible way (Social Care Accessibility Guidelines). <https://www.scie.org.uk/publications/misc/accessguidelinespublications.asp> (2005). Accessed 7 Dec 2021
 39. Wengelin, Å.: Mot en evidensbaserad språkvård? En kritisk granskning av några svenska klarspråksråd i ljuset av forskning om läsbarhet och språkbearbetning. *Sakprosa* **7**(2), 17 (2015). <https://doi.org/10.5617/sakprosa.983>
 40. Vollenwyder, B., Schneider, A., Krueger, E., Brühlmann, F.: How to use plain and easy-to-read language for a positive user experience on websites. In: Miesenberger, K., Kouroupetoglou, G. (eds.) *Computers Helping People with Special Needs: 16th International Conference, ICCHP 2018*, pp. 514–522. Springer, Heidelberg (2018)
 41. Chinn, D.: An empirical examination of the use of Easy Read health information in health consultations involving patients with intellectual disabilities. *J. Appl. Res. Intell. Disabil.* **33**(2), 232–247 (2020). <https://doi.org/10.1111/jar.12657>
 42. Turnpenny, A., Caiels, J., Whelton, B., Richardson, L., Beadle-Brown, J., Crowther, T., Forder, J., Apps, J., Rand, S.: Developing an easy read version of the adult social care outcomes toolkit (ASCOT). *J. Appl. Res. Intell. Disabil.* **31**(1), e36–e48 (2018). <https://doi.org/10.1111/jar.12294>
 43. Yaneva, V., Temnikova, I., Mitkov, R.: Accessible texts for autism: an eye-tracking study. In: *ASSETS 2015, the 17th International ACM SIGACCESS Conference of Computer and Accessibility*, pp. 49–57 (2016). <https://doi.org/10.1145/2700648.2809852>
 44. Yaneva, V., Temnikova, I., Mitkov, R.: Evaluating the readability of text simplification output for readers with cognitive disabilities. In: *Proceedings of the Tenth International Conference on Language Resources and Evaluation (LREC'16)*, pp. 293–299 (2016)
 45. Maaß, C.: *Leichte Sprache. Das Regelbuch*. LIT Verlag, Münster (2015)
 46. Maaß, C., Rink, I., Hansen-Schirra, S.: Easy languages in Germany. In: Lindholm, C., Vanhatalo, U. (eds.) *Handbook of Easy Languages in Europe*, pp. 191–218. Frank & Timme, Berlin (2021)
 47. CHANGE (2016) How To Make Information Accessible. <https://www.changepeople.org/getmedia/923a6399-c13f-418c-bb29-051413f7e3a3/How-to-make-info-accessible-guide-2016-Final>. Accessed 1 Nov 2021
 48. Mencap (2013) Make it clear. <https://inclusionireland.ie/wp-content/uploads/2020/10/makeitclearapr09.pdf>. Accessed 1 Nov 2021
 49. Linares-Espinós, E., Hernández, V., Domínguez-Escrig, J.L., Fernández-Pello, S., Hevia, V., Mayor, J., Padilla-Fernández, B., Ribal, M.J.: Metodología de una revisión sistemática. *Actas Urol. Esp.* **42**(8), 499–506 (2018)
 50. CASP (2020) CASP Checklists. <https://casp-uk.net/casp-tools-checklists/>. Accessed 22 Jan 2022
 51. Johanna Briggs Institute (2017) Checklist for Systematic Reviews and Research Syntheses. https://jbi.global/sites/default/files/2019-05/JBI_Critical_Appraisal-Checklist_for_Systematic_Reviews2017_0.pdf. Accessed 22 Jan 2022
 52. Rivero-Contreras, M., Engelhardt, P.E., Saldaña, D.: An experimental eye-tracking study of text adaptation for readers with dyslexia: effects of visual support and word frequency. *Ann. Dyslexia* **71**(1), 170–187 (2021). <https://doi.org/10.1007/s11881-021-00217-1>
 53. Schatz, T., Haberstroh, J., Bindel, K., Oswald, P., Pantel, J., Paulitsch, M., Konopik, N., Knopf, M.: Improving comprehension in written medical informed consent procedures. *GeroPsych: J. Gerontopsychol. Geriatr. Psychiatry* **30**(3), 97–108 (2017). <https://doi.org/10.1024/1662-9647/a000169>
 54. Fajardo, I., Tavares, G., Ávila, V., Ferrer, A.: Towards text simplification for poor readers with intellectual disability: when do connectives enhance text cohesion? *Res. Dev. Disabil.* **34**(4), 1267–1279 (2013). <https://doi.org/10.1016/j.ridd.2013.01.006>
 55. Grant, M.J., Booth, A.: A typology of reviews: an analysis of 14 review types and associated methodologies. *Health Inf. Libr. J.* **26**(2), 91–108 (2009). <https://doi.org/10.1111/j.1471-1842.2009.00848.x>
 56. Campoverde-Molina, M., Luján-Mora, S., Valverde, L.: Accessibility of university websites worldwide: a systematic literature review. *Univers. Access Inf. Soc.* (2021). <https://doi.org/10.1007/s10209-021-00825-z>
 57. Deilen, S., Hansen-Schirra, S., Maaß, C.: Anwendbarkeit der ISO 17100 auf intralinguales Übersetzen in Leichte und Einfache Sprache. *Magazin* **27**, 43–53 (2019). <https://doi.org/10.12795/mAGAzin.2020.i28.01>
 58. Hansen-Schirra, S., Hansen, S., Wolfer, S., Konieczny, L.: Fachkommunikation, Popularisierung, Übersetzung: Empirische Vergleiche am Beispiel der Nominalphrase im Englischen und Deutschen. *Linguistik Online* (2009). <https://doi.org/10.13092/lo.39.480>
 59. Maaß, C., Rink, I.: Leichte Sprache: Verständlichkeit ermöglicht Gesundheitskompetenz. *Public Health Forum* **25**(1), 50–53 (2017). <https://doi.org/10.1515/pubhef-2016-2148>

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Annex 8. Published articles within this dissertation: Article 2

Screen reader users, please refer to Chapter 3.

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ARTICLE

Visual support in easy language: The impact of images on comprehension, perceived difficulty and eye movements

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Abstract

Easy Language (EL) presents information in a simplified way and benefits people who have difficulty understanding standard language. The present study evaluates the effects of visual support inclusion, as it is a recurring recommendation in EL guidelines. We examined 52 adults (23 men and 29 women; mean age of 39.9; 26 with intellectual disabilities [ID], 26 neurotypical) in a mixed design study. They read EL texts that presented either no visual support, photographs or illustrations. Their eye movements were recorded, and they answered comprehension, text difficulty and style preference questions. The inclusion of visual support had no effect on comprehension, nor did the type of visual support (photographs/illustrations). The group (ID/neurotypical) and the type of visual support also showed no effects on the perceived difficulty of the text. Neurotypical participants showed a preference for illustrations. Photographs may be more difficult to interpret than illustrations due to longer fixations and shorter saccades in both groups. The group with an ID showed more and longer fixations, especially on text and whitespace, while the neurotypical group tended to explore the image more. Results prompt a discussion on the potential improvements of EL guidelines and highlight the need for similar empirical studies in the area.

Keywords: comprehension; Easy Language; eye tracking; intellectual disability; visual support

1. Introduction

Working toward accessible communication means aiming for information to be available to everyone in a way that it is ‘accurate, clear, direct, precise and easy to understand’ (Perego, 2020, 21). Everyone can benefit from making standard communication more accessible. In that regard, one could opt to use Plain Language

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(less-simplified variant of easy-to-understand languages) or Easy Language (more-simplified) (Matamala, 2022) to convey information in a clearer way.

Easy Language (EL) is a 'language variety in which a set of recommendations regarding wording, structure, design and evaluation are applied to make information accessible to people with reading comprehension difficulties for any reason' as stated in the ISO standard dedicated to it (ISO, 2023, 2). If the standardized recommendations are followed and applied, the resulting EL text should deviate from standard use with linguistic elements related to content, vocabulary and structure (Bernabé, 2020; Lindholm & Vanhatalo, 2021; Nomura *et al.*, 2010) and with graphic elements, such as visual support, design or layout (Nomura *et al.*, 2010).

The present study, as outlined in Section 2, investigates the effects of incorporating visual support in texts, in line with what is recommended in Easy Language guidelines. First, the theoretical foundations and previous research on which this study builds will be reviewed (Sections 1.1–1.3). We then provide a detailed explanation of the study itself, including its objectives (Section 2) and methodology (Section 3). The findings are presented in Section 4, followed by a discussion in Section 5. Finally, the paper concludes with a summary of the main results and a reflection on its limitations.

1.1. *The use of images with text*

1.1.1. *The multimedia principle*

Cognitive psychology has shown that mental imagery, concreteness and verbal association play an important role in supporting learning across different domains (Clark & Paivio, 1991). Building on that foundation, Cognitive Load Theory (CLT) (Sweller *et al.*, 1998) argues that working memory has a limited capacity and operates through partially independent systems for processing verbal/auditory information and visual/spatial material, whereas long-term memory is essentially unlimited and stores structured knowledge that can become increasingly automated.

Mayer's Cognitive Theory of Multimedia Learning (CTML) (2014) integrates these perspectives, proposing that learners gain more from words and pictures presented together than from words alone. CTML is based on three assumptions: (1) visual and auditory information are processed through separate channels (drawing on dual-coding theory), (2) each channel has limited capacity (consistent with CLT) and (3) learning is an active process of selecting, organizing and integrating new information with prior knowledge. The theory also outlines twelve design principles, including the multimedia principle itself, which emphasizes the use of both verbal (text or narration) and visual (images, animations or video) representations to promote deeper understanding by engaging multiple processing channels.

Based on this theory, empirical research has demonstrated that combining text with images generally leads to more effective learning than relying on text alone or pictures alone, a phenomenon often referred to as the multimedia principle (Anglin *et al.*, 2004; Butcher, 2014; Mayer, 2014). However, not all images are equally beneficial. Research shows that while relevant visuals can significantly enhance comprehension, decorative or tangential images may have little effect or even hinder learning. For instance, Sung and Mayer (2012) found that graphics often increased learners' enjoyment of online lessons but did not consistently improve understanding, highlighting the potentially seductive effect of irrelevant visuals. Similar findings

are reported in Levie and Lentz (1982), Guo et al. (2020) and Beymer et al. (2007). A more detailed discussion of empirical studies in this area will be presented in Section 1.2.

1.1.2. Visual support in Easy Language texts

Visual support is mentioned in some way and has a prominent position in all 23 reviewed Easy Language guidelines in González-Sordé and Matamala (2023). Photographs, illustrations and symbols may accompany text ‘so that if a reader encounters an unknown word, the visual representation can be used to bootstrap understanding of the text, allowing the reader to obtain the intended meaning’ (Rivero-Contreras et al., 2023, 2). Nevertheless, while EL guidelines widely promote the use of images, there is not a unanimous guidance on how to put this into practice. In fact, recommendations from different guidelines can be contradictory. For example, guidelines by The Department of Health in the UK (2010) state that images should be placed on the left of the text, while the Social Care Institute for Excellence’s Accessibility Guidelines (2005) defend that they should appear on the right. Since both were published in the UK, differences cannot be linked to cultural preferences.

It is also unclear which type of visual support is best to use. For example, in García-Muñoz (2012, 74), it is advised to ‘explore if the public prefers drawings [or] photography [...] and keep the same style in all the text’ Nevertheless, these guidelines do not explain how to determine what the public prefers. On this, Sutherland and Isherwood (2016, 308) determined that ‘aside from the simplified written text, it is not clear from the current paucity of experimental research whether other aspects of [EL] such as symbols, pictures (line drawings), or photographs necessarily enhance understanding [...]’. Overall, there is little supporting evidence in the literature for the recommendations contained in many [EL] design guidelines’.

Although literature reviews show that there has been a rise of empirical studies on EL (Chinn & Homeyard, 2017, 1190; González-Sordé & Matamala, 2023; Lindholm & Vanhatalo, 2021, 15; Rivero-Contreras & Saldaña, 2020; Sutherland & Isherwood, 2016, 297–298), it is observably necessary to foster research that evaluates the effectiveness of certain aspects of this language variety. In the following section, we will explore some findings that the present study premises on.

1.2. Research background

Studies collected through the review of recent literature in the area will be presented according to their results: (1) the inclusion of visual support showed positive effects, (2) negative effects or no effects.

Rivero-Contreras et al. (2021, 2023) showed that visual support facilitated sentence processing for adults with and without dyslexia (2021) and with different levels of education (2023). In Schatz et al. (2017), neurotypical participants performed better when the EL version was accompanied by simple illustrations than when it was not. Jones et al. (2007) found that comprehension scores of participants with mild or borderline learning disabilities were significantly higher for the symbolized texts than the non-symbolized ones. Hibbing and Rankin-Erikson (2003) found that the addition of illustrations to text could enhance struggling middle-school readers’ comprehension. Levie and Lentz (1982) reviewed 55 experimental studies and found that meaningful, well-integrated visuals consistently improve comprehension and

recall compared to text found alone, and that they are especially beneficial to poorer readers. When it comes to studies on people with intellectual disabilities (ID), Wadihah and Fauzi (2021) found that the use of images accompanying text improved reading comprehension for intellectually disabled students. Buell (2017) tested adults with an ID and found evidence to demonstrate that images decreased cognitive effort.

Hurtado *et al.* (2014) and Saletta *et al.* (2019), on the other hand, found negative and uncertain effects of visual support when it comes to reading comprehension. Saletta *et al.* (2019) found that adding images in EL texts did not improve reading comprehension for young adults with intellectual or developmental disabilities. They tested three types of images (photographs, line drawings and control images), all with the same outcome. And Hurtado *et al.* (2014) demonstrated that under certain conditions, photographs can even increase cognitive effort for readers with an ID. Additionally, this last study found no significant differences in comprehension (which was assessed through a questionnaire) between participants when showed a 'picture only' and when showed an EL text with a picture.

Likewise, Dye *et al.* (2004) observed that the inclusion of photographs in the questionnaire did not affect the ability of adults with learning disabilities to complete it. Yaneva *et al.* (2016) also found no effects in comprehension after showing neurotypical adults and participants with autism EL texts both with and without pictures (photographs and icons). Finally, Poncelas and Murphy (2007) declare that the participants with an ID did not understand any of the versions (text-based and symbol-based) of the simplified manifesto they showed them.

All said, extensive research confirms that adding relevant visuals to text improves learning (Sung & Mayer, 2012) and comprehension (Beymer *et al.*, 2007; Guo *et al.*, 2020; Levie & Lentz, 1982), whereas decorative images provide little benefit and can even distract readers (Guo *et al.*, 2020; Levie & Lentz, 1982).

As shown, there are not enough studies performed in the area to be able to have conclusive findings regarding what type of images to use, or whether visual support should be considered an essential feature of Easy Language. As stated in Hurtado *et al.*, 'the generalised use of text and picture formats for all people with an ID in spite of the scant evidence supporting its effectiveness is concerning' (Hurtado *et al.*, 2014, 822). The use of eye tracking in EL research is growing (Borghardt *et al.*, 2021; Deilen & Schiffel, 2020), but it has still not been used to its full potential.

1.3. Monitoring eye movements

Eye tracking measures eye position, eye movement and pupil size to detect zones in which the user has a particular interest at a specific time (González-Sánchez *et al.*, 2017). One of the basic output measures of interest is fixations, which are eye movements that stabilize the retina over a stationary object of interest and indicate that the participant focused their attention on it (Duchowski, 2007, 46). For instance, when looking at text, the fixation position indicates which part of the sentence is currently being processed to a certain extent (Borghardt *et al.*, 2021). In that regard, eye movements have been shown to be directly influenced by textual variables (e.g., 'increased linguistic complexity leads to increased fixation duration and decreased saccade length' [Borghardt *et al.*, 2021, 4]) and provide information on different cognitive processes (e.g., Rayner, 1998; White *et al.*, 2022) (see Section 3.5). Nevertheless, eye movements alone do not provide the complete picture of text processing

and reading comprehension that we aim to build (Boland, 2004). For that reason, it is advised to combine eye-tracking data with other data (Van Gog et al., 2005), as has been done in the present study with comprehension, perceived difficulty and preference questions.

For years, researchers have been using eye tracking to explore the processing of information in text and images or the integration of information in both elements, with a recurrent focus on education and learning. For example, Hannus and Hyönä (1999) determined that children (10-year-olds of high and low intellectual ability) inspected the illustrations in science textbooks minimally and that learning was mainly driven by the text. Zhao et al. (2014) later found that, although text (rather than a picture) is more likely used to construct mental models in initial coherence-formation processing of text and picture, secondary students seemed to also rely on the picture to answer the question after having had a first contact with the material. Additionally, Krejtz et al. (2016) showed that interactive elements are optimal to spur reading, leading to a more complete visual inspection of the material, rather than static illustrations.

Eye tracking has also already been used to study EL (Rivero-Contreras et al., 2023; Rivero-Contreras et al., 2021; Denzen et al., 2012; Yaneva et al., 2016), as the tracking of eye movements is a non-invasive method to assess online cognitive skills and processes involved in reading (Mézière et al., 2023; Rayner et al., 2006; Rayner et al., 2011). The German research group ‘Simply complex – Easy Language’ stands out in the use of this technology in EL research (Deilen, 2020; Schifffl, 2020). The findings of Rivero-Contreras et al. (2021) and Yaneva et al. (2016), which examine visual support through eye-tracking methods, have already been discussed in Section 1.2.

It is important to bear in mind that opting for this technology for a study on EL can also present some challenges. Participants with an ID are among the primary users of EL and require researchers to carefully consider necessary adaptations in the experiment’s design and implementation, as well as the associated ethical constraints (Borghardt et al., 2021; Csákvári & Gyori, 2015; Deilen & Schifffl, 2020). Listed below are some challenges researchers may face when performing eye-tracking tests on users with an ID, compiled by Deilen and Schifffl (2020); with comments from the authors on how these were acknowledged or resolved in the present study:

- (1) Participants with an ID may not be able to communicate their desires or comprehend given information as easily as neurotypical participants (Csákvári and Gyori, 2015; Deilen & Schifffl, 2020). For this reason, we provided all written information in EL (including all data collection information and consents) and frequently asked the participant if they wanted to carry on with the test or if they had any doubts.
- (2) Participants with an ID may find it hard to limit their movement throughout the experiment due to memory or executive control deficits (Deilen & Schifffl, 2020). In our study, we identified that the participants with an ID often turned their heads when the researcher started talking. For this reason, we had to frequently remind them to stay still and later review the gaze plots¹ in search

¹Gaze plots are a way of reviewing the participant’s eye movements after the recording has stopped. Gaze plots show the location, order and time spent looking at locations on the stimulus, which in our study was a page including text and an image or text only.

of any issues that might invalidate the recording of eye movements. This led to the rejection of 2 recordings.

- (3) Participants with an ID are more prone to present problems of vision or wear thick glasses that interfere with an optimal calibration² process (Warburg, 2001; Csakvari and Gyori, 2015), an issue that still has no general solution (Deilen & Schiff, 2020). In our study, we identified that 2 participants with an ID wore thick glasses that deformed their eyes, and another user with an ID squinted their eyes while reading. For this reason, we asked participants if they had any problems of vision we should acknowledge at the beginning of the test (3 users with an ID said they did), and we searched for any issues in the gaze plots once the test was finished. This issue led to the rejection of 2 additional recordings.

2. Aims of the study

As argued in the previous section, the limited research on the impact of visual support on EL comprehension does not help determine whether visual support is beneficial for a user facing reading or comprehension barriers. In fact, many of the reviewed studies showed no beneficial effects of visual support for the reader (e.g., Dye et al., 2004; Poncelas & Murphy, 2007; Yaneva et al., 2016), as did two studies that resembled the present one in terms of aims and method (Hurtado et al., 2014; Saletta et al., 2019).

The contribution of the present paper is threefold. First, we examine how the type of visual support used (illustrations, photographs, or no image) affects content comprehension, perceived difficulty and preference. Second, we monitor the reading behavior with the means of eye tracking. Finally, we study the effects of visual support in EL comprehension both on a group of people with ID and on a group of neurotypical participants. Our hypotheses areas follows :

H1. *Visual support of any type has significant effects on text comprehension for readers with intellectual disabilities.* Easy Language guidelines (García-Muñoz, 2012; ISO, 2023; Nomura et al., 2010; UNE, 2018) suggest that appropriate visual support facilitates text comprehension. As per previous research (Section 1.2), a significant difference is expected for individuals with ID (Buell, 2017; Wadihah & Fauzi, 2021).

H2. *People with and without intellectual disabilities explore the page differently.* Authors expect the group with an ID to make more and longer fixations; thus, also a longer fixation time. This group is also expected to perform shorter saccades (see Section 3.5 for a discussion on eye-tracking metrics and how they can reveal how readers engage with and process textual information).

Finally, a part of our study is exploratory due to the lack of previous consistent findings. For this reason, we also formulate two open research questions:

Q1. *How does the presence and type of visual support influence perceived level of text difficulty?*

²Calibration is the process by which the characteristics of a participant's eyes are estimated as the basis for a fully customised and accurate calculation of the gaze points (where the participant is looking). The participant is presented with targets, and the tracker collects data about the participant's eyes and their gaze to that target.

Q2. *How does the presence and type of visual support influence the way readers explore the page?*

3. Method

We designed an eye-tracking study combined with three questionnaires on comprehension, perceived difficulty and preference of visual support. This is a mixed design study which presents an independent variable with 3 levels: (1) no visual support, (2) illustration and (3) photograph; and the two groups of participants (ID/neurotypical) as the between-subjects factor.

Previous to the study, we performed a pilot test with 6 participants (medium age of 28.5; 5 women and 1 man). These participants had no cognitive disabilities or reading difficulties and followed the full procedure of the test. This experience allowed the researchers to perform slight changes to the design based on their observations and the analysis of the results. We will now expose in detail the final test design and method.

3.1. Participants

Initially, we aimed for a total of 60 participants, 30 in each group, but some of the users with an ID had to be discarded due to eye-tracking calibration or data collection problems (see [Section 1.3](#)). The final sample includes 52 participants (23 men and 29 women; mean age of 39.9 [SD = 14.5]). 26 of them had ID, and 26 did not. Participants with an ID (12 men and 14 women; mean age of 44.4 [SD = 13.2]) were recruited by contacting two local non-profit organizations that work on watching over the quality of life and giving jobs to people with intellectual or developmental disabilities (Som – Fundació, Taller Jeroni de Moragas). Neurotypical participants (11 men and 15 women; mean age of 34.8 [SD = 11.5]) were recruited through word-of-mouth promotion. In all cases, participation was strictly voluntary, and no participant was reimbursed.

All participants were native speakers of Catalan with normal or corrected vision (the recordings of 2 out of the 3 participants who declared having eye problems had to be discarded). Participants were not asked to provide a formal diagnosis of ID. Since having an ID was already a requirement to receive support from the collaborating foundations, this was considered sufficient to meet the diagnostic criterion. To ensure consistency within the group, two screening tests were administered, confirming that none of the participants showed intelligence levels or reading comprehension skills that differed significantly from the rest. Refer to [Section 4.1](#) for the participants' results on the screening tests on (1) reading comprehension and (2) intelligence and abstract reasoning.

3.2. Materials

3.2.1. Evaluation instruments

We used two **screening tests**, one that assessed reading comprehension (*Test de lectura comprensiva* [TLC]) (Comes, 1990) and one that evaluated intelligence and abstract reasoning (Raven's Progressive Matrices [RPM]) (Raven, 1998), to collect data on these aspects for each participant and group. TLC has been proven to be a

fully valid initial assessment of text comprehension skills in readers with varying proficiency levels (Baez-Naghelli *et al.*, 2015; Del Cueto *et al.*, 2019; Ferreres *et al.*, 2009). Similarly, RPM has demonstrated strong validity and reliability and is widely regarded as an appropriate measure of nonverbal and general intelligence (Kazem *et al.*, 2007; Queiroz-Garcia *et al.*, 2021).

Screening tests were conducted prior to the eye-tracking assessment and took approximately one hour per participant. The TLC and RPM tests were administered in group sessions, where participants completed the assessments individually and autonomously, all within the same room. Responses were recorded on paper, and participants could request assistance from the researcher if needed. In contrast, questions assessing comprehension, perceived difficulty and preference were administered on a separate day during individual one-on-one sessions with the researcher, held in the eye-tracker room. During these sessions, participants provided their responses orally.

All **comprehension questions** were of a similar low difficulty and asked on explicit information in the text (Fajardo *et al.*, 2014) and on elements that appeared or were related to the image. See an example:

Què envolta el poble de Rupit?

A) *Un pantà.* B) *Una riera.* C) *Salts d'aigua.*

What is the town of Rupit surrounded by?

A) A swamp. B) A stream. C) Waterfalls.

Perceived difficulty was assessed through a Likert scale (Yaneva *et al.*, 2016) after each page, which presented options from 1 to 4 to avoid a neutral answer. This measure reflects the subjective impressions of the participants on text difficulty.

Has trobat aquest text difícil de llegir?

1 2 3 4
Gens, ha estat fàcil. No gaire. M'ha costat una mica. M'ha costat molt.

Did you find the text difficult to read?

1) Not at all, it was easy. 2) Not very. 3) It was a little difficult. 4) It was very difficult.

Finally, at the end of the experiment, participants were asked an open question on their **preference** in terms of visual support ('would you rather read plain text, a text with a photograph or a text with an illustration?').

3.2.2. Stimuli

Stimuli shown in the experiment were based on an EL brochure-style publication on tourist attractions of the Catalan towns of Rupit and Pruit (Vidal, 2021). The texts were in EL, included no low-frequency words and had low text complexity. Researchers chose this brochure due to its adequacy for the purpose of the test: images in it share the same representative function (Carney & Levin, 2002), which facilitated the task of formulating adequate and homogeneous comprehension questions. The content in the original brochure was complemented with other

information about the described locations from different tourist guides, and it was slightly adapted so all the pages shown (6 in total) (1) had the same layout, (2) had about the same length (between 65 and 70 words) and (3) presented a similar number of ideas. The Fernández Huerta readability index³ for all 6 texts was between 90.12 and 102.70, in which results over 90 are labelled as ‘very easy’ for adult readers. Sentences were presented in black 14-point Arial font on a white background, and paragraphs were double-spaced.

Each of the 6 texts had 3 different presentations, corresponding to the 3 levels of the independent variable: no visual support, photograph and illustration. All participants read the same six texts in the same order, but with different conditions regarding visual support. This was achieved through a Latin square array. For the sake of minimizing the possible influence of extraneous factors, a set of stimuli was arbitrarily assigned to each participant with only one criterion: making sure that in the end, the same number of participants would have read through each set of stimuli.

When it comes to images, stimuli presented (1) the original photographs used in the brochure and (2) illustration-style copies of them, created with digital illustration tools. All images were representational (Carney & Levin, 2002) and relevant to the content in the text. Pages had a size of 1230 × 819. On the pages with visual support, a 520 × 390 (4:3) image appeared in the top left corner, as this is their usual placement in Spanish and Catalan EL texts (Plena Inclusión, 2021). Photographs and illustrations were in color and of high resolution. The right half of the page showed the text, which, as stated before, was always between 65 and 70 words in length and was presented in 10 lines. On pages where no visual support was provided, the text was centered on the screen. See Table 1 for an example.

It is important to consider that a group of people belonging to the EL target group validated both the original text and the supporting images and considered them adequate for an EL adaptation before publication. Validation with the target group is strongly recommended to publish under the ‘Easy Language’ category. At Plena Inclusión, an advocacy movement that fights for the rights of people with intellectual and developmental disabilities in Spain, they validate images by asking the participants ‘what do you see in the image?’ and ‘how does the image relate to the text?’. If an issue arises, they ask the follow-up questions ‘how should the image be to explain this topic well?’ and ‘what do we do to ensure the image is properly related to the text?’ (Plena Inclusión, 2021).

3.3. Apparatus

Eye movements were recorded with a Tobii T60 (sampling rate of 60 Hz) in a desk monitor setup. Head movements were not restrained, although participants were given instructions to stay still while performing the test (as discussed in Section 1.3, this was hard for some participants with an ID). Viewing was binocular, and the movements of both eyes were recorded. Participants were seated approximately 60 cm away from the 43 cm display size monitor with a screen resolution of 1280 × 1024 pixels. The Tobii T60 eye tracker and the stimuli were controlled through a laptop. A different laptop was used to record the participant’s answers and comments in a digital document.

³Adaptation of the Flesch–Kincaid test to assess Spanish texts; also used for Catalan in the absence of a specific index.

Table 1. Different versions of a stimulus

1)  Les rutes guiades A la primavera i a l'estiu, Rupit organitza diverses rutes guiades per conèixer el municipi. Una de les rutes porta fins al salt de Sallent. La ruta passa pels boscos del voltant del poble. Pel camí, podem veure antics molins abandonats, gorges, salts d'aigua i fonts. Al final de la ruta, arribem al salt del Sallent. Aquest lloc és on acaba la riera de Rupit.	2)  Les rutes guiades A la primavera i a l'estiu, Rupit organitza diverses rutes guiades per conèixer el municipi. Una de les rutes porta fins al salt de Sallent. La ruta passa pels boscos del voltant del poble. Pel camí, podem veure antics molins abandonats, gorges, salts d'aigua i fonts. Al final de la ruta, arribem al salt del Sallent. Aquest lloc és on acaba la riera de Rupit.
3) Les rutes guiades A la primavera i a l'estiu, Rupit organitza diverses rutes guiades per conèixer el municipi. Una de les rutes porta fins al salt de Sallent. La ruta passa pels boscos del voltant del poble. Pel camí, podem veure antics molins abandonats, gorges, salts d'aigua i fonts. Al final de la ruta, arribem al salt del Sallent. Aquest lloc és on acaba la riera de Rupit.	Direct translation: Guided routes In spring and summer, Rupit organizes several guided tours for people to get to know the town. One of the routes leads to the Sallent jump. The route passes through the woods around the village. Along the way, we can see old, abandoned mills, gorges, waterfalls and fountains. At the end of the route, we arrive at the Sallent jump. This place is where the Rupit stream ends.

3.4. Procedure

Participants first signed the written informed consent and demographics form. They then performed the TLC and RPM tests in a group session. Later, they proceeded with the eye-tracking experiment in a separate room, with the only company of the observing researcher. For participants with an ID, the two sessions were conducted on different days to reduce the risk of fatigue (Deilen & Schiffel, 2020) and to allow extra time for explanation and assistance. In contrast, the sessions for neurotypical participants were conducted on the same day. The eye-tracking test lasted around 40 minutes and for each participant we retrieved a maximum of 25 minutes of recorded eye movements (around 4 minutes per page of stimuli). The recording was paused while the participants answered the comprehension, perceived difficulty and preference questions, which explains the difference in these times.

The researcher always explained the procedure and calibrated the eye tracker before starting this last test. Then the participant read the first page of stimuli describing a tourist attraction on Rupit and Pruit and answered two multiple-answer comprehension questions orally (see the stimuli explained in Section 3.2.2). The researcher switched to the next screen once the participant told them they had finished reading. They could read the text again if they needed to, once the questions were asked, since the aim was not to measure short-term memory or recall. As mentioned, the eye tracker only recorded eye movements performed while the participants were reading the text prior to the posing of the question. Participants were also asked about their perceived difficulty of the text, which they also answered orally. This process was repeated until readers had read through all 6 pages of the stimuli.

The study protocol (CEEAH CA40) was approved by the Research Ethics Committee of the Universitat Autònoma de Barcelona in February 2022.

3.5. Eye-tracking measures

Eye-tracking measures can be categorized as local or global. Global measures are aggregated over broader regions, such as sentences or multiple sentences, and provide information on overall reading behavior, including individual differences between groups with varying reading skills (Mézière et al., 2023, 428). For example, Rayner et al. (2006) showed that reading more difficult texts results in longer average fixation durations. Similarly, Reichle et al. (2013) and Blythe and Joseph (2012) found that less skilled readers tend to make more and longer fixations than skilled readers, with longer fixations reflecting prolonged processing times or processing difficulties.

Recent studies have also demonstrated that global eye-tracking measures can predict reading comprehension. Southwell et al. (2020) had participants read long passages silently and then answer multiple-choice questions. They found that eye movements predicted comprehension scores with correlations ranging from 0.35 to 0.40, with more fixations and shorter fixation durations being associated with better performance. D'Mello et al. (2020) reported similar findings, further highlighting the predictive value of global measures.

In contrast, local measures provide more detailed insights into the specific cognitive processes affected by reading ability (Mézière et al., 2023). However, because most research has emphasized global measures, it remains unclear whether local eye movements can reliably predict reading comprehension accuracy.

Given this background, the present study will focus on the global measures listed below, as they have been more consistently linked to reading comprehension outcomes and offer a robust starting point for examining individual differences in reading behavior.

1. Fixation count: the sum of the number of fixations (defined in Section 1.3) in an area (Clifton et al., 2007; Duchowski, 2007).

Fixation count is an indicator of visual processing of that area or stimuli (e.g., the image, the text) (Krejtz et al., 2016). More (and shorter) fixations may reflect attentive reading (Faber et al., 2018; Southwell et al., 2020) as the number of fixations tends to increase when the text is difficult (Rayner et al., 2006) and more fixations are shown to be linked to help memory performance (Fehlmann et al., 2020). Orduna-Hospital et al. (2023) showed that people with an ID tended to exhibit a higher number of fixations.

2. Average fixation duration: the average duration of a single fixation (White et al., 2022).

Longer fixations are associated with reading difficulty, and poor readers tend to exhibit them (Rayner et al., 2006) while shorter fixations are associated with better comprehension (Copeland & Gedeon, 2013; Southwell et al., 2020). The slower the cognitive processing, the longer the fixation (He et al., 2015). Studies suggest that unskilled readers (such as readers with an ID or learning disabilities) will have longer fixation duration (Everatt & Underwood, 1994; Rivero-Contreras, 2023).

3. Total fixation time: the sum of all single fixations on a certain area (Clifton et al., 2007; Duchowski, 2007).



Image 1. Groups of AOIs in a page of stimuli.

It reflects encoding processes (Child et al., 2020) and is an indicator of lexical access and integration (Inhoff & Rayner, 1986; Morton, 1969; Whaley, 1978). A longer total fixation time is considered an indicator of a deeper and more effortful processing of visual information (Just & Carpenter, 1980; Krejtz et al., 2016).

4. Average saccade amplitude: the average distance travelled by the eye between two fixation points (Paeye & Madelain, 2011, 149).

A pattern of long saccades indicates greater exploration (Wang & Sparks, 2016). Poor readers tend to exhibit shorter saccades (Rayner et al., 2006). Orduna-Hospital et al. (2023) showed that people with an ID exhibited a higher number of saccades. Subjects without ID showed faster saccades and with a higher amplitude than those with ID.

Finally, areas of interest (AOIs) are an analytical tool that allows for calculating these measures and receiving quantitative, relevant metrics. Put simply, AOIs are the boundaries drawn around an area of each page of stimuli that fall into different categories. In the present study, researchers determined three types of AOIs: image, text and whitespace (see Image 1).

4. Results

To examine differences in the screening tests, comprehension, perceived difficulty and style preference, we have run an analogous 3-way analysis of variance and a series of independent t-tests. These results, as well as the ones from the participant's eye movements, will be presented in this section. We used R for the statistical analysis. Results will be discussed in Section 5.

4.1. Screening tests: TLC and RPM

There were no intra-group outliers in the results from the screening tests. Participants with an ID got on average 33.7% of the answers correct in the TLC test on reading comprehension ($SE = 0.829$), whereas the neurotypical group scored 85.8% ($SE = 0.443$). The difference was significant, $t(52) = 17.198$, $p < .001$.

In regard to the RPM test on abstract reasoning and intelligence, the ID group got 62.9% of the questions right ($SE = 1.604$), whereas the neurotypical group obtained 95.1% of accurate answers ($SE = 0.374$). The difference was also significant ($t(52) = 6.54$, $p < .001$) (Tables 2 and 3).

Table 2. T-Test results from the screening tests

T-Test scores (between group with an ID and neurotypical)	
TLC (reading comprehension)	$(t(52) = -17,198, p < .001)$
RPM (intelligence and abstract reasoning)	$(t(52) = -6,54, p < .001)$

Table 3. Accuracy results from the screening tests

	TLC score (reading comprehension)	RPM score (intelligence and abstract reasoning)
ID	33.7%	62.9%
Neurotypical	85.8%	95.1%

4.2. Comprehension, perceived difficulty and preference questions

We performed basic percentage and statistical calculus from the participants' answers to the comprehension, perceived difficulty and preference questions and a Mann–Whitney U test to compare the tendencies for both groups. Both the comprehension and perceived difficulty questions showed relevant between-group differences. The question on the page layout preference, on the other hand, showed no between-group relevance (Table 4).

Regarding the perceived difficulty of the texts, interestingly, the group with an ID gave a mean of 1.69 out of 4 on difficulty for all 3 types of visual support, showing their rating was independent of the variable. The neurotypical group rated 1.23 out of 4 in difficulty for those texts accompanied by photographs ($p = .002$) or illustrations ($p < .001$), and a slightly lower rate of 1.07 on average for those with no visual support ($p = .002$) and showing a relevant difference between groups for all three types of visual support ($p < .001$) (Table 5).

Finally, when analyzing the answers to the comprehension questions, we can see a relevant between-group difference and a non-relevant within-group difference among participants. The inclusion of visual support is non-relevant for any of the

Table 4. T-Test results from the comprehension, perceived difficulty and preference questions

T-Test scores (between group with an ID and neurotypical)	
Comprehension questions	$(t(624) = -12,967, p < .001)$
Perceived difficulty	$(t(312) = 6,16, p < .001)$
Layout preference	$(t(48) = 0, p = 1)$

Table 5. Perceived difficulty out of 4

	ID		Neurotypical	
	Mean	Median	Mean	Median
Photograph	1.69	1	1.23	1
Illustration	1.69	1	1.23	1
No visual support	1.69	1	1.07	1

Table 6. Correct answers to comprehension questions out of 104

	ID		Neurotypical	
	Correct answers	% in group	Correct answers	% in group
Photograph	58	55.7	98	94.2
Illustration	59	56.7	100	96.1
No visual support	56	53.8	99	95.1

Table 7. Visual support preference

	ID		Neurotypical	
	Participants	% of group	Participants	% of group
Photograph	9	34.6	7	26.9
Illustration	1	3.8	5	19.2
No visual support	1	3.8	1	3.8
No preference	15	57.6	13	50

groups (ID: $p = .34$; neurotypical: $p = 1$). Neither does the type of visual support show effects in the accuracy of the participants (ID: $p = 1$; neurotypical: $p = .48$), while the between-group difference is shown to be relevant ($p < .001$). The participants with an ID answered on average 55.4% of the questions correctly, against the 95.1% of the neurotypical group. These results are portrayed in Table 6.

Finally, most participants (53.8%) showed no clear preference when it came to the type of visual support in the text. Among those who did show a preference, the majority of participants preferred the use of pictures (34.6% of ID, 26.9% of neurotypical). While the preference of no visual support is anecdotal and very low for both groups (only one participant and 3.8% in both groups), the between-group difference is only bigger when it comes to the preference of illustrations: only one participant (3.8%) chose this typology in the group with an ID, versus the 19.2% of participants in the neurotypical group. Nevertheless, between-group differences show no relevance ($p = 1$). These results are displayed in Table 7.

4.3. Differences in eye movement characteristics

To verify whether there were differences in reading depending on the characteristics of the stimuli and the participant groups, as per our initial hypotheses, we ran a 3-way mixed design ANOVA with group (neurotypical versus ID) as the between-subjects variable, areas of the page (whitespace versus image versus text) and experimental condition (photograph versus illustration) as within-subjects independent variables.

Before conducting statistical tests, outlying fixations in terms of duration were identified using the standard ± 1.58 IQR/sqrt(n) criterion (Chambers et al., 1983). Fixations exceeding 1032 ms were classified as outliers, accounting for 11.79% of cases. Prior to analysis, these outliers were replaced with the largest non-outlying fixation duration (1031 ms), following a procedure known as winterization (Kuwak & Kim, 2017). A similar approach was applied to outliers in saccadic amplitude (11.17%).

4.3.1. Fixation count

The analysis on the fixation count yielded a significant difference between groups; individuals with an ID exhibited a higher number of fixations ($M = 10.82$, $SE = .956$) than the cognitively neurotypical ($M = 5.63$, $SE = .996$), ($F(1, 46) < .001$, $p < .001$, $\eta^2 = .105$).

The difference in the number of fixations for different types of images was not significant ($F(1, 46) = .2$, $p = .660$, $\eta^2 < .001$), nor was the interaction between group and type of image ($F(1, 46) = .07$, $p = .793$, $\eta^2 < .001$), showing that both groups had a similar number of fixations on the two types of images (illustrations and photographs).

The analysis also revealed significant differences in fixation count between areas of the page, ($F(1.23, 56.54) = 27.32$, $p < .001$, $\eta^2 = .213$), see Figure 1. Post hoc comparisons indicated that both groups had the highest number of fixations on whitespace ($M = 12.89$, $SE = 1.65$), followed by text ($M = 8.51$, $SE = .59$) and image ($M = 3.25$, $SE = .231$).

Interestingly, the interaction effect between participant group and areas of the page was significant, ($F(1.23, 56.54) = .007$, $p = .007$, $\eta^2 = .065$), see Figure 1. Post hoc comparisons indicated that participants with an ID had a significantly higher number of fixations on whitespace ($M = 18.17$, $SE = 2.286$) than the neurotypical participants ($M = 7.62$, $SE = 2.383$), ($t(46) = 3.195$, $p < .001$). They also looked significantly more at text ($M = 10.55$, $SE = .827$) than the neurotypical group ($M = 6.48$, $SE = .862$), ($t(46) = 3.413$, $p = .001$). The difference between groups was smallest for the image, yet still significant ($t(46) = 2.050$, $p = .046$). Participants with an ID exhibited more fixations ($M = 3.73$, $SE = .319$) than the neurotypical participants ($M = 2.78$, $SE = .333$).

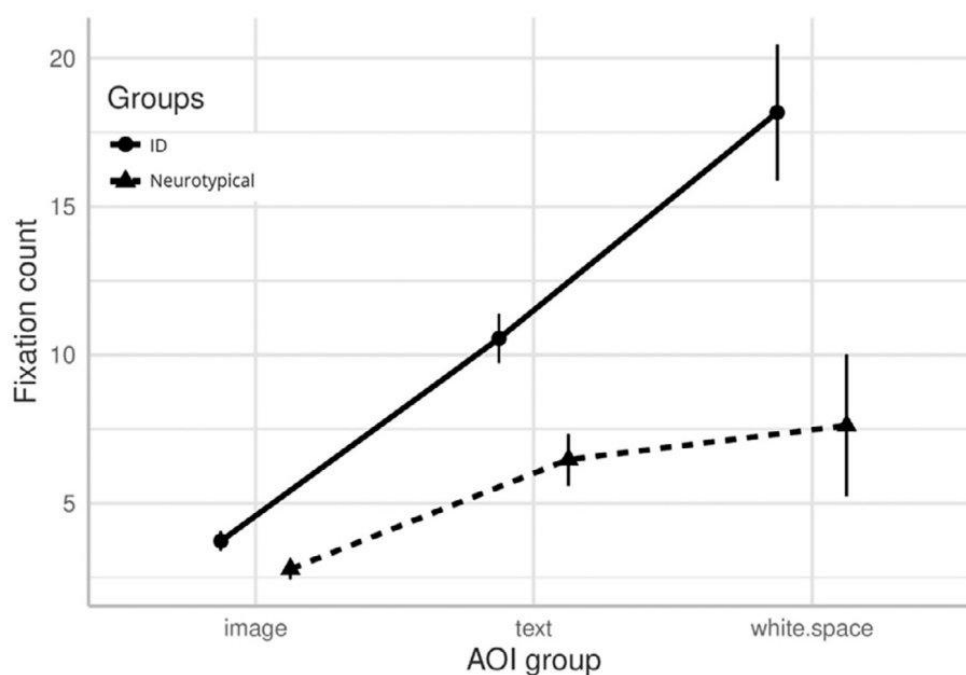


Figure 1. The interaction between participant group and AOI group on fixation count.

4.3.2. Average fixation duration

Participants with an ID also showed significantly longer average fixations ($M = 308$, $SE = 11.3$) than the users in the neurotypical group ($M = 266$, 11.8), ($F(1, 46) = .006$, $p = .012$, $\eta^2 = .066$).

The analysis revealed a significant interaction effect between the group and the area of the page ($F(1.44, 66.24) < .001$, $p < .001$), see Figure 2. Post hoc comparisons suggested that the longest fixations of the group with an ID were on the text ($M = 358$, $SE = 14.4$), while their fixations on whitespace ($M = 293$, $SE = 15.1$) and the image ($M = 274$, $SE = 12.7$) were much shorter. Interestingly, neurotypical users show the longest fixations on images ($M = 291$, $SE = 13.2$), while their fixations on text ($M = 261$, $SE = 15.1$) and white space ($M = 245$, $SE = 15.8$) are shorter ($F(1.44, 66.24) < .001$, $p < .001$). Interestingly, the relevance of differences on average fixation duration between areas of the page for one group is opposed to the other: for the group with an ID, we only see a relevant difference between image and text ($p < .001$) and image and whitespace ($p < .001$), but not between image and whitespace ($p = .5$). On the contrary, the neurotypical group only show relevant differences in their average fixation duration between image and whitespace

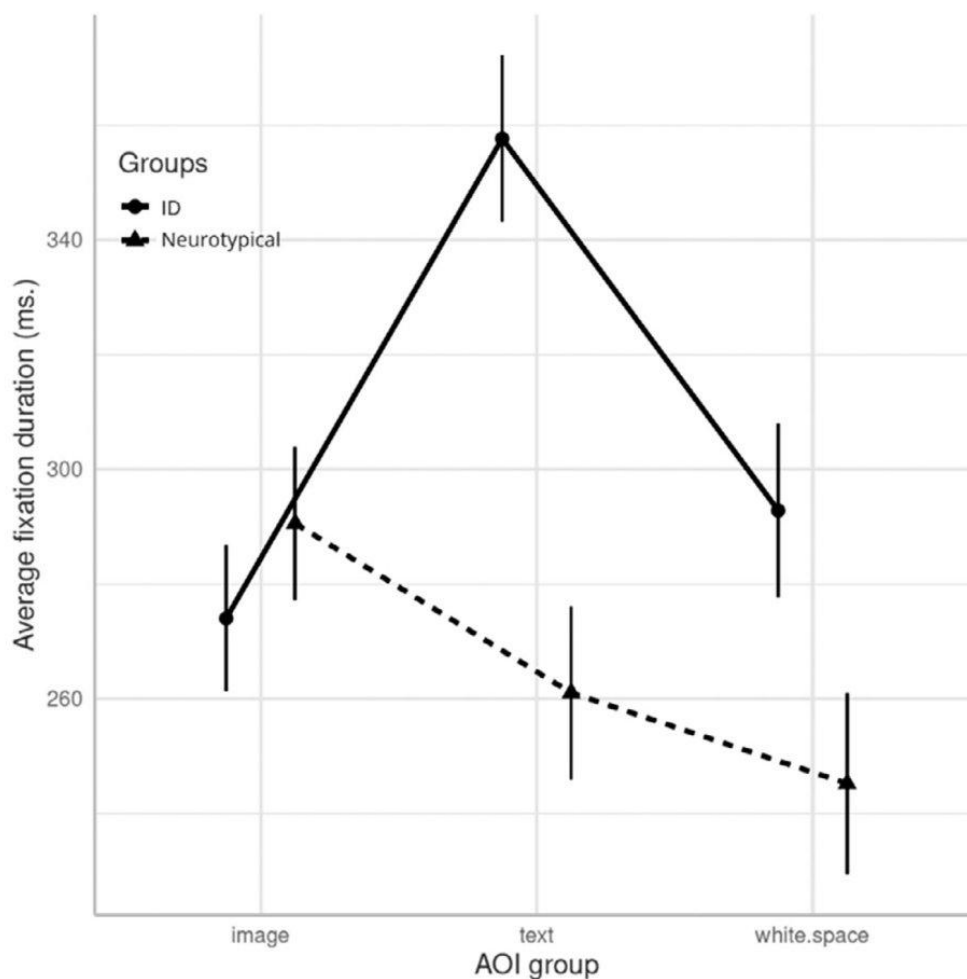


Figure 2. The interaction between participant group and AOI group on average fixation duration.

($p = .02$), but not for the other two pairs of AOIs (image-text ($p = .2$), text-whitespace ($p = .22$)).

With this, there is a highly significant difference between the duration of the fixations on the text ($t(46) = 4.635$, $p < .001$) and on whitespace ($t(46) = 2.181$, $p = .034$) between the two groups, being much higher in both cases for the participants with an ID. This difference is not observed for images ($t(46) = -.905$, $p = .37$).

There was also a significant interaction between type of image and page area, ($F(1.66, 76.42) = .039$, $p = .031$), see Figure 3. Both groups performed longer fixations on the image when it was a photograph ($M = 303$, $SE = 12.1$) than when it was an illustration ($M = 261$, $SE = 10.8$), ($t(46) = 3.035$, $p = .039$), whereas type of image did not affect the average fixation durations on text ($t(46) = 1.215$, $p = .231$) and white space ($t(46) = .262$, $p = .795$).

4.3.3. Total fixation time

The difference in the total fixation time (tft) depending on the image type was not significant ($F(1, 46) = .15$, $p = .696$, $\eta^2 = < .001$). However, we observed a significant

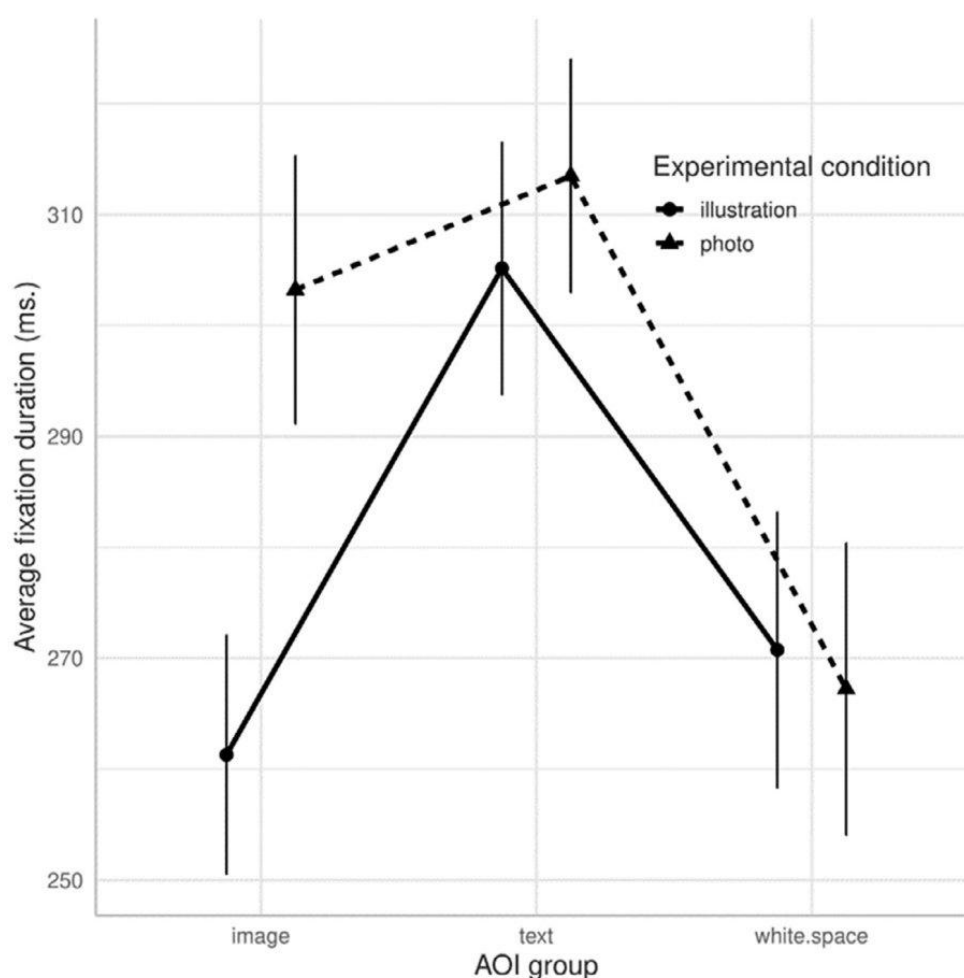


Figure 3. The interaction between experimental condition and AOI group on average fixation duration.

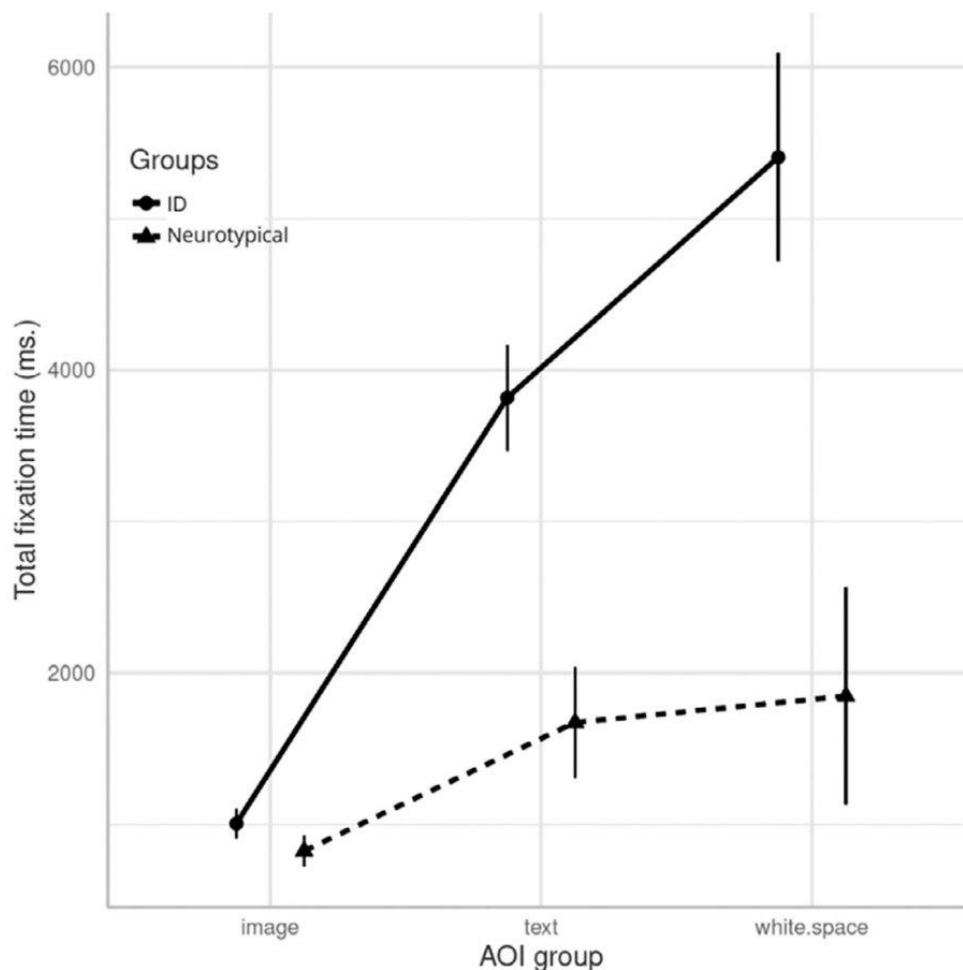


Figure 4. The interaction between participant group and AOI group on total fixation time.

main effect of the page areas. Both groups showed a significantly higher tft on whitespace ($M = 3626$, $SE = 496$) and text ($M = 2745$, $SE = 253$) than on images ($M = 914$, $SE = 70$), ($F(1.44, 66.31) < .001$, $p < .001$, $\eta^2 = .189$) (see Figure 4).

The participants with an ID fixated on whitespace for longer ($M = 5406$, $SE = 686$) than the neurotypical group ($M = 1847$, $SE = 715$), ($t(46) = 3.592$, $p < .001$). The same happens with text, where the group with an ID fixated for more time ($M = 3818$, $SE = 350$) than the neurotypical group ($M = 1673$, $SE = 365$), ($t(46) = 4.243$, $p < .001$). However, there was not a significant effect on total fixation time of the interaction between image type and participant group ($F(1, 46) = .04$, $p = .846$, $\eta^2 < .001$), and the two groups did not differ significantly in the time they looked at the images ($t(46) = 1.292$, $p = .203$).

4.3.4. Saccadic amplitude

Regarding saccadic amplitude, we observed a significant interaction effect between group and page area, ($F(1.29, 59.35) = .04$, $p = .022$, $\eta^2 = .044$). We see a significant between-group difference in the saccadic amplitude on image, with smaller saccades

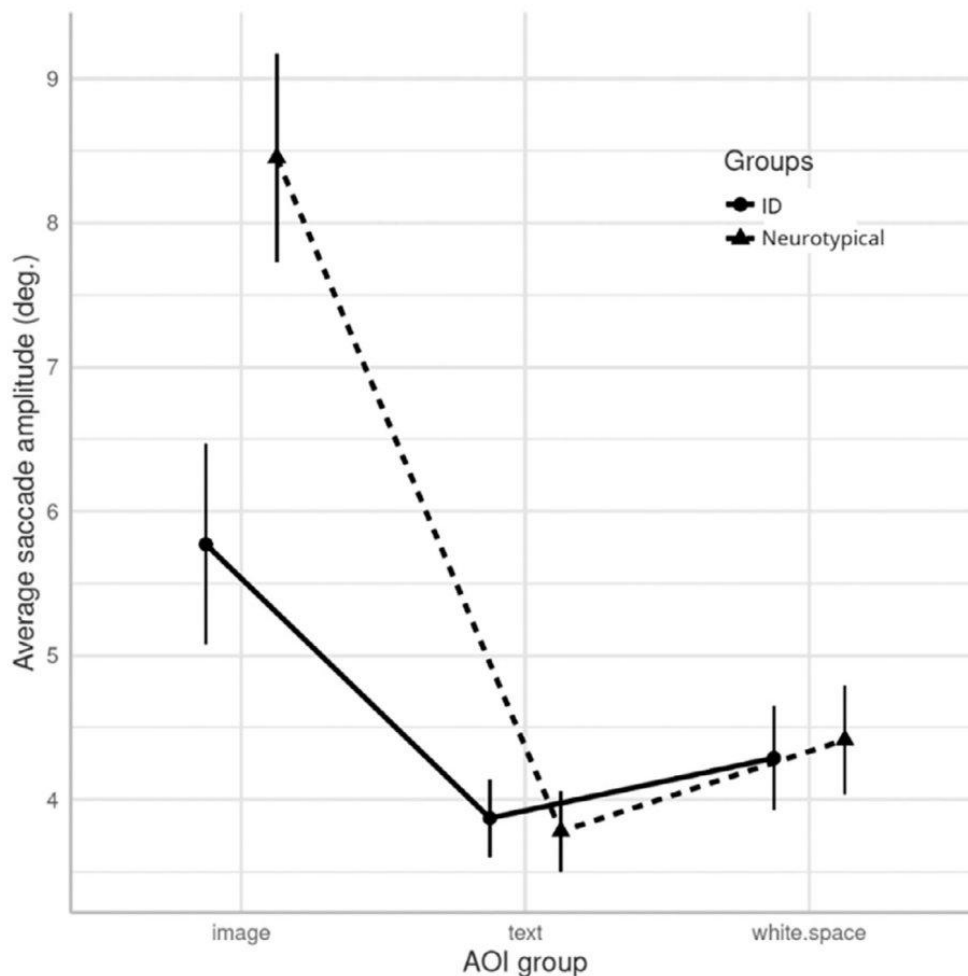


Figure 5. The interaction between participant group and AOI group on average saccade amplitude.

for the group with an ID ($M = 5.77$, $SE = .692$) than for the neurotypical group ($M = 8.45$, $SE = .722$), ($t(46) = 2.680$, $p = .01$, see Figure 5).

Analogous comparisons for text ($t(46) = .239$, $p = .8121$) and white space ($t(46) = -.243$, $p = .8089$) were not significant. In addition, participants performed smaller saccades on the photographs ($M = 4.72$, $SE = .244$) than on the illustrations ($M = 5.48$, $SE = .244$), ($F(1, 46) = 6.47$, $p = .014$, $\eta^2 = .016$). This effect of image type was quantified by group ($F(1, 46) = .372$, $p = .06$, $\eta^2 = .016$). The neurotypical group showed significantly bigger saccades for illustrations ($M = 6.22$, $SE = .353$) than photographs ($M = 4.88$, $SE = .353$), ($t(46) = 3.100$, $p = .003$), whereas the group with an ID showed small saccades for both types of images, with non-relevant differences ($t(46) = .444$, $p = .6591$). These results also show a significant between-group difference in saccadic amplitude for illustrations, with the neurotypical participants performing significantly bigger saccades ($M = 6.22$, $SE = .353$) than the participants with an ID ($M = 4.74$, $SE = .338$), ($t(46) = 3.030$, $p = .004$). This difference was not significant for saccades on photographs, which were small for both groups ($t(46) = .5$) (see Figure 6).

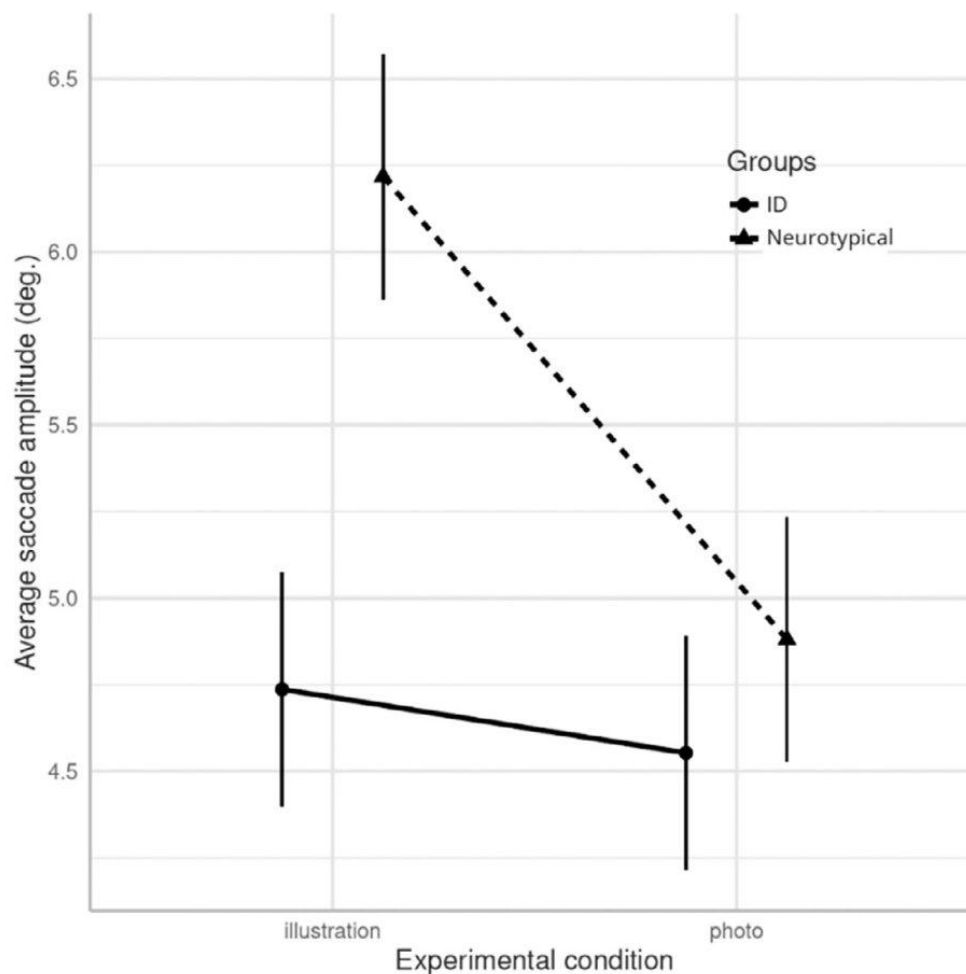


Figure 6. The interaction between participant group and experimental condition on average saccade amplitude.

5. Discussion

We will first review the hypotheses and contrast them with the results of our study (findings reject H1 and confirm H2). We will also answer the exploratory research questions Q1 and Q2. Later on, we will discuss other interesting findings outside the scope of our initial hypotheses.

H1. *Visual support of any type has significant effects on text comprehension for readers with intellectual disabilities.* Visual support inclusion was not related to accuracy in comprehension questions in any of the groups of participants. The type of visual support also showed no effects on reading comprehension. Therefore, we found no evidence of differential influence of photographs or illustrations helping in the comprehension of the text that they accompany.

H2. *People with and without intellectual disabilities explore the page differently.* The group with an ID was expected to make more and longer fixations, show a longer fixation time and perform shorter saccades. The total fixation time of the participants with an ID on the text was also higher than those in the neurotypical group, probably indicating a

higher difficulty to decode the text or interpret its content (Rayner, 1998). The same happens with the average fixation duration: the group with an ID shows much longer fixations on text and whitespace, indicating a higher cognitive effort when reading (Southwell et al., 2020). Differently, the neurotypical group shows shorter fixations overall, with their longest ones being on the image (opposite to the results of the group with an ID), arguably because they may find more interest in exploring that area.

Regarding saccades, the neurotypical participants performed longer ones on the image area, possibly due to them searching for items or details in the scene. Saccades were also longer when the image was an illustration, showing extensive eye movements around the abstract picture. The overall smaller saccades of the group with an ID show that they were focusing on areas of interest on the page with more and longer fixations, rather than scanning and exploring around it.

Q1. *How does the presence and type of visual support influence perceived level of text difficulty?* There were no significant differences on the perceived difficulty of the text that could be linked to the inclusion or type of visual support.

Q2. *How does the presence and type of visual support influence the readers' eye movements?* We found that saccades were longer on illustrations than on photographs, a difference that was especially significant in the neurotypical group. This group showed extensive eye movements around the abstract picture.

Having assessed the initially posed hypotheses and questions, it is also very interesting to see that the participants, especially those on the group with an ID, had the highest number of fixations and average total fixation time on whitespace. We suggest that this may have occurred because the texts shown lengthened between 65 and 70 words rather than being of sentence-length, and the participants might have needed to rest their gaze on the whitespace briefly; although it may also reflect a difference in how the two groups scan the scene and integrate the different areas of the page (Skversky-Blocq et al., 2022).

Other aspects worth discussing would be the between-group difference on the answers on perceived difficulty, style preference and comprehension questions. There were no relevant differences on the perceived difficulty of the text that could be linked to the participant groups. Regarding preference on the inclusion and type of visual support in the page, most participants showed no preference or would rather not communicate it. Photographs were the preferred style for both groups, but it is very interesting to discuss the number of participants that chose illustrations, which is much higher in the neurotypical group (19.2%) than in the group with an ID (3.8%). This may possibly be due to participants with an ID being more aware and averse to infantile styles of visual support, as some participants in the group communicated to the researcher. Lastly, results make it clear that the comprehension questions were easy for the neurotypical group (95.1% of correct answers) and quite difficult to answer for the participants with an ID (55.4% of accuracy). It is hard to determine whether these results are fully due to the participants with an ID being unable to comprehend the needed information in the text, but it probably indicates a difference in the reading comprehension capacities of each group.

6. Conclusions

We were able to assess our initial hypotheses and shed light on the more exploratory aspects analyzed. On the one hand, contrary to H1, visual support was not related to

accuracy in comprehension questions. This questions whether this should be such an established aspect of EL texts. On the other hand, H2 was confirmed, indicating that global eye-tracking measures are a good tool to predict the cognitive effort of processing different types of texts and that, although participants with an ID might need some adaptations in the test design and setting, it is possible and advisable to use this methodology with EL primary groups.

Additionally, there was no effect of the group or visual support on how difficult the participants perceived the text. In this regard, the way participants with an ID perceive the text in terms of difficulty does not match their lower results on comprehension, showing a misperception of their reading abilities or a reluctance to verbalize their struggles. Notably, neurotypical participants showed a higher preference for illustrations than that of participants with an ID, possibly reflecting a desire of the latter for less infantilizing support.

On this basis, the present study makes a meaningful contribution to the limited empirical evidence directly examining EL recommendations and offers valuable insights into the relationship among visual support, eye-tracking measures and reading comprehension. Nevertheless, it is important to acknowledge its limitations and suggest directions for future research.

6.1. Limitations and future research directions

First, regarding the eye-tracking measures used in the present study, global measures are not very informative about the specific cognitive processes affected by reading ability (Mézière *et al.*, 2023, 428). For example, we do not know whether the differences between groups in processing times are due to linguistic (e.g., lexical access) or non-linguistic (e.g., working memory) processes. Therefore, it would be valuable for future studies to assess local measures (although since most studies have focused on global measures, it remains uncertain whether local eye movements can also predict reading comprehension accuracy). Second, it would be valuable to examine within-group differences in comprehension by presenting participants with the same information in both standard language and EL, incorporating this as a within-group variable. Third, while we aimed for a larger sample, our final participant pool included 52 individuals (26 per group). Given the limited research involving adults with an ID in this area, we encourage future studies to replicate our findings or conduct similar investigations with larger samples.

We also observed unexpected results outside our original hypotheses that merit further study. For instance, the group with an ID reacted negatively to illustrations, while these were much more appreciated by the neurotypical group. In addition, many linguistic and graphical aspects of EL remain unexplored and should be addressed in future work. Validating EL adaptations empirically is key to ensuring their effectiveness and improving accessible communication.

Our study made a significant contribution to the limited empirical evidence directly assessing EL recommendations, although it is essential that future research continues to evaluate their validity and applicability.

Data availability statement. The data and analysis scripts related to the reported results are available on OSF: https://osf.io/ecwkc/?view_only=ba4285b1ccb44fb19ceb2c0f7bcc9ede

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References

- Anglin, G. J., Vaez, H., & Cunningham, K. L. (2004). Visual representations and learning: The role of static and animated graphics. In D. H. Jonassen (Ed.), *Handbook of research on educational communications and technology* (pp. 865–916). Lawrence Erlbaum Associates Publishers.
- Asociación Española de Normalización. (2018). UNE 153101:2018 EX: *Lectura fácil. Pautas y recomendaciones para la elaboración de documentos*.
- Baez-Naghelli, C., Águila, L., Nieves, D., Grande, M., & Mena, T. (2015). *Test leer Para Comprender: Evaluación de la comprensión lectora en educación primaria*. Ediciones Paidós.
- Bernabé, R. (2020). New taxonomy of easy-to-understand access services. *Monografías de Traducción e Interpretación*, 12, 345–380. <https://doi.org/10.6035/MonTI.2020.12.12>.
- Beymer, D., Orton, P. Z., & Russell, D. M. (2007). An eye tracking study of how pictures influence online reading. In C. Baranauskas, P. Palanque, J. Abascal, & S. D. J. Barbosa (Eds.), *Human-computer interaction – INTERACT 2007* (pp. 3–7). Springer. https://doi.org/10.1007/978-3-540-74800-7_41
- Blythe, H. I., & Joseph, H. S. S. L. (2012). Children's eye movements during reading. In S. P. Liversedge, I. Gilchrist, & S. Everling (Eds.), *The Oxford handbook of eye movements* (pp. 644–662). Oxford University Press.
- Boland, J. (2004). Linking eye movements to sentence comprehension in reading and listening. In M. Carreiras & C. Clifton (Eds.), *The on-line study of sentence comprehension: Eyetracking, ERP, & beyond*. Psychology Press.
- Borghardt, L., Deilen, S., Fuchs, J., Gros, A., Hansen-Schirra, S., Nagels, A., Schiff, L., & Sommer, J. (2021). Neuroscientific research on the processing of easy language. *Frontiers in Communication*, 6. <https://doi.org/10.3389/fcomm.2021.698044>.
- Buell, S. (2017). *Health-based information for people with intellectual disabilities: An investigation into the linguistic properties of "easy read" literature and its contribution to the construction of meaning: The Easy Read Project* [Doctoral thesis]. University of East Anglia. <https://ueaeprints.uea.ac.uk/id/eprint/65618>
- Butcher, K. R. (2014). The multimedia principle. In R. E. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (pp. 174–205). Cambridge University Press. <https://doi.org/10.1017/CBO9781139547369.010>
- Carney, R. N., & Levin, J. R. (2002). Pictorial illustrations still improve students' learning from text. *Educational Psychology Review* 14(1), 5–26. <http://www.jstor.org/stable/23363486>
- Chambers, J. M., Cleveland, W. S., Kleiner, B., & Tukey, P. A. (1983). *Graphical methods for data analysis*. Wadsworth & Brooks/Cole Statistics.
- Child, S., Oakhill, J., & Garnham, A. (2020). Tracking your emotions: An eye-tracking study on reader's engagement with perspective during text comprehension. *Quarterly Journal of Experimental Psychology*, 73(6), 929–940. <https://doi.org/10.1177/1747021820905561>.
- Chinn, D., & Homeyard, C. (2017). Easy read and accessible information for people with intellectual disabilities: Is it worth it? A meta-narrative literature review. *Health Expectations*, 20(6), 1189–1200. <https://doi.org/10.1111/hex.12520>.
- Clark, J. M., & Paivio, A. (1991). Dual coding theory and education. *Educational Psychology Review*, 3, 149–210. <https://doi.org/10.1007/BF01320076>.

- Clifton, C., Jr., Staub, A., & Rayner, K. (2007). Eye movements in reading words and sentences. In R. P. G. van Gompel, M. H. Fischer, W. S. Murray, & R. L. Hill (Eds.), *Eye movements: A window on mind and brain* (pp. 341–371). Elsevier. <https://doi.org/10.1016/B978-008044980-7/50017-3>
- Comes, A. (1990). *TLC: Test de lectura comprensiva*. TEA.
- Copeland, L., & Gedeon, T. (2013). Measuring reading comprehension using eye movements. In *4th IEEE international conference on cognitive infocommunications (CogInfoCom 2013) – Proceedings* (pp. 791–796). <https://doi.org/10.1109/CogInfoCom.2013.6719207>.
- Csákvári, J., & Gyori, M. (2015). Applicability of standard eye-tracking technique in people with intellectual disability: Methodological conclusions from a series of studies. *Studies in Health Technology and Informatics*, 217, 63–70. <https://pubmed.ncbi.nlm.nih.gov/26294454/>
- Deilen, S. (2020). Visual segmentation of compounds in easy language: Eye movement studies on the effects of visual, morphological, and semantic factors on the processing of German noun-noun compounds. In S. Hansen-Schirra & C. Maaß (Eds.), *Easy language research: Text and user perspectives* (pp. 241–256). Frank & Timme.
- Deilen, S., & Schiffel, L. (2020). Using eye-tracking to evaluate language processing in the easy language target group. In S. Hansen-Schirra & C. Maaß (Eds.), *Easy language research: Text and user perspectives* (pp. 273–281). Frank & Timme.
- Del Cueto, J., Conte, N. B., Parellada, C., & Roldan, L. A. (2019). Validación de un screening académico Para evaluar la comprensión lectora: Estudio piloto. In *XI Congreso Internacional de Investigación y Práctica Profesional en Psicología*. <https://www.aacademica.org/000-111/120>
- Denzen, E. M., Santibáñez, M. E., Moore, H., Foley, A., Gersten, I. D., Gurgol, C., Majhail, N. S., Spellecy, R., Horowitz, M. M., & Murphy, E. A. (2012). Easy-to-read informed consent forms for hematopoietic cell transplantation clinical trials. *Biology of Blood and Marrow Transplantation*, 18(2), 183–189. <https://doi.org/10.1016/j.bbmt.2011.07.022>.
- Department of Health. (2010). *Making written information easier to understand for people with learning disabilities: Guidance for people who commission or produce easy read information*.
- D'Mello, S. K., Southwell, R., & Gregg, J. (2020). Machine-learned computational models can enhance the study of text and discourse: A case study using eye tracking to model reading comprehension. *Discourse Processes*, 57(5–6), 420–440. <https://doi.org/10.1080/0163853X.2020.1739600>.
- Duchowski, A. T. (2007). *Eye tracking methodology: Theory and practice*. Springer.
- Dye, L., Hare, D. J., & Hendy, S. (2004). Capacity to consent to participate in research: A reconceptualisation. *British Journal of Learning Disabilities*, 31(1), 1–7. <https://doi.org/10.1111/j.1468-3156.2004.00262.x>.
- Everatt, J., & Underwood, G. (1994). Individual differences in reading subprocesses: Relationships between reading ability, lexical access, and eye movement control. *Language and Speech*, 37(3), 283–297. <https://doi.org/10.1177/002383099403700305>.
- Faber, M., Bixler, R., & D'Mello, S. K. (2018). An automated behavioral measure of mind wandering during computerized reading. *Behavior Research Methods*, 50(1), 134–150. <https://doi.org/10.3758/s13428-017-0857-y>.
- Fajardo, I., Ávila, V., Ferrer, A., Tavares, G., Gómez, M., & Hernández, A. (2014). Easy-to-read texts for students with intellectual disability: Linguistic factors affecting comprehension. *Journal of Applied Research in Intellectual Disabilities*, 27(3), 212–225. <https://doi.org/10.1111/jar.12065>.
- Fehlmann, B., Coynel, D., Schickantz, N., Milnik, A., Gschwind, L., Hofmann, P., Papassotiropoulos, A., & de Quervain, D. J. (2020). Visual exploration at higher fixation frequency increases subsequent memory recall. *Cerebral Cortex Communications*, 21(1). <https://doi.org/10.1093/texcom/tgaa032>.
- Ferreres, A., Abusamra, V., Casajús, A., Cartoceti, R., Squillace, M., & Sampedro, B. (2009). Pruebas de screening Para la evaluación de la comprensión de textos. *Neuropsicología Latinoamericana*, 1(1), 41–56.
- García Muñoz, Ó. (2012). *Lectura fácil: Métodos de redacción y evaluación*. Real Patronato sobre Discapacidad.
- Gonzalez-Sanchez, J., Baydogan, M., Chavez-Echeagaray, M. E., Atkinson, R., & Burleson, W. (2017). Affect measurement: A roadmap through approaches, technologies, and data analysis. In M. Jeon (Ed.), *Emotions and affect in human factors and human-computer interaction* (pp. 255–288). Elsevier. <https://doi.org/10.1016/B978-0-12-801851-4.00011-2>
- González-Sordé, M., & Matamala, A. (2023). *Empirical evaluation of easy language recommendations: A systematic literature review from journal research in Catalan, English, and Spanish*. Universal Access in the Information Society. <https://doi.org/10.1007/s10209-023-00975-2>.

- Guo, D., McTigue, E. M., Matthews, S. D., & Zimmer, W. (2020). The impact of visual displays on learning across the disciplines: A systematic review. *Educational Psychology Review*, 32, 627–656. <https://doi.org/10.1007/s10648-020-09523-3>.
- Hannus, M., & Hyönä, J. (1999). Utilization of illustrations during learning of science textbook passages among low- and high-ability children. *Contemporary Educational Psychology*, 24(2), 95–123. <https://doi.org/10.1006/ceps.1998.0987>.
- He, W., Garrido, M. I., Sowman, P. F., Brock, J., & Johnson, B. W. (2015). Development of effective connectivity in the core network for face perception. *Human Brain Mapping*, 36(6), 2161–2173. <https://doi.org/10.1002/hbm.22762>.
- Hibbing, A. N., & Rankin-Erickson, J. L. (2003). A picture is worth a thousand words: Using visual images to improve comprehension for middle school struggling readers. *The Reading Teacher*, 56 758–770.
- Hurtado, B., Jones, L., & Burniston, F. (2014). Is easy read information really easier to read? *Journal of Intellectual Disability Research*, 58(9), 822–829. <https://doi.org/10.1111/jir.12097>.
- Inhoff, A. W., & Rayner, K. (1986). Parafoveal word processing during eye fixations in reading: Effects of word frequency. *Perception & Psychophysics*, 40(6), 431–439. <https://doi.org/10.3758/BF03208203>.
- International Organization for Standardization. (2023). *ISO/IEC DIS 23859:2023: Information technology—User interfaces—Requirements and recommendations on making written text easy to read and understand*. ISO.
- Jones, F. W., Long, K., & Finlay, W. M. L. (2007). Symbols can improve the reading comprehension of adults with learning disabilities. *Journal of Intellectual Disability Research*, 51(7), 545–550. <https://doi.org/10.1111/j.1365-2788.2006.00926.x>.
- Just, M. A., & Carpenter, P. A. (1980). A theory of reading: From eye fixations to comprehension. *Psychological Review*, 87(4), 329–354. <https://doi.org/10.1037/0033-295X.87.4.329>.
- Kazem, A. M., Alzubaidi, A. S., Yousif, Y. H., Aljamali, F. A., Al-Mashhdany, S. I., Alkharusi, H. A., Al-Busaidi, O. B., Alsarmi, A. M., Al-Bulushi, S. S., Al-Bahrani, W. A., & Al-Fori, S. M. (2007). Psychometric properties of Raven's Colored progressive matrices for Omani children aged 5 through 11 years. *Social Behavior and Personality*, 35(10), 1385–1398. <https://doi.org/10.2224/sbp.2007.35.10.1385>.
- Krejtz, K., Duchowski, A. T., Krejtz, I., Kopacz, A., & Chrzastowski-Wachtel, P. (2016). Gaze transitions when learning with multimedia. *Journal of Eye Movement Research*, 9(1). <https://doi.org/10.16910/jemr.9.1.5>.
- Kwak, S. K., & Kim, J. H. (2017). Statistical data preparation: Management of missing values and outliers. *Korean Journal of Anesthesiology*, 70(4), 407–411. <https://doi.org/10.4097/kjae.2017.70.4.407>.
- Levie, W. H., & Lentz, R. (1982). Effects of text illustrations: A review of research. *Educational Technology Research and Development*, 30, 195–232. <https://doi.org/10.1007/BF02765184>.
- Lindholm, C., & Vanhatalo, U. (2021). *Handbook of easy languages in Europe*. Frank & Timme.
- Matamala, A. (2022). Easy-to-understand language in audiovisual translation and accessibility: State of the art and future challenges. *XLinguae*, 15(2), 130–144. <https://doi.org/10.18355/XL.2022.15.02.10>.
- Mayer, R. E. (2014). *The Cambridge handbook of multimedia learning*. (2nd ed.). Cambridge University Press.
- Mézière, D. C., Yu, L., Reichle, E. D., der Malsburg, T., & McArthur, G. (2023). Using eye-tracking measures to predict reading comprehension. *Reading Research Quarterly*, 58, 425–449. <https://doi.org/10.1002/rrq.498>.
- Morton, J. (1969). Interaction of information in word recognition. *Psychological Review*, 76(2), 165–178. <https://doi.org/10.1037/h0027366>.
- Nomura, M., Nielsen, G., & Tronbacke, B. (2010). *Guidelines for easy-to-read materials*. International Federation of Library Associations and Institutions (IFLA).
- Orduna-Hospital, E., Hernández-Aranda, D., & Sanchez-Cano, A. (2023). Ocular motility patterns in intellectual disability: Insights from the developmental eye movement test. *Life*, 13(12). <https://doi.org/10.3390/life13122360>.
- Paeye, C., & Madelain, L. (2011). Reinforcing saccadic amplitude variability. *Journal of the Experimental Analysis of Behavior*, 95(2), 149–162. <https://doi.org/10.1901/jeab.2011.95-149>.
- Perego, E. (2020). *Accessible communication: A cross-country journey*. Frank & Timme.
- Plena Inclusión. (2021). ¿Cómo usamos las imágenes en la lectura fácil? <https://www.plenainclusion.org/noticias/como-usamos-las-imagenes-en-la-lectura-facil/>
- Poncelas, A., & Murphy, G. (2007). Accessible information for people with intellectual disabilities: Do symbols really help? *Journal of Applied Research in Intellectual Disabilities*, 20(5), 466–474. <https://doi.org/10.1111/j.1468-3148.2006.00334.x>.

- Queiroz-Garcia, I., Espirito Santo, H., & Pires, C. (2021). Propriedades psicométricas da forma geral das Matrizes Progressivas de Raven numa amostra Portuguesa. *Revista Portuguesa de Investigação Comportamental e Social*, 7(1), 84–101. <https://doi.org/10.31211/rpics.2021.7.1.210>.
- Raven, J. C. (1998). *Raven's progressive matrices*. Pearson Clinical.
- Rayner, K. (1998). Eye movements in reading and information processing: 20 years of research. *Psychological Bulletin*, 124(3), 372–422. <https://doi.org/10.1037/0033-2909.124.3.372>.
- Rayner, K., Chace, K. H., Slattery, T. J., & Ashby, J. (2006). Eye movements as reflections of comprehension processes in reading. *Scientific Studies of Reading*, 10(3), 241–255. https://doi.org/10.1207/s1532799xssr1003_3.
- Rayner, K., Pollatsek, A., Ashby, J., & Clifton, C. (2011). *Psychology of reading*. Psychology Press.
- Reichle, E. D., Livergood, S. P., Drieghe, D., Blythe, H. I., Joseph, H. S., White, S. J., & Rayner, K. (2013). Using EZ reader to examine the concurrent development of eye-movement control and reading skill. *Developmental review*, 33(2), 110–149. <https://doi.org/10.1016/j.dr.2013.03.001>.
- Rivero Contreras, M., Engelhardt, P. E., & Saldaña Sage, D. (2023). Do easy-to-read adaptations really facilitate sentence processing for adults with a lower level of education? An experimental eye-tracking study. *Learning and Instruction*, 84. <https://doi.org/10.1016/j.learninstruc.2022.101731>.
- Rivero-Contreras, M., Engelhardt, P. E., & Saldaña, D. (2021). An experimental eye-tracking study of text adaptation for readers with dyslexia: Effects of visual support and word frequency. *Annals of Dyslexia*, 71, 170–187. <https://doi.org/10.1007/s11881-021-00217-1>.
- Rivero-Contreras, M., & Saldaña, D. (2020). ¿Legibilidad es sinónimo de comprensión en Lectura Fácil? Una revisión de estudios sobre comprensión lectora en textos adaptados o simplificados y su calidad metodológica. In A. E. Díez Mediavilla & R. Gutiérrez Fresneda (Coords.), *Lectura y dificultades lectoras en el siglo XXI* (pp. 714–728). Octaedro.
- Saletta, M., Kaldenberg, E., Rivera, K., & Wood, A. (2019). Do illustrations promote reading comprehension in adults with intellectual or developmental disabilities? *Education and Training in Autism and Developmental Disabilities* 54(3), 225–236. <https://www.jstor.org/stable/26780623>
- Schatz, T., Haberstroh, J., Bindel, K., Oswald, P., Pantel, J., Paulitsch, M., Konopik, N., & Knopf, M. (2017). Improving comprehension in written medical informed consent procedures. *GeroPsych: The Journal of Gerontopsychology and Geriatric Psychiatry*, 30(3), 97–108. <https://doi.org/10.1024/1662-9647/a000169>.
- Schiff, L. (2020). Easy language research: Text and user perspectives. In S. Hansen-Schirra & C. Maaß (Eds.), *Easy language research: Text and user perspectives* (pp. 227–239). Frank & Timme.
- Skversky-Blocq, Y., Shmuel, S., Cohen, O., & Shechner, T. (2022). Looking fear in the face: Adults but not adolescents gaze at social threat during observational learning. *International Journal of Psychophysiology*, 182, 240–247. <https://doi.org/10.1016/j.ijpsycho.2022.11.004>.
- Social Care Institute for Excellence. (2005). *How to produce information in an accessible way (social care accessibility guidelines)*. NHS England
- Southwell, R., Gregg, J., Bixler, R., & D'Mello, S. K. (2020). What eye movements reveal about later comprehension of long connected texts. *Cognitive Science*, 44(10), 1–24. <https://doi.org/10.1111/cogs.12905>.
- Sung, E., & Mayer, R. E. (2012). When graphics improve liking but not learning from online lessons. *Computers in Human Behavior*, 28(5), 1618–1625. <https://doi.org/10.1016/j.chb.2012.03.026>.
- Sutherland, R. T., & Isherwood, T. (2016). The evidence for easy-read for people with intellectual disabilities: A systematic literature review. *Journal of Policy and Practice in Intellectual Disabilities*, 12(4), 297–310. <https://doi.org/10.1111/jppi.12201>.
- Sweller, J., van Merriënboer, J. J. G., & Paas, F. G. W. C. (1998). Cognitive architecture and instructional design. *Educational Psychology Review*, 10, 251–296. <https://doi.org/10.1023/A:1022193728205>.
- Van Gog, T., Ericsson, K. A., & Rikers, R. M. J. P. (2005). Instructional design for advanced learners: Establishing connections between the theoretical frameworks of cognitive load and deliberate practice. *Educational Technology Research and Development*, 53, 73–81. <https://doi.org/10.1007/BF02504799>.
- Vidal, L. (2021). *La Mirada Tàctil. Versió LF: Llocs d'interès de Rupit i Pruit*. Oficina de Patrimoni Cultural, Diputació de Barcelona, Ajuntament de Rupit i Pruit.
- Wadihah, H., & Fauzi, A. (2021). Using image media on reading text to improve reading comprehension of students with intellectual disabilities. *Jurnal Asesmen dan Intervensi Anak Berkebutuhan Khusus*, 21(1).
- Wang, Y., & Sparks, B. A. (2016). An eye-tracking study of tourism photo stimuli: Image characteristics and ethnicity. *Journal of Travel Research*, 55(5), 588–602. <https://doi.org/10.1177/0047287514564598>.

- Warburg, M. (2001). Visual impairment in adult people with intellectual disability: Literature review. *Journal of Intellectual Disability Research*, 45(5), 424–438. <https://doi.org/10.1046/j.1365-2788.2001.00348.x>.
- Whaley, C. P. (1978). Word-nonword classification time. *Journal of Verbal Learning and Verbal Behavior*, 17(2), 143–154. [https://doi.org/10.1016/S0022-5371\(78\)90110-X](https://doi.org/10.1016/S0022-5371(78)90110-X).
- White, H., Heck, A., Jubran, R., Chroust, A., & Bhatt, R. S. (2022). Average fixation duration in infancy: Stability and predictive utility. *Infancy: The Official Journal of the International Society on Infant Studies*, 27(5), 866–886. <https://doi.org/10.1111/infa.12483>.
- Yaneva, V., Temnikova, I., & Mitkov, R. (2016). Accessible texts for autism: An eye-tracking study. In *ASSETS 2015, the 17th international ACM SIGACCESS conference on computers and accessibility* (pp. 49–57). <https://doi.org/10.1145/2700648.2809852>
- Zhao, F., Schnotz, W., Wagner, I., & Gaschler, R. (2014). Eye-tracking indicators of reading approaches in text-picture comprehension. *Frontline Learning Research*, 2(5), 46–66. <https://doi.org/10.14786/flr.v2i4.98>.

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Annex 9. Published articles within this dissertation: Article 3

Screen reader users, please refer to Chapter 4.

Parallèles

Null and overt pronouns and subordinate clauses in Catalan Easy Language: An eye-tracking study on adults with and without intellectual disabilities

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Abstract

Easy Language guidelines discourage the use of full overt pronouns and subordinate clauses. This study examines how manipulating these linguistic elements influences perceived reading difficulty, reader preference, and the cognitive effort involved in text processing. We also assessed the effects of null and overt pronouns on content comprehension. 26 adults with intellectual disabilities and 26 neurotypical adults participated in a mixed-design experiment involving two reading tasks. For both tasks, we recorded participants' eye movements while they rated the perceived difficulty and reported their preference. Additionally, Task 1 included open-ended comprehension questions. The linguistic elements only had significant effects on fixation patterns and focal attention. Crucially, they did not significantly alter perceived text difficulty. These findings suggest that including subordinate clauses does not significantly hinder comprehension. However, further research is essential to guide the future development of Easy Language, as evidence is still limited regarding its additional linguistic and graphic features and the needs of different target groups.

Keywords

Easy Language, eye tracking, intellectual disability, pronouns, subordinate clauses, accessibility

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1. Introduction

Usability and accessibility in communication depend heavily on how understandable the content is, and this can be markedly improved through text simplification methods (Saggion et al., 2011; Perego, 2020). Historically, cognitive barriers have received less scholarly attention than physical or sensorial ones (Alarcon et al., 2019). However, the field is evolving, with growing interest in cognitive accessibility among researchers and policymakers, leading to new developments and practices in the field.

To contribute to this expanding area of research, this article details the research undertaken to address this topic. We will begin by outlining key concepts related to this study and the research performed in the area. Next, we will review relevant prior research, followed by the presentation of our hypotheses, study design, and methodology. Finally, we will present the results, discuss their implications, and conclusions.

2. Related work

This section reviews the main literature relevant to the present study. It first introduces the concept of Easy Language. Then, it focuses on specific linguistic features that are central to this research (null and overt pronouns, and subordinate clauses), describing how they are used in Catalan and how they are addressed in Easy Language recommendations. Finally, the section outlines the research background that informs this study, identifying areas where further investigation is needed.

2.1. Easy Language

Easy Language (EL) is a language variety that adapts texts at both the linguistic and graphic levels to make information accessible to people who may have trouble reading and understanding standard language (ISO, 2021, p. 2).

In the Catalan context, we can refer to the Inclusion Europe (Inclusion Europe, 1998) or International Federation of Library Associations and Institutions (IFLA, 2012) guidelines. The Spanish Association for Standardisation published a standard (UNE, 2018) that is the main guide for EL practice in Spain, and which is also used as a guide for practice in Catalonia. Although Catalonia and Spain are relatively advanced in terms of EL literature for practitioners, these guidelines have notable shortcomings. For example, the existing literature primarily relies on intuition about text accessibility (Maaß, 2020) and findings from previous studies focused on isolated linguistic elements (Hansen-Schirra et al., 2020). This content therefore often lacks grounding in empirical studies that measure the effects of complexity reduction on cognitive processing in EL texts.

Empirical evidence is therefore needed to determine which adaptations should be recommended in the guidelines (Lindholm & Vanhatalo, 2021, p. 15; Sutherland & Isherwood, 2016, pp. 297-298). The IFLA guidelines for EL in Catalan state: “more scientific research is needed on reading difficulties and the concept of Easy Language” (IFLA, 2012, p. 41). In essence, although research in this field has grown in the past years, it is still not sufficient, as recent literature reviews have suggested (Sutherland & Isherwood, 2016; González-Sordé & Matamala, 2023) and as shown in §2.2.2.

2.1.1. Ellipses and co-reference through null and overt pronouns

Catalan is a null-subject language or pro-drop language (Pérez & Mestre, 2022; Mayol & Clark, 2010). Subjects are omitted more often than objects in several typologically diverse languages (Allen, 2000; Serratrice et al., 2004). In Catalan, it is common to find the subject of the sentence being omitted once it is considered that it can be easily inferred, as exemplified in Table 1. This

occurrence is called “null subject” (Mayol & Clark, 2010). In a broader sense, when a pronoun (subject or not) is omitted for the same reason, it is a “null pronoun” (Mayol & Clark, 2010).

Coherent discourse often includes the repetition of certain concepts. One example of this are anaphors, which are “referential expressions that co-refer with an antecedent found earlier in the same discourse” (Ducrot & Todorov, 2003, p. 323). As it can be observed in Table 1, Catalan regularly uses pronouns as co-referents for different elements of the sentence (IEC, 2022). Some high-frequency overt pronouns are subject pronouns (“*ell, ella, ells, elles*”), direct object pronouns (“*el, la, els, les*”), as well as “*li*” (singular indirect object pronoun), “*en*” and “*hi*” (unstressed or weak pronouns, called “*pronoms febles*” in Catalan).

Null pronoun	Overt pronoun
<i>The omission of the null pronoun (in this case, a null subject) is marked with [NULL] in the position where an overt subject would normally appear.</i>	<i>The position of the overt pronoun in Catalan is marked as [OVERT] in the English translation, since the pronoun used in the example (“li”) has no direct equivalent in English.</i>
[Catalan] La Laura va al mercat cada matí. Avui, [NULL] ha comprat taronges.	[Catalan] La Laura ha comprat taronges. Li agraden molt.
[English] Laura goes to the market every morning. Today, [NULL] bought oranges.	[English] Laura bought oranges. [OVERT] likes them very much.

Table 1. Examples of null and overt pronouns

2.1.2. Subordinate clauses

A subordinate clause does not form a simple sentence by itself and is connected to the main clause of a sentence (Merriam-Webster Dictionary, 2024). Substantive clauses and relative clauses are types of subordinate clauses. As Table 2 illustrates, substantive clauses perform one of the syntactic functions typically associated with a noun phrase, while relative clauses modify the preceding noun or noun phrase (IEC, 2022).

Substantive clause	Relative clause
[Catalan] M’ha dit que vindrà a la tarda .	[Catalan] L’home que venia cada tarda a la biblioteca fa molts dies que no ve.
[English] NULL told me that NULL will come in the afternoon .	[English] The man that came to the library every afternoon has not come for a few days.

Table 2. Examples of subordinate clauses

2.1.3. Ellipses, co-reference and subordinate clauses in Easy Language guidelines

The linguistic elements presented (null and overt pronouns, subordinate clauses) are frequent features of standard Catalan, yet their use is discouraged in EL guidelines. To exemplify this, Table 3 presents extracts from the UNE standard on EL (UNE, 2018), as these are the guidelines relevant in both Spanish and Catalan contexts. Nevertheless, the same suggestions are phrased differently in the ISO standard (ISO, 2021).

Recommendations in the UNE standard	Discouraged linguistic aspects
“Elliptical constructions should not be used. The reader should not have to make inferences. In any case, omissions should be minimal, and referential identification should be guaranteed. (INCORRECT) Juan bought 2 balls. One for himself and another for his nephew. (CORRECT) Juan bought 2 balls. One ball is for himself, and the other is for his nephew.” (UNE, 2018, p. 23)	Null and overt pronouns
“The reader should not have to make inferences to understand the text.” (UNE, 2018, p. 24)	Null and overt pronouns
“The same word must be used throughout the text to refer to the same object or referent.” (UNE, 2018, p. 20)	Overt pronouns
“Simple sentences should be used, and complex sentences should be avoided. If in some cases they cannot be avoided, it is advisable to separate the ideas into different lines. [...] NOTE 2: Subordinate clauses can be used, but with moderation and linked with conjunctions commonly used in spoken language.” (UNE, 2018, p. 22)	Subordinate clauses

Table 3. Recommendations that refer to the linguistic elements assessed in the study

In summary, EL recommendations advise against co-referencing and using ellipses, elements that force the reader to make inferences. Subordinate clauses and other complex sentences should also be kept to a minimum, in favour of simple sentences.

2.2. Research background

Since only a small number of studies have addressed EL directly (González-Sordé & Matamala, 2023), most research on the linguistic elements and measures relevant to our work come from other contexts. Moreover, no studies have focused on Catalan EL to date.

2.2.1. Relevant linguistic research

Given the lack of research on the linguistic features of EL on readers with intellectual disabilities, empirical studies are essential. A study by Fajardo et al. (2014) assessed linguistic aspects of EL, including the effect of co-referential and inferential information, on students with intellectual disabilities (ID). Participants, aged between 16 and 22 ($M = 18.9$, $SD = 1.84$), read EL texts and then performed a reading comprehension test. The study found that the only linguistic feature that was a good predictor of inferential comprehension was the number of sentences. The higher the sentence density, the lower the ability of students with an ID to find relationships between sentences (Fajardo et al., 2014, p. 221). This finding may reflect the reduced ability of students with an ID to effectively store and retrieve information from memory (Wolman, 1991). Other linguistic aspects analysed, such as word frequency and word length, showed no significant effect on comprehension. The authors argue that these results could question the validity of some EL recommendations, such as that of “augmenting word frequency” (Fajardo et al., 2014, p. 212).

While Fajardo et al. focus on word frequency and word length, other research has considered pronominal structures, particularly in pro-drop languages, although they are mostly performed on children (Grinstead et al., 2018; Dickinson et al., 2023; Mazzagio & Shield, 2020). Grinstead et al. (2018) argued that the presence of null subjects reflects the challenges Spanish-speaking children with specific language impairments face in acquiring discourse-sensitive constructions. More recently, Dickinson et al. (2023) reported that Spanish children with developmental language disorders use overt subject pronouns less frequently than their typically developing peers in switch-reference contexts, that is, when the subject of the prior finite verb differs from the subject of the current clause. In related work, Mazzagio and Shield (2020) observed that Italian children with autism spectrum disorder (ASD) showed lower accuracy than typically developing children in producing first-, second-, and third-person singular pronouns. These children often substituted nouns or proper names for pronouns, and in marked contexts they displayed a preference for overt pronouns over null pronouns.

On a different note, Loureda et al. (2024) performed an eye-tracking study on neurotypical adults and found that reading times were higher when the co-referent was an overt pronoun than when the element was repeated. For those elements that can be omitted, they found that null pronouns showed lower reading times than overt pronouns (Loureda et al., 2024; Gelormini & Almor, 2011). This could suggest that the presence of null pronouns facilitates reading. Nevertheless, their participant pool did not include the EL target audience, and reading time was shown to be an inconsistent predictor of text comprehension (Wallot et al., 2014).

Finally, few studies have focused on the processing of subordinate clauses. In this regard, studies on neurotypical English-speaking adults showed that working memory plays a significant role in relative clause processing difficulty through reading tasks in which eye movements (Staub, 2010) and comprehension (Roland et al., 2021) were measured. The frequency of the relative embedded clause¹ also affects relative clause processing, as argued in a corpus analysis by Real and Christiansen (2007).

2.2.2. Empirical research on EL and the case of German Easy Language

Research on EL remains generally limited, with the notable exception of German EL. González-Sordé and Matamala (2023) highlight that while some empirical studies exist, overall, the field lacks sufficient publications and broadly applicable results. Still, several studies in different contexts shed light on how EL adaptations can influence comprehension.

Frondeen and Kaakinen (2023) used eye-tracking to study how adults with ID read Swedish EL texts. They found that short, frequent words were read more quickly, while long, infrequent words caused difficulties. However, the small sample size and lack of comparison with neurotypical readers limit the generalisability of these results. In the Spanish context, Fajardo et al. (2013) showed that simplified news texts supported students with mild ID, particularly for literal comprehension. Interestingly, reducing coreferences improved performance, while denser texts hindered inferential comprehension.

Other studies extend the scope beyond the group of users with an ID. Rivero-Contreras et al. (2021) tested visual support and lexical simplification with young adults with and without dyslexia. Both adaptations aided sentence processing, especially for those with lower print exposure and smaller vocabularies. Similarly, Schmutz et al. (2019) examined EL on web usability on neurotypical users. Despite enhanced content recognition, the EL versions were associated with longer reading times, reduced preference ratings, and a decreased likelihood of revisiting

¹ Subordinate clause provides additional information about a noun and is integrated into the main sentence, often modifying a specific element within it.

the webpage, highlighting that improvements for certain users may impose disadvantages on others. Finally, Buell et al. (2020) explored health information comprehension among adults with IDs, focusing on simplified language and mediation. Although neither factor alone improved understanding, combining both produced better results. Their findings suggest that comprehension relies not only on textual form but also on individual language-processing capacities.

In contrast, and as mentioned earlier, EL in Germany has a well-established research tradition and strong legal support. Under German law (BITV 2.0, 2011), German EL is the preferred means of providing accessible written information. Since 2010, it has been the subject of extensive scientific investigation, particularly by the research group Simply Complex – Easy Language, which has applied methods such as eye-tracking and functional MRI to evaluate and refine EL guidelines. Unlike in other variants, German EL is not only guided by practical recommendations but also by rulebooks validated through interdisciplinary research at the University of Hildesheim, where the Research Centre for Easy Language was founded in 2014. Several studies have offered important insights. Pappert and Bock (2020) confirmed that segmenting compound nouns improved reading performance for adults with ID. Schiffli (2020) compared readers with cognitive impairments to neurotypical readers and found no significant differences in how word frequency, length, and repetition influenced comprehension, suggesting that such factors affect both groups in similar ways.

Despite these advances, studies with individuals with cognitive or sensory impairments remain difficult due to ethical concerns and informed consent requirements. For this reason, most research has relied on eye-tracking (e.g., Gutermuth, 2020), though even this method poses challenges when working with participants with an ID (Deilen & Schiffli, 2020). As these participants often struggle with instructions or communication, their participation requires careful adjustments in study design and implementation, along with sensitivity to ethical issues (Deilen & Schiffli, 2020; Borghardt et al., 2021; Csákvári & Gyori, 2015).

3. Hypotheses

Drawing on the reviewed literature and related work in the field, the present study examines how specific linguistic features of Catalan that are unadvised in EL guidelines, namely null and overt pronouns and subordinate clauses, influence reading comprehension, perceived difficulty, preference, and cognitive effort among adults with and without ID. The following hypotheses are proposed:

H1. The presence of null and overt pronouns makes the text harder to understand for people with an ID.

H2a. People with an ID perceive texts with null and overt pronouns as more difficult to understand and prefer texts without these elements.

H2b. People with an ID perceive texts with subordinate clauses as more difficult to understand and prefer texts without these elements.

H3a. The presence of null and overt pronouns affects the cognitive effort required for text processing.

H3b. The presence of subordinate clauses affects the cognitive effort required for text processing.

4. Study design

We tested these hypotheses across two reading tasks performed in one session. Task 1 focused on null and overt pronouns while Task 2 focused on the presence of subordinate clauses. We

designed a mixed-design experimental study in which we manipulated independent variables within subjects (absence/presence of the linguistic element). The grouping of participants (ID/neurotypical) was a second main independent variable.

Both tasks measured (1) the cognitive effort of text processing (through eye-tracking), (2) perceived text difficulty (through self-reported questions answered through Likert-type scales), and (3) text preference (through open-ended questions). Task 1 assessed one additional measure: the comprehension of the content through open-ended questions. In Task 2, this type of question was not included because the texts used in this experiment were significantly shorter, making it more difficult to assess content comprehension through such questions. Additionally, this decision was made to reduce the risk of participant fatigue, particularly among those in the group with an ID (Deilen & Schiff, 2020).

It is worth mentioning that we performed a pilot test beforehand with 6 neurotypical participants (average age of 28.5; 5 women and 1 man) which allowed us to make minor adjustments to the stimuli and questions.

5. Method

The study protocol (CEEAH CA40) was approved by Universitat Autònoma de Barcelona in February 2022. The following section outlines the methodological framework, detailing the procedures and tasks included in the study.

5.1. Participants

We initially aimed for 30 participants in each group, however, four users in the group with an ID had to be excluded due to issues with eye-tracking calibration or data collection (a common issue, as presented in Deilen & Schiff, 2020). The final sample consists of 52 participants (23 men and 29 women; mean age 39.9, $SD = 14.5$), of which 26 have an ID and 26 are neurotypical. The participants with an ID (12 men and 14 women; mean age 44.4, $SD = 13.2$) were recruited through two local non-profit organisations (Som — Fundació, Taller Jeroni de Moragas). The neurotypical participants (11 men and 15 women; mean age 34.8, $SD = 11.5$) were recruited via word-of-mouth. The two groups did not differ significantly in terms of age ($t(25) = 1.276$, $p = 0.213$). Participation was voluntary and unpaid, all participants were Catalan speakers with normal or corrected-to-normal vision, and their identifying data remains confidential.

The formal diagnosis of ID was not requested from the participants. Having an ID was a requirement to be a beneficiary of the collaborating foundations, and this condition was considered sufficient to fulfil the diagnostic criteria. It was verified that none of them had an intelligence level or reading comprehension that significantly deviated from the group using two screening tests (see the results in section 6.1).

5.2. Procedure

Participants first provided written informed consent and completed a demographics form, after which they were encouraged to ask questions or express any concerns. Next, they took part in the reading comprehension screening test (TLC) (Comes, 1990) and the abstract reasoning screening test (Raven's Progressive Matrices [RPM]) (Raven, 1998) in a small group setting. Subsequently, participants completed reading Tasks 1 and 2 in a separate room, accompanied only by the observing researcher. For participants with ID, these two sessions were held on separate days to minimise fatigue (Deilen & Schiff, 2020) and allow additional time for clarification and support. In contrast, neurotypical participants completed both sessions on the same day.

For Tasks 1 and 2, participants were seated in front of a computer screen and asked to focus on various points on the screen to calibrate the eye-tracker. After each page of stimuli, participants answered either open-ended comprehension questions (for Task 1) or questions about perceived text difficulty (for both Tasks 1 and 2) orally. To reduce memory bias and because the goal was not to assess memory or retrieval, participants were allowed to re-read the text before answering the questions. At the end of each task, participants were asked about their preferred text style.

Task 1 lasted around 15 minutes and for each participant we retrieved a maximum of 13 minutes of recorded eye movements (around 3 minutes per page of stimuli). Task 2 lasted around 20 minutes and for each participant we retrieved a maximum of 17 minutes of recorded eye movements (around 2 or 3 minutes per page of stimuli). The recording of eye movements was paused while the participants answered the perceived difficulty, preference, and comprehension questions and the researcher registered the oral answers in their computer.

Eye-tracking raw data were pre-processed using the vendor's software to identify fixations and saccades. Prior to the main analyses, we examined individual fixation durations and saccadic amplitudes for outliers, using the criterion $\pm 1.58 \times \text{IQR} / \sqrt{n}$, where IQR denotes the interquartile range (Chambers, 1983). All outlying values (both fixation durations and saccadic amplitudes) were replaced with the nearest non-outlying value (i.e., the respective maximum or minimum; Wickham et al., 2025). Data cleaning and statistical analyses were conducted in R (R Core Team, 2025).

5.3. Materials

5.3.1. Stimuli

The stimuli in Task 1 included 4 short Brothers Grimm tales taken from a published Catalan EL adaptation (Grimm & Grimm, 2018) that had been validated by the target group of EL, and the texts used did not contain low-frequency words. All the pages shown (four to each participant) had a similar text length (between 75 and 100 words; and between 9 and 12 lines). For Task 1, all texts scored between 87 and 99 (mean = 93.5) on the Fernández Huerta readability index, indicating that they are “easy” (80-89) or “very easy” (90-99) and that they could be suitable for neurotypical children aged 9 to 11. Notably, texts with and without pronouns scored almost identically in terms of readability.

In Task 2, we showed participants 6 short texts on health recommendations for people living in Barcelona, taken from a published booklet in Catalan EL (Agència de Salut Pública, 2023) validated by the target group of EL. The texts also contained no low-frequency words. All the pages shown (six to each participant) had a similar text length (between 35 and 45 words; and between 4 and 7 lines). For Task 2, all texts scored between 73 and 99 on the Fernández Huerta readability index ($M = 85.75$), suggesting they range from “somewhat easy” (70-79) to “easy” (80-89) and “very easy” (90-99). These texts are considered appropriate for neurotypical children aged 9 to 12. Interestingly, texts with and without subordinate clauses had very similar readability scores, with those containing subordinate clauses scoring slightly higher.

The pages shown in both tasks presented a similar structure and they all appeared in the centre of the screen. Sentences were presented in black 14-point Arial font on a white background, with double-spaced paragraphs.

We created a different version of the tale for each level of the independent variable: one version had null and object pronouns (in Task 1) or subordinate clauses (in Task 2). In the second version, all subjects were explicit and each referent was identified through one word (in Task 1) or the text only consisted of simple sentences (in Task 2), as per EL recommendations.

All participants read the texts in the same order but with differences in terms of the inclusion of the linguistic aspects assessed. Participants saw the same number of pages of each level of the independent variable (2 of each in Task 1, making a total of 4 pages; 3 of each in Task 2, making a total of 6 pages). This was achieved by creating two sets of stimuli for each reading task through a Latin square array.

5.3.2. Evaluation instruments

First, participants signed the consent form, which was written in EL and read aloud by the researcher, if requested by the participant. Then, they filled out the demographics form, where they reported their age, gender, whether they had any non-corrected vision problems, and whether they knew about EL. After that, we used a reading comprehension screening test (TLC) (Comes, 1990) and an intelligence and abstract reasoning screening test (Raven's Progressive Matrices [RPM]) (Raven, 1998) to collect data on these aspects for each participant. Both screening tests took about one hour per participant in total and were performed prior to the experiment. TLC and RPM were applied in group sessions, with the users answering the questions autonomously and individually. Participants answered in silence by circling the response on their piece of paper (both screening tests followed an "a, b, c" choice structure). All participants knew how to read autonomously, and they were always allowed to ask the researcher for assistance.

Task 1 assessed text comprehension using 12 low-difficulty, open-ended questions (three per page across four pages). These questions required participants to recall information directly from the text (Fajardo et al., 2014), specifically referents, subjects or objects. Participants completed the task individually, accompanied by the researcher, and answered the questions orally. An example is provided below.

Text A <i>Explicit referent; no null or overt pronouns.</i>	Text B <i>Null and overt pronouns.</i>
[Catalan] (...) Aleshores, una pagesa va passar pel carrer i va cridar: "venc melmelada!" El sastre va convidar la pagesa a pujar a casa. [English] (...) Then a peasant woman passed by on the street and shouted: "I'm selling jam!" The tailor invited the peasant woman up to the house.	[Catalan] (...) Aleshores, una pagesa va passar pel carrer i va cridar: "venc melmelada!" El sastre la va convidar a pujar a casa. [English] (...) Then a peasant woman passed by on the street and shouted: "I'm selling jam!" The tailor invited her up to the house.
Question: Who entered the tailor's house?	

Table 4. Extract from Task 1 stimuli and example of a comprehension question

Perceived difficulty was assessed in both tasks through a Likert scale (Yaneva et al., 2016), which presented options from 1 to 4 to avoid a neutral answer. Again, the participants answered these questions individually and orally:

Did you find the text difficult to read?

1) Not at all, it was easy. 2) Not very. 3) I struggled a little bit. 4) I struggled a lot.

Finally, participants were asked an open question on their preference at the end of both tasks

after being shown (1) a short text with null and full pronouns (Task 1) or with subordinate clauses (Task 2) and (2) another without those elements. Participants answered individually and orally to the question “which one of these pages do you prefer?”

5.3.3. Apparatus

Eye movements were recorded with a Tobii T60 (sampling rate of 60 Hz) in a desk monitor setup. Head movements were not restrained, although participants were instructed to stay still while completing the test. Viewing was binocular, and the movements of both eyes were recorded. Participants were seated approximately 60 cm away from the 43 cm diagonal display size monitor with a screen resolution of 1280 x 1024 pixels. The Tobii T60 eye tracker was controlled by a laptop computer, and another laptop computer was used to record the participant’s answers in a digital document.

5.4. Eye movements and eye-tracking measures

Eye movements are directly influenced by different text elements, like linguistic complexity, which “leads to increased fixation duration and decreased saccade length” (Borghardt et al., 2021, p. 4). Eye movements can be a useful indicator of the reader’s cognitive processes (e.g., Rayner, 1998), although they cannot be the only measure used when assessing text processing and reading comprehension (Boland, 2004) and should be combined with data retrieved through different methods (Van Gog et al., 2005). In our study, eye-tracking data is complemented with the results from the perceived difficulty and preference questions. Additionally, for the task on null and overt pronouns, it is complemented with results from comprehension questions.

Eye-tracking measures are categorised as either global or local, each serving distinct analytical purposes. While local measures (e.g., first-fixation duration) reveal detailed cognitive processes influenced by reading ability over small segments, global measures summarise reading behaviour over larger text segments like sentences and capture overall patterns, including differences between readers of varying skill levels (Mézière et al., 2023). Since global measures also predict reading comprehension (Southwell et al., 2020; D’Mello et al., 2020) and local measures have uncertain predictive value, our study focused on global measures. We analysed fixation count and average fixation duration, widely used indicators of cognitive processing effort (see, for example, Just et al., 1982), along with the *K* coefficient to assess the ambient and focal attention.

- Ambient/focal attention captured by the second-order metric; *K* coefficient of ambient-focal attention measures the dynamics of visual attention. A *K* below 0 indicates ambient processing, and one above 0 indicates focal processing (Krejtz et al., 2016; Krejtz et al., 2014). Ambient attention relates to awareness of the peripheral visual field, while focal attention allows individuals to perceive fine details in the central visual field. Focal processing reflects deeper attention and active information processing (Trevarthen, 1968; Eisenberg & Zacks, 2016). Research indicates that longer fixation durations and shorter saccade amplitudes are characteristic of focal vision (Helmert et al., 2005; Krejtz et al., 2012), which may indicate greater linguistic complexity (Borghardt et al., 2021, p. 4).
- Number of fixations refers to the total number of fixations in one area (Clifton et al., 2007; Duchowski, 2007) and a greater number of fixations indicates a need for more time to process text (Rodríguez et al., 2025). In the present study, we calculated the number of fixations for the whole text.
- Average fixation duration (in milliseconds) is the duration of a single fixation, on average (White et al., 2022; Duchowski, 2007). Slower cognitive processing tends to show longer

fixations (He et al., 2015; Borghardt et al., 2021). Rare or unfamiliar words, which lack stored entries in our mental lexicon, are processed through the slower sublexical route. This involves step-by-step decoding via grapheme-phoneme rules, making it more time-consuming than direct lexical access. As a result, long and uncommon words tend to produce the longest gaze times as they are harder to process (Tiffin-Richards & Schroeder, 2015).

We determined distinct areas of interest (AOIs) across the different pages of our stimuli (see Image 1). As pictured in the example in Image 1, our AOIs were drawn around each sentence. Working with texts in EL allowed us to make the AOIs also consist of one line of text, as the texts were structured with one unit of meaning or sentence per line, as recommended in the guidelines and standards (ISO, 2021; UNE, 2018). Everything outside of the AOIs was considered “whitespace”, as our stimuli only consisted of text.

The area designated as “whitespace” was included to track participants’ eye movements and gaze behaviour across the page (Bruckmaier et al., 2019). Other studies have included whitespace as part of the areas analysed to assess attention patterns (Kim et al., 2012; Wei et al., 2018). Previous research have used the gaze on whitespace as an indicator of cognitive effort (Ferreira et al., 2008; Renkewitz & Jahn, 2010; Scholz et al., 2018; Johansson et al., 2022). This is based on the idea that shifting one’s gaze away from the material aids in retrieving information held in short-term memory.

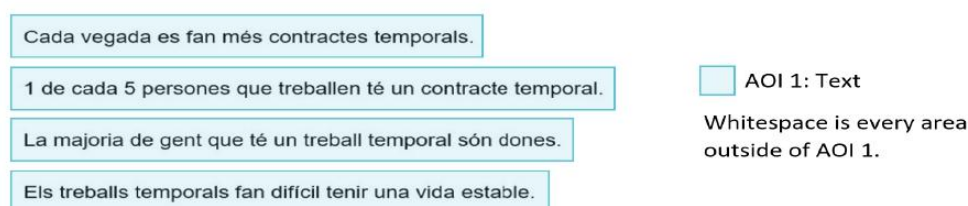


Image 1. Areas of interest in a page of stimuli from Task 2

6. Results

After reporting the results of the screening tests, results of Task 1 and Task 2 will be presented separately.

6.1. Screening tests

Screening tests confirmed that there were no intra-group outliers in the resulting data. Performance on the TLC reading comprehension test showed a significant difference: Participants with an ID achieved an average of 33.7% correct answers ($SE = 0.829$), while the neurotypical group scored 85.8% ($SE = 0.443$). This difference was significant, $t(52) = 17.198$, $p < 0.001$.

The ID group answered 62.9% of the questions correctly on the RPM test on abstract reasoning and intelligence ($SE = 1.604$), whereas the neurotypical group obtained 95.1% on the RPM ($SE = 0.374$). Again, the difference was statistically significant ($t(52) = 6.54$, $p < 0.001$).

6.2. Task 1: null and overt pronouns

First, we will present the results of the comprehension, perceived difficulty, and preference questions. Then, we will move on to the results of the eye-tracking metrics. The analysis of comprehension, perceived difficulty, and preference employed the two-way mixed-design (2 x

2 x 2) analysis of variance (ANOVA) followed by pairwise comparisons with Turkey's range test (HSD) correction for multiple comparisons if necessary.

The ANOVA on comprehension questions proved statistically significant for the main effects of the group ($F(1, 620) = 106.323, p < 0.001, \eta^2 = 0.145$), while neither the main effect of the presence of pronouns ($F(1, 620) = 0.102, p = 0.337, \eta^2 = 0.001$) nor the interaction term of both variables was statistically significant ($F(1, 620) = 1.437, p = 0.230, \eta^2 = 0.001$). When there were full and overt pronouns in the text, the group with an ID scored the lowest ($M = 67.94\%, SE = 0.025$).

The results on perceived text difficulty revealed that the group variable showed a significant effect ($F(1, 204) = 69.221, p < 0.001, \eta^2 = 0.248$), while the presence of pronouns ($F(1, 204) = 2.433, p = 0.120, \eta^2 = 0.008$) and the interaction of both of the variables ($F(1, 204) = 2.433, p = 0.120, \eta^2 = 0.008$) showed no significant effect on perceived difficulty. In general, the group with an ID perceived the texts as more difficult ($M = 1.94, SE = 0.109$) than the neurotypical group ($M = 1.03, SE = 0.018$).

Finally, the results of the preference questions showed no significant intra-group difference ($F(1, 150) = .266, p = 0.109, \eta^2 = 0.05$). Most participants in both groups (ID = 80.7%, neurotypical = 65.3%) showed no clear preference between a text with null and overt pronouns and without these elements.

6.2.1. Eye movements

A 2 (group: ID vs typical) x 2 (pronouns: included vs omitted) x 2 (AOI type: text vs whitespace) mixed design ANOVA was employed to analyse the eye-movement metrics (K coefficient, number of fixations, and average fixation duration).

Regarding differences in ambient and focal attention, there was a significant effect of group ($F(1, 50) = 9.05, p = 0.004, \eta^2 = 0.112$). The attention of the group with an ID was less ambient ($M = -0.039, SE = 0.065$) than the neurotypical group ($M = -0.328, SE = 0.07$). There was a significant effect of AOI type, ($F(1, 50) = 31.05, p < 0.001, \eta^2 = 0.020$). Not surprisingly, both groups were, on average, less ambient while reading text ($M = -0.078, SE = 0.05$) than when looking at whitespace ($M = -0.289, SE = 0.053$).

The interaction effect between the group and AOI type was also statistically significant ($F(1, 50) = 9.34, p = 0.004, \eta^2 = 0.020$) (see Figure 1). When reading text AOI, the group with an ID was significantly more focal ($M = .124, SE = 0.068$) than the neurotypical group ($M = -0.280, SE = 0.073$), ($t(50) = 4.03, p < 0.001$). The group with an ID showed ambient processing on whitespace ($M = -.203, SE = .072$) and focal processing on text ($M = .124, SE = .068$).

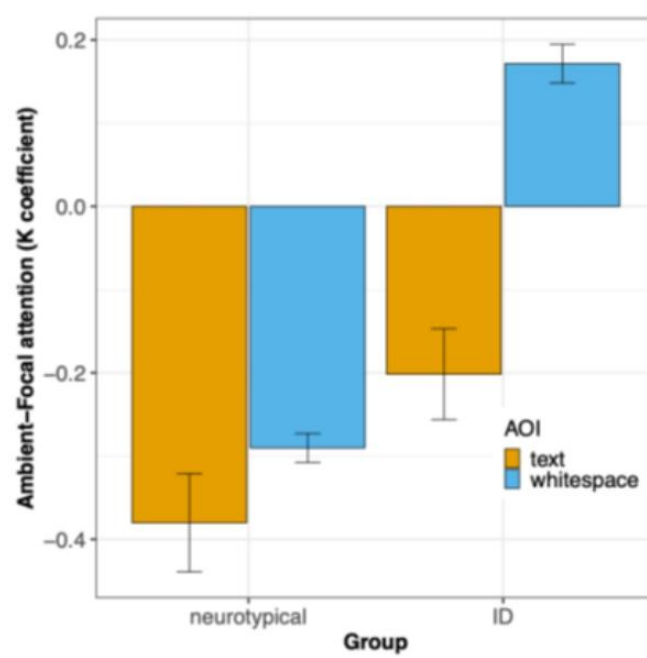


Figure 1. Ambient and focal attention (K coefficient) depending on group and AOI type in Task 1. Bar heights represent mean values of K coefficient; whiskers indicate the 95% confidence intervals for the means.

The ANOVA for the number of fixations as a dependent variable showed a significant effect of group ($F(1, 50) = 6.21, p = 0.016, \eta^2 = 0.062$). The group with an ID performed more fixations ($M = 17.40, SE = 2.02$) than the neurotypical group ($M = 10.00, SE = 2.19$). The analysis also revealed a significant main effect of AOI type ($F(1, 50) = 28.82, p < 0.001, \eta^2 = 0.057$). Both groups, on average, exhibited significantly more fixations on whitespace ($M = 18.44, SE = 2.67$) than on text ($M = 8.99, SE = 0.62$).

Also, we observed a significant interaction between the inclusion of pronouns and AOI type, ($F(1, 50) = 4.94, p = 0.031, \eta^2 = 0.005$), as illustrated in Figure 2. The pairwise comparisons decomposing this interaction term revealed a significant difference in the number of fixations in the text depending on the inclusion of null and overt pronouns with a significantly higher number of fixations on texts without these elements ($M = 9.39, SE = 0.641$) than those that included them ($M = 8.58, SE = 0.631$), ($t(50) = 3.18, p = 0.002$). Both groups also demonstrated a statistical tendency for a higher number of fixations on whitespace when the text had null and overt pronouns ($M = 20.03, SE = 3.07$) than when it did not ($M = 16.84, SE = 2.54$) ($t(50) = 1.75, p = 0.085$). These results may denote effort in visual processing (Rodríguez et al., 2025) of texts without pronouns.

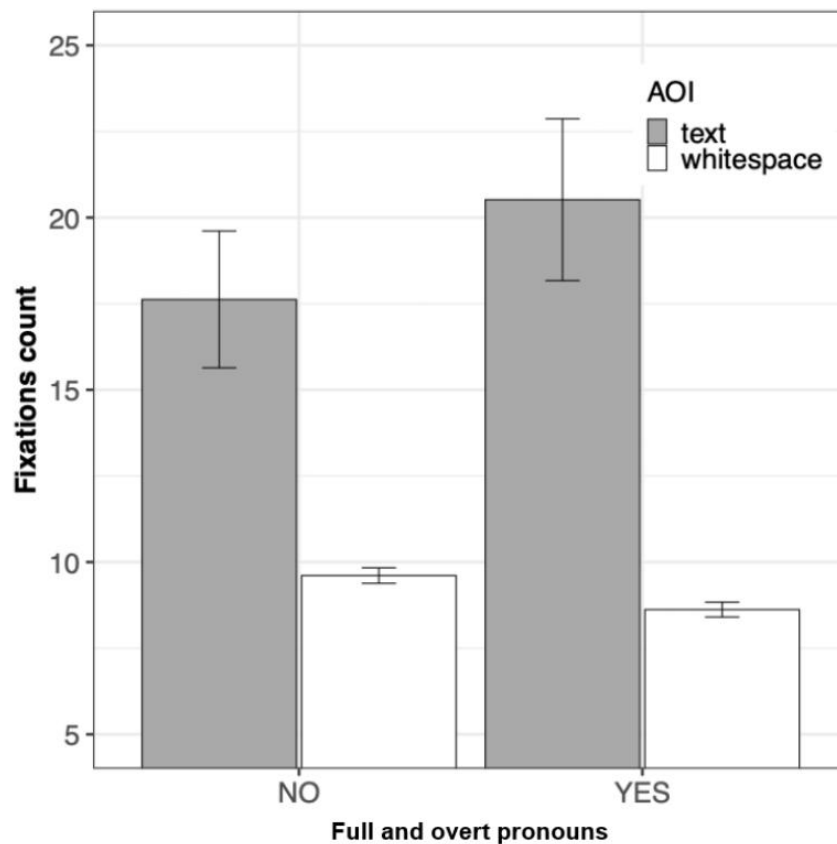


Figure 2. Number of fixations depending on AOI type and inclusion of pronouns in Task 1. Bar heights represent mean values of fixation count; whiskers indicate the 95% confidence intervals for the means.

The analysis for average fixation duration as a dependent variable revealed a significant main effect of the group ($F(1,50) = 18.43, p < .001, \eta^2 = .219$), with longer average fixation duration in the group with an ID ($M = 327\text{ms.}, SE = 12.70$) than in the neurotypical group ($M = 247\text{ms.}, SE = 13.70$). There was also a statistically significant main effect of AOI ($F(1,50) = 28.82, p < .001, \eta^2 = .057$), with longer average fixation durations for text ($M = 306\text{ms.}, SE = 10.50$) than for white space ($M = 269\text{ms.}, SE = 9.43$). Finally, the interaction effect of the group and AOI was obtained only on the marginally significant level, $F(1,50) = 3.97, p = .052, \eta^2 = .008$. Pairwise comparison for this effect revealed slightly larger differences in average fixation duration on text ($M = 353\text{ms.}, SE = 14.30$) and white space ($M = 302\text{ms.}, SE = 12.80$) in the group with an ID than a difference in average fixation duration on text ($M = 259\text{ms.}, SE = 15.40$) and white space ($M = 235\text{ms.}, SE = 13.80$) in the neurotypical group, as illustrated in Figure 3.

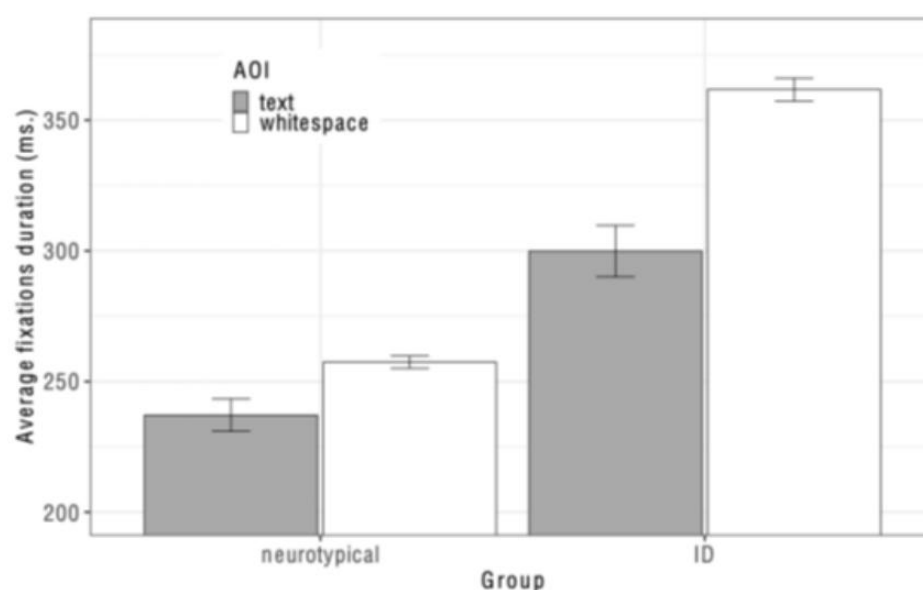


Figure 3. Average fixation duration depending on AOI type and group in Task 1. Bar heights represent means; whiskers indicate the 95% confidence intervals for the means.

In summary, the group and AOI type (text vs. whitespace) showed meaningful differences in the number of fixations, and visual attention mode: ambient vs focal. The analysis of ambient and focal attention indicated that when reading text, the group with an ID showed more focal attention than the neurotypical group. This effect was independent of the type of text (inclusion of pronouns). We observed that the inclusion of null and overt pronouns yields more fixations on whitespace, which is one of the indicators of cognitive load.

We demonstrated that participants in the ID group in general exhibited significantly more and longer fixations which might be an indicator of deeper cognitive involvement in task completion in this group. That is especially visible in the analysis of eye movements located on the text.

6.3. Task 2: subordinate clauses

The results will be reported following the same structure as for Task 1. Data on the perceived text difficulty was analysed through a two-way ANOVA, with group and text type (with or without subordinate clauses) as independent variables. The group showed a significant effect ($F(1, 308) = 34.977, p < 0.001, \eta^2 = 0.101$). In general, the ID group perceived the texts as more difficult ($M = 1.67, SE = 0.77$) than the neurotypical group ($M = 1.17, SE = 0.35$). The presence of subordinate clauses, on the other hand, showed no significant effect ($F(1, 308) = .274, p = 0.600, \eta^2 = 0.008$); nor did the interaction of both variables ($F(1, 308) = .005, p = .940, \eta^2 < 0.001$).

The participants' preference (between texts with or without subordinate clauses) showed a significant intra-group difference ($F(1, 150) = 73.529, p < 0.001, \eta^2 = 0.100$). All 26 neurotypical participants and most participants with an ID (65.4%) expressed no preference.

6.3.1. Eye movements

A series of 2 (group: ID vs typical) x 2 (subordinate: included vs omitted) x 2 (AOI type: text vs white space) mixed-design ANOVA was conducted with eye-movement related metrics as dependent variables (K coefficient, number of fixations, and average fixation duration).

Regarding ambient and focal attention, it yielded a significant effect of the group ($F(1, 47) = 27.48, p < .001, \eta^2 = .256$). The ID group was less ambient ($M = -0.197, SE = 0.079$) than the neurotypical group ($M = -0.799, SE = 0.084$). There was also a significant main effect of AOI ($F(1, 47) = 36.14, p < .001, \eta^2 = 0.133$). Both groups were less ambient while reading text ($M = -0.296, SE = 0.053$) than when looking at a whitespace ($M = -0.698, SE = 0.078$). The results corroborate those from the first task. Interestingly, the analyses revealed marginally significant 3-way interaction of group, AOI and subordinate clauses ($F(1, 47) = 3.30, p = .076, \eta^2 = 0.008$). The pairwise comparisons showed that the neurotypical group exhibited a significantly higher K coefficient ($M = -0.474, SE = 0.079$) when reading text with clauses than text without clauses ($M = -0.631, SE = 0.084$). The effect is shown on Figure 4.

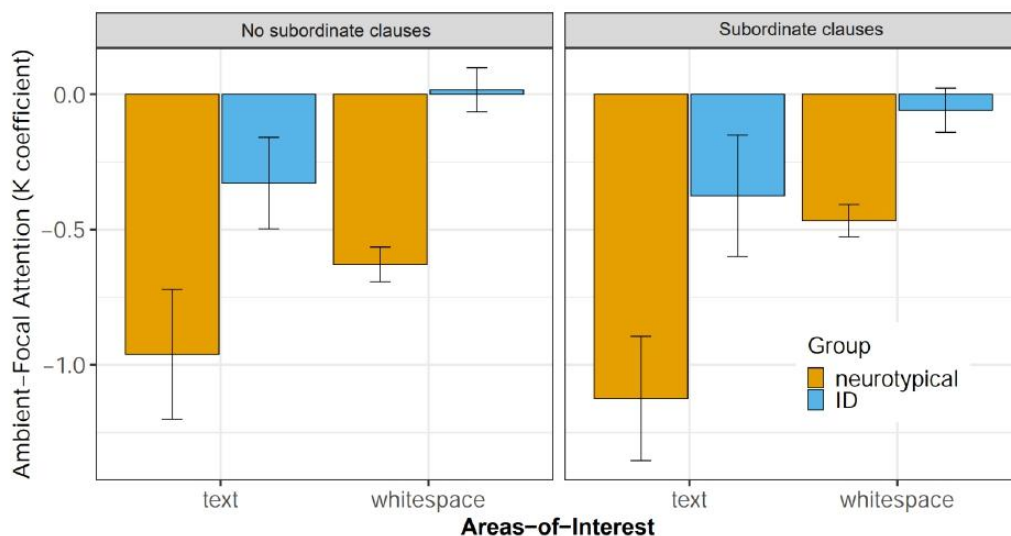


Figure 4. Ambient-Focal attention in both groups while reading text or looking at whitespace. Bar heights represent mean values of K coefficient; whiskers indicate the 95% confidence intervals for the means.

Next, we analysed the differences in the number of fixations. The analysis revealed that the group with an ID had more fixations ($M = 217.50, SE = 22.50$) than the neurotypical group ($M = 83.20, SE = 24.0$), ($F(1, 47) = 16.66, p < 0.001, \eta^2 = 0.171$).

The group with an ID also had a longer average duration of fixations ($M = 442, SE = 20.00$) than the neurotypical group ($M = 294, SE = 21.3$), ($F(1, 47) = 25.50, p < 0.001, \eta^2 = .278$). The interaction between AOI type and group indicates that participants with an ID had much longer fixations on the text ($M = 499, SE = 24.8$) than on whitespace ($M = 384, SE = 19.8$), $t(47) = 5.64, p < 0.001$. This difference was not statistically significant for neurotypical participants, ($t(47) = 1.50, p = 0.139$) (see Fig. 5).

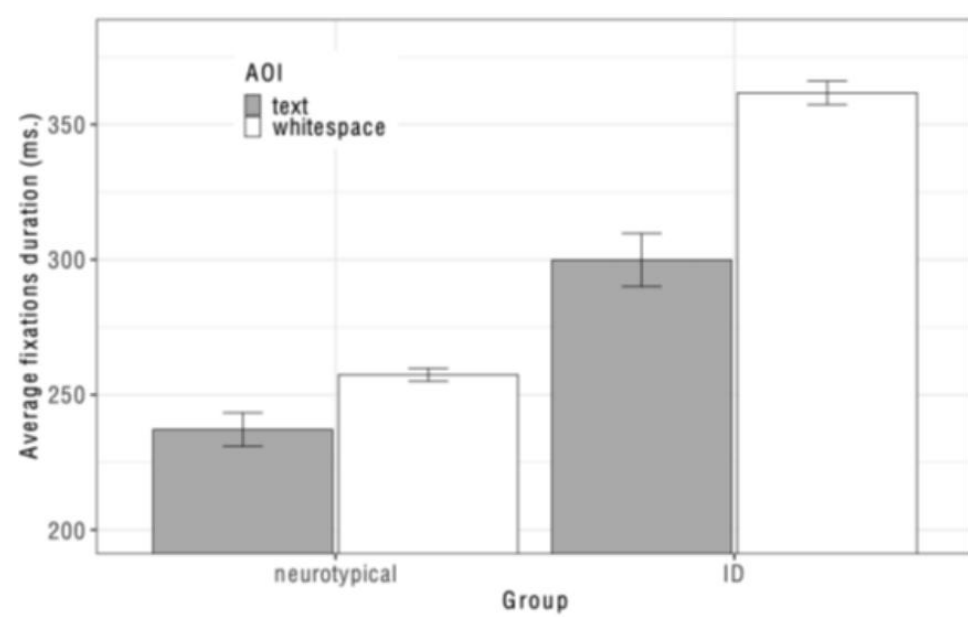


Figure 5. Average fixation duration results of Task 2.

Bar heights represent mean values of average fixation duration; whiskers indicate the 95% confidence intervals for the means.

In summary, we found systematic differences between participants with an ID and their neurotypical counterparts. The group with an ID was less ambient and had more frequent and longer fixations while reading the text than the neurotypical group. We did not observe any significant differences due to the presence or absence of subordinate clauses.

7. Discussion and conclusions

This study examined linguistic elements often discouraged by EL guidelines. There is ongoing expert debate regarding the effectiveness of these adaptations, as most guidelines are primarily rooted in practice and intuition rather than empirical evidence. The study aims to help bridge this gap. In the following section, we address our hypotheses based on the empirical results of the present study.

H1. The presence of null and overt pronouns makes the text harder to understand for people with an ID.

In Task 1, comprehension was assessed through open-ended questions. The results showed that H1 was not supported, as there was no significant effect of null or overt pronouns on comprehension in either the group with an ID or the neurotypical group ($F(1, 620) = 0.102$, $p = 0.337$, $\eta^2 = 0.001$). Therefore, we cannot conclude that these elements are either detrimental or beneficial for content comprehension in either group. This finding calls into question whether such pronouns could, in fact, be used in Catalan EL texts without impairing comprehension.

H2a. People with an ID perceive texts with null and overt pronouns as more difficult to understand and prefer texts without those elements.

H2b. People with an ID perceive texts with subordinate clauses as more difficult to understand and prefer texts without those elements.

These aspects were assessed using a Likert scale for perceived difficulty, along with direct preference questions. Hypothesis H2a was not supported: 80.7% of the group with an ID showed no preference regarding the inclusion or omission of null and overt pronouns and no significant differences were observed in either group's perception of text difficulty based on the inclusion of these elements ($F(1, 204) = 2.433, p = 0.120, \eta^2 = 0.008$). H2b is also false, as 65.4% of the group with an ID showed no preference and the inclusion of subordinate clauses did not significantly affect perceived difficulty in either group ($F(1, 308) = .274, p = 0.600, \eta^2 = 0.008$).

H3a. The presence of null and overt pronouns affects the cognitive effort required for text processing.

H3b. The presence of subordinate clauses affects the cognitive effort required for text processing.

These aspects were evaluated using eye-tracking data, which supported hypothesis H3a by revealing significant differences related to the inclusion of null and overt pronouns. For both groups, texts containing null and overt pronouns elicited more fixations on whitespace ($M = 20.03, SE = 3.07$) than texts without these elements ($M = 16.84, SE = 2.54$), ($t(50) = 1.75, p = 0.085$). Conversely, texts without null or overt pronouns prompted more fixations on the text itself ($M = 9.39, SE = 0.641$) compared to texts that included them ($M = 8.58, SE = 0.631$), ($t(50) = 3.18, p = 0.002$). This indicates that texts without null or overt pronouns require greater cognitive effort to process (Rodríguez et al., 2025), which contradicts the recommendations outlined in EL guidelines. On the other hand, H3b was not supported because the presence of subordinate clauses had no significant effect on eye movements. Additionally, there were no significant interactions between the linguistic elements and the group.

The study has also provided some relevant findings outside of the scope of our initial hypotheses. To begin with, the group (ID/neurotypical) is the only variable that consistently showed a significant effect on almost all measures, as expected. Regarding ambient-focal attention, while the neurotypical group showed ambient attention in all cases, the group with an ID was always more focused on the text. Overall, the group with an ID also showed both a greater number of fixations and longer fixations durations.

The study's findings indicate no discernible differences regarding the use of subordinate clauses in EL across the variables analysed. In contrast, the results offer some support for the use of pronouns, aligning with and complementing Loureda et al. (2024), who suggested that the presence of null pronouns facilitates reading for neurotypical adults. The present findings contradict established EL guidelines (see section 2.1.3). Specifically, the inclusion of simple sentences had no measurable effect on any variable. Furthermore, the omission of null and overt pronouns was shown to hinder reading in both groups, as evidenced by more fixations on the text, indicating increased cognitive effort. However, this omission did not significantly affect either group's performance on comprehension questions.

Despite the contributions of the present study, several limitations should be acknowledged, that suggest avenues for future research. In Task 2, processing difficulty was measured exclusively through eye-tracking, preference ratings, and perceived difficulty questions, without including comprehension questions. While the choice for this approach is explained in section 4, adding comprehension measures could have further enriched the analysis. Another limitation is the relatively small sample size. Ethical constraints regarding participants with an ID, combined with the need for a controlled environment for eye-tracking, required careful planning and extended recruitment time, which limited the number of participants. Future studies should aim to replicate this work with a larger pool of participants. Furthermore, no previous study

was fully comparable to the present one, suggesting the need for replication studies both of prior research and of the current study itself. Future research could also explore additional eye-tracking measures and study other features or target users of EL. Comparing results across languages with frequent use of null and overt pronouns and subordinate clauses could provide additional insights. To control for order effects in future studies, the texts should be presented in a randomized text order, addressing a limitation of the current design.

Although we cannot yet draw definitive conclusions regarding specific EL guideline recommendations, the present study underscores the value of empirically testing EL and opens new avenues for research. No clear benefits were observed from following the EL recommendations concerning null and overt pronouns or the use of subordinate clauses. We hope these results inspire much-needed future studies with larger participant samples, examining additional linguistic or graphic elements of EL or different target groups.

Conflict of interests and data availability statement

Authors declare no financial or proprietary interests. The data and analysis scripts related to the reported results are available on OSF: https://osf.io/md6g7/overview?view_only=c90295d6d1cc44708abb3dc4aca762a0

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8. References

- Agència de Salut Pública (2023). *La Salut a Barcelona 2022. Lectura Fàcil*. Agència de Salut Pública. <https://www.aspb.cat/wp-content/uploads/2023/12/ASPB-salutbarcelona2022-breu-231211.pdf>
- Alarcon, R., Moreno Lopez, L., Segura-Bedmar, I., & Martínez Fernández, P. (2019). Lexical simplification approach using easy-to-read resources. *Revista de Procesamiento de Lenguaje Natural*, 63.
- Allen, S. (2000). A discourse-pragmatic explanation for argument representation in child Inuktitut. *Linguistics*, 38, 483-521. <https://doi.org/10.1515/ling.38.3.483>
- Asociación Española de Normalización (2018). *UNE 153101:2018 EX: Lectura Fácil. Pautas y recomendaciones para la elaboración de documentos*.
- Boland, J. (2004). Linking eye movements to sentence comprehension in reading and listening. In M. Carreiras, & C. Clifton Jr. (Eds.), *The on-line study of sentence comprehension* (pp. 51-76). Psychology Press, New York.
- Borghardt, L., Deilen, S., Fuchs, J., Gros, A., Hansen-Schirra, S., Nagels, A., Schiffl, L., & Sommer, J. (2021). Neuroscientific Research on the Processing of Easy Language. *Frontiers in Communication*, 6. <https://doi.org/10.3389/fcomm.2021.698044>
- Bruckmaier, G., Binder, K., Krauss, S., & Kufner, H. M. (2019). An Eye-Tracking Study of Statistical Reasoning With Tree Diagrams and 2 × 2 Tables. *Frontiers in psychology*, 10, 632. <https://doi.org/10.3389/fpsyg.2019.00632>

- Buell, S., Langdon, P.E., Pounds, G., & Bunning, K. (2020). An open randomized controlled trial of the effects of linguistic simplification and mediation on the comprehension of 'easy read' text by people with intellectual disabilities. *Journal of Applied Research in Intellectual Disabilities*, 33(2), 219-231. <https://doi.org/10.1111/jar.12666>
- Chambers, J. M. (1983). *Graphical Methods for Data Analysis* (1st ed.). Chapman and Hall/CRC. <https://doi.org/10.1201/9781351072304>
- Clifton, C., Staub, A., & Rayner, K. (2007). Eye movements in reading words and sentences. In R. P. G. van Gompel (Ed.), *Eye Movements: A window on mind and brain* (pp. 341-371). Elsevier.
- Comes, A. (1990). *TLC: Test de lectura comprensiva*. TEA.
- Csákvári, J., & Gyori, M. (2015). Applicability of standard eye-tracking technique in people with intellectual disability: methodological conclusions from a series of studies. *Studies in health technology and informatics*, 217, 63-70. <https://pubmed.ncbi.nlm.nih.gov/26294454/>
- Deilen, S., & Schiffli, L. (2020). Using eye-tracking to evaluate language processing in the easy language target group. In S. Hansen-Schirra, & C. Maaß (Eds.), *Easy Language Research: Text and User Perspectives* (pp. 273-281). Frank & Timme.
- Dickinson, K.V., Ortiz-Ramírez, P.A., Arrieta-Zamudio, A., Grinstead, J., & Flores-Ávalos, B. (2023). Overt Subject Pronoun Use in Switch-Reference Contexts in Child Spanish Developmental Language Disorder: A Discriminant Function Analysis. *Journal of Speech, Language, and Hearing Research*, 66(2), 605-619. https://doi.org/10.1044/2022_JSLHR-21-00483
- D'Mello, S. K., Southwell, R., & Gregg, J. (2020). Machine-learned computational models can enhance the study of text and discourse: A case study using eye tracking to model Reading comprehension. *Discourse Processes*, 57(5-6), 420-440.
- Duchowski, A.T. (2007). *Eye Tracking Methodology Theory and Practice*. Springer.
- Ducrot, O., & Todorov, T. (2003). *Diccionario enciclopédico de las ciencias del lenguaje*. Siglo XXI Editores.
- Eisenberg, M. L., & Zacks, J. M. (2016). Ambient and focal visual processing of naturalistic activity. *Journal of Vision*, 16(2), Article 5. <https://doi.org/10.1167/16.2.5>
- Fajardo, I., Ávila, V., Ferrer, A., Tavares, G., Gómez, M., & Hernández, A. (2014). Easy-to-read texts for students with intellectual disability: Linguistic factors affecting comprehension. *Journal of Applied Research in Intellectual Disabilities*, 27, 212-225. <https://doi.org/10.1111/jar.12065>
- Federal Ministry of Justice and Consumer Protection. (2011). BITV 2.0. Verordnung zur Schaffung barrierefreier Informationstechnik nach dem Behindertengleichstellungsgesetz. (Barrierefreie-Informationstechnik-Verordnung – BITV 2.0). Retrieved October 25, 2024, from http://www.gesetze-im-internet.de/bitv_2_0/BJNR184300011.html
- Ferreira, F., Apel, J., & Henderson, J. M. (2008). Taking a new look at looking at nothing. *Trends in cognitive sciences*, 12(11), 405-410. <https://doi.org/10.1016/j.tics.2008.07.007>
- Fronđen, C., & Kaakinen, J. (2023). Reading Easy Language texts written by public authorities: Evidence from eye tracking. *Finnish Journal of Linguistics*, 36, 7-36. <https://doi.org/10.61197/fjl.126062>
- Gelormini-Lezama, C., & Almor, A. (2011). Repeated Names, Overt Pronouns, and Null Pronouns in Spanish. *Language and Cognitive Processes*, 26(3), 437-454. <https://doi.org/10.1080/01690965.2010.495234>
- González-Sordé, M., & Matamala, A. (2023). Empirical evaluation of Easy Language recommendations: a systematic literature review from journal research in Catalan, English, and Spanish. *Universal Access in the Information Society*. <https://doi.org/10.1007/s10209-023-00975-2>
- Grimm, J., & Grimm, H. (2018). *21 contes dels germans Grimm*. ING Edicions.
- Grinstead, J., Lintz, P., Pratt, A., Vega-Mendoza, M., De la Mora, J., Cantú-Sánchez, M., & Flores-Avalos, B. (2018). Null Subject Occurrence in Monolingual Spanish SLI: A Discriminant Function Analysis. *Languages*, 3(2). <https://doi.org/10.3390/languages3020017>
- Gutermuth, Silke. 2020. *Leichte Sprache für alle? Eine zielgruppenorientierte Rezeptionsstudie zu Leichter und Einfacher Sprache*. (Doctoral dissertation).
- Hansen-Schirra, S., & Maaß, C. (2020). *Easy language research: Text and user perspectives (Vol. 2)*. Frank & Timme.
- He, W., Garrido, M.I., Sowman, P.F., Brock, J., & Johnson, B.W. (2015). Development of effective connectivity in the core network for face perception. *Human brain mapping*, 36(6), 2161-2173. <https://doi.org/10.1002/hbm.22762>
- Helmert, J. R., Joos, M., Pannasch, S., & Velichkovsky, B. M. (2005). Two Visual Systems and Their Eye Movements: Evidence from Static and Dynamic Scene Perception. *Proceedings of the Annual Meeting of the Cognitive Science Society*, 27. Retrieved from <https://escholarship.org/uc/item/9nv0c661>
- Inclusion Europe (1998). *El Camí Més Fàcil: Directrius Europees per Generar Informació de Lectura Fàcil*. www.lecturafacil.net/media/resources/ILSMH_catal%C3%A0.pdf
- Institut d'Estudis Catalans (2022). *Gramàtica essencial de la llengua catalana*. <https://geiec.iec.cat/inici>

- International Federation of Library Associations and Institutions (2012). *Directrius per a materials de Lectura Fàcil*. www.lecturafacil.net/media/resources/2012_Directrius_IFLA_Catal%C3%A0.pdf
- International Organization for Standardization (2021). *ISO/IEC DIS 23859-1:2021(E): Information technology — User interfaces — Requirements and recommendations on making written text easy to read and understand*.
- Johansson, R., Nyström, M., Dewhurst, R., & Johansson, M. (2022). Eye-movement replay supports episodic remembering. *Proceedings of the Royal Society B*, 298(1997). <https://doi.org/10.1098/rspb.2022.0964>
- Just, M. A., Carpenter, P. A., & Woolley, J. D. (1982). Paradigms and processes in reading comprehension. *Journal of Experimental Psychology: General*, 111(2), 228–238. <https://doi.org/10.1037/0096-3445.111.2.228>
- Kim, S. H., Dong, Z., Xian, H., Upatasing, B., & Yi, J. S. (2012). Does an Eye Tracker Tell the Truth about Visualizations?: Findings while Investigating Visualizations for Decision Making. *IEEE transactions on visualization and computer graphics*, 18(12), 2421–2430. <https://doi.org/10.1109/TVCG.2012.215>
- Krejtz, I., Szarkowska, A., Krejtz, K., Walczak, A., & Duchowski, A. (2012). Audio description as an aural guide of children's visual attention: evidence from an eye-tracking study. In *Proceedings of the Symposium on Eye Tracking Research and Applications (ETRA '12)*. Association for Computing Machinery, New York, NY, USA, 99–106. <https://doi.org/10.1145/2168556.2168572>
- Krejtz, K., Duchowski, A. T., & Cöltekin, A. (2014). High-Level Gaze Metrics From Map Viewing. Charting Ambient/Focal Visual Attention. In P. Kiefer, I. Giannopoulos, M. Raubal, & A. Krüger (Eds.), *CEUR Workshop Proceedings* (pp. 37–41). Presented at the 2nd International Workshop on Eye Tracking for Spatial Research co-located with the 8th International Conference on Geographic Information Science (GIScience 2014), CEUR-WS. Retrieved from <http://ceur-ws.org/Vol-1241/>
- Krejtz, K., Duchowski, A. T., Krejtz, I., Kopacz, A., & Chrzastowski-Wachtel, P. (2016). Gaze transitions when learning with multimedia. *Journal of Eye Movement Research*, 9(1). <https://DOI:10.16910/jemr.9.1.5>
- Lindholm, C., & Vanhatalo, U. (2021). *Handbook of easy languages in Europe*. Frank & Timme.
- Loureda Lama, Ó., Izquierdo Alegria, D., Gelormini-Lezama, C., Hernández Pérez, C., Teucher, M., Cruz Rubio, A., & Julio Vergara, C. (2024). La encapsulación y la correferencia en español mediante pronombres demostrativos y repeticiones léxicas: Una aproximación experimental con eye-tracking. *Revista Signos. Estudios De Lingüística*, 57(114). <https://revistasignos.cl/index.php/signos/article/view/1164>
- Maaß, C. (2020). *Easy Language – Plain Language – Easy Language Plus*. Frank & Timme.
- Mayol, L., & Clark, R. (2010). Pronouns in Catalan: Games of partial information and the use of linguistic resources. *Journal of Pragmatics*, 42(3). <https://DOI:10.1016/j.pragma.2009.07.004>
- Mazzaggio, G., & Shield, A. (2020). The Production of Pronouns and Verb Inflections by Italian Children with ASD: A New Dataset in a Null Subject Language. *Journal of Autism and Developmental Disorders*, 50(4), 1425–1433. <https://DOI:10.1007/s10803-019-04349>
- Merriam-Webster. (n.d.). Subordinate clause. In *Merriam-Webster.com dictionary*. Retrieved October 8, 2024, from <https://www.merriam-webster.com/dictionary/subordinate%20clause>
- Mézière, D.C., Yu, L., Reichle, E.D., von der Malsburg, T., & McArthur, G. (2023). Using Eye-Tracking Measures to Predict Reading Comprehension. *Reading Research Quarterly*, 58, 425–449. <https://doi.org/10.1002/rrq.498>
- Pappert, S., & Bock, B. M. (2020). Easy-to-read German put to the test: Do adults with intellectual disability or functional illiteracy benefit from compound segmentation? *Reading and Writing: An Interdisciplinary Journal*, 33(5), 1105–1131. <https://doi.org/10.1007/s11145-019-09995-y>
- Perego, E. (2020). *Accessible Communication: A Cross-country Journey*. Frank & Timme.
- Perez, M., & Mestre, R. (2022). *Diccionari de lingüística*. Publicacions de la Generalitat Valenciana.
- R Core Team (2025). R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. Retrieved from <https://www.R-project.org/>
- Raven, J.C. (1998). *Raven's Progressive Matrices*. Pearson Clinical.
- Rayner, K. (1998). Eye movements in reading and information processing: 20 years of research. *Psychological Bulletin*, 124, 372–422. <https://DOI:10.1037/0033-2909.124.3.372>
- Real, F., & Christiansen, M.H. (2007). Processing of relative clauses is made easier by frequency of occurrence. *Journal of Memory and Language*, 57(1), 1–23. <https://DOI:10.1016/j.jml.2006.08.014>
- Renkewitz, F., & Jahn, G. (2010). Looking at Nothing Indicates Memory Search in Multiattribute Decision Making. In *Proceedings of the Annual Meeting of the Cognitive Science Society*, 32(32).
- Rivero-Contreras, M., Engelhardt, P. E., & Saldaña, D. (2021). An experimental eye-tracking study of text adaptation for readers with dyslexia: effects of visual support and word frequency. *Annals of dyslexia*, 71(1), 170–187. <https://doi.org/10.1007/s11881-021-00217-1>
- Rodríguez, K. V., Fonseca, L., Iaconis, F. R., Del-Punta, J., & Gasaneo, G. (2025). Eye tracking studies, a way to understand difficulties in reading processing. *Ocnos*, 24(1). https://doi.org/10.18239/ocnos_2025.24.1.488
- Roland, D., Mauner, G., & Hirose, Y. (2021). The processing of pronominal relative clauses: Evidence from eye movements. *Journal of Memory and Language*, 119. <https://DOI:10.1016/j.jml.2021.104244>

- Saggion, H., Gómez Martínez, E., Etayo, E., Anula, A., & Bourg, L. (2011). Text Simplification in Simplex: Making Text More Accessible. *Revista de la Sociedad Española Para el Procesamiento del Lenguaje Natural*, 47, 341-342. <http://journal.sepln.org/sepln/ojs/ojs/index.php/pln/article/view/1000>
- Schiff, L. (2020). Hierarchies in Lexical Complexity: Do Effects of Word Frequency, Word Length and Repetition Exist for the Visual Word Processing of People with Cognitive Impairments? In S. Hansen-Schirra, & C. Maaß (Eds.), *Easy Language Research: Text and User Perspectives* (pp. 227-239). Frank & Timme GmbH.
- Schmutz, S., Sonderegger, A., & Sauer, J. (2019). Easy-to-read language in disability-friendly web sites: Effects on nondisabled users. *Applied Ergonomics*, 74, 97-106. <https://doi.org/10.1016/j.apergo.2018.08.013>
- Scholz, A., Klichowicz, A., & Krems, J. F. (2018). Covert shifts of attention can account for the functional role of "eye movements to nothing". *Memory & cognition*, 46(2), 230-243. <https://doi.org/10.3758/s13421-017-0760-x>
- Serratrice, L., Sorace, A., & Paoli, S. (2004). Crosslinguistic influence at the syntax-pragmatics interface: Subjects and objects in English-Italian bilingual and monolingual acquisition. *Bilingualism: Language and Cognition*, 7, 183-205. <https://doi.org/10.1017/S1366728904001610>
- Southwell, R., Gregg, J., Bixler, R., & D'Mello, S. K. (2020). What eye movements reveal about later comprehension of long connected texts. *Cognitive Science*, 44(10), 1-24.
- Staub, A. (2010). Eye movements and processing difficulty in object relative clauses. *Cognition*, 116, 71-86. <https://doi.org/10.1016/j.cognition.2010.04.002>
- Sutherland, RT., & Isherwood, T. (2016). The Evidence for Easy-Read for People With Intellectual Disabilities: A Systematic Literature Review. *Journal of Policy and Practice in Intellectual Disabilities*, 12(4), 297-310. <https://doi.org/10.1111/jppi.12201>
- Tiffin-Richards, S. P., & Schroeder, S. (2015). Word length and frequency effects on children's eye movements during silent reading. *Vision Research*, 113(Pt A), 33-43. <https://doi.org/10.1016/j.visres.2015.05.008>
- Trevarthen, C. B. (1968). Two mechanisms of vision in primates. *Psychologische Forschung*, 31(4), 299-337. <https://doi.org/10.1007/BF00422717>
- van Gog, T., Paas, F., van Merriënboer, J. J. G., & Witte, P. (2005). Uncovering the Problem-Solving Process: Cued Retrospective Reporting Versus Concurrent and Retrospective Reporting. *Journal of Experimental Psychology: Applied*, 11(4), 237-244. <https://doi.org/10.1037/1076-898X.11.4.237>
- Wallot, S., O'Brien, BA., Haussmann, A., Kloos, H., & Lyby, MS. (2014). The role of reading time complexity and reading speed in text comprehension. *Journal of experimental psychology. Learning, memory, and cognition*, 40(6), 1745-1765. <https://doi.org/10.1037/xlm0000030>
- Wei, S., Lei, Q., Chen, Y., Xin, Y. P., Kastberg, S., & Kim, S. (2018). Evaluating the effects of highlighting text animations on the attention distribution of students with math learning difficulties. *2018 ASEE Annual Conference & Exposition*.
- White, H., Heck, A., Jubran, R., Chroust, A., & Bhatt, RS. (2022). Average fixation duration in infancy: Stability and predictive utility. *Infancy: the official journal of the International Society on Infant Studies*, 27(5), 866-886. <https://doi.org/10.1111/infa.12483>
- Wickham, H., Pedersen, T., & Seidel, D. (2025). Scales: Scale Functions for Visualization. R package version 1.4.0.9000. Retrieved from <https://github.com/r-lib/scales>
- Wolman, C. (1991). Sensitivity to causal cohesion in stories by children with mild mental retardation, children with learning disabilities, and children without disabilities. *The Journal of Special Education*, 25, 135-154. <https://doi.org/10.1177/002246699102500202>
- Yaneva, V., Temnikova, I., & Mitkov, R. (2016). Evaluating the readability of text simplification output for readers with cognitive disabilities. *Proceedings of the Tenth International Conference on Language Resources and Evaluation (LREC'16)*, 293-299.



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