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The impact of formal parameters on media accessibility

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UNIVERSITAT AUTÒNOMA DE BARCELONA

Departament de Traducció i d'Interpretació i d'Estudis de l'Àsia Oriental

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The impact of formal parameters on media accessibility

PhD thesis presented by:
Marta Bosch i Baliarda

Supervised by:
Dr. Pilar Orero
Dr. Olga Soler Vilageliu

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List of abbreviations and acronyms

ACILS	Association of Sign Language Interpreters and Guide-Interpreters of Catalonia, (*Associació d'Intèrprets de Llengua de Signes i Guies-Intèrpret de Catalunya*)
ADQ	Asking different questions (approach)
ANIMAQU	Animated questionnaire for deaf and hard of hearing people
AOI	Area of interest
ASQT	Asking the same question and translating (approach)
AV	Audiovisual
AVMSD	Audio Visual Media Standard Definition
AVT	Audiovisual translation
CATI/CAPI	Computer-assisted telephone interview / Computer-assisted personal interview
CAVI	Computer-assisted video interviewing
CCMA	Catalan Broadcasting Corporation (*Corporació catalana de mitjans audiovisuals*)
CI	Community Interpreting
CNLSE	Centre for the Standardization of Spanish Sign Language (*Centro de Normalización Lingüística de la Lengua de Signos Española)*
CODA	Children of Deaf Adults
CSLRA	Charter on Sign Language Rights for All
DGS	German Sign Language (*Deutsche Gebärdensprache*)
DTV	Digital Television
DTV4ALL	Digital Television for All
DVD	Digital versatile disk
EBU	European Broadcasting Union
ERGA	European Regulators Group for Audiovisual Media Services

ET	Eye-tracking
EU	European Union
EUD	European Union of the Deaf
FESOCA	Catalan Federation of Deaf People (*Federació de Persones Sordes de Catalunya*)
H1	Dominant hand
H2	Non-dominant hand
HBB4ALL	Hybrid Broadcast Broadband for All
HbbTV	Hybrid Broadcast Broadband Television
ICT	Information and Communication Technologies
IS	International Sign (System)
ITC	Independent Television Commission
ITU	International Telecommunication Union
IVQ	Interactive Video Questionnaire
LSC	Catalan Sign Language (*Llengua de signes catalana*)
LSE	Spanish Sign Language (*Lengua de signos española*)
LSFB	French Belgian Sign Language (*Langue des Signes de Belgique Francophone)*
NDA	National Disability Authority
NDCS	National Deaf Children's Society
NGT	Dutch Sign Language (*Nederlandse Gebarentaal*)
Ofcom	Office of Communications
ÖGS	Austrian Sign Language (*Österreichische Gebärdensprache*)
RTVE	Spanish Radio and Television Corporation (*Corporación de Radio y Televisión Española*)
SASL	South African Sign Language

SLI	Sign language interpreting
STDEV	Standard deviation
TRAPD	Translation, review, adjudication, pretesting and documentation
TV	Television
UNCRDP	United Nations Convention on the Rights of Persons with Disabilities
UPM	Polytechnic University of Madrid (*Universidad Politécnica de Madrid)*
video-CAPI	Video computer-assisted personal interview
video-CASI	Video computer-assisted self-administered interview
VSL-CAPI	Video sign language computer-assisted personal interview
VSL-CASI	Video sign language computer-assisted self-administered interview
VSL-questionnaire	Video sign language questionnaire
W3C	World Wide Web Consortium
WFD	World Federation of the Deaf

Chapter 1

Introduction

1. Introduction

In this introductory chapter (Chapter 1), I provide the background for my research centred on the inclusive approach to accessibility and the rights for the (deaf) sign language users (§ 1.1). In section 1.2, the focus of my research is contextualised by presenting an overview of the different signing access services on TV (§ 1.2.1) and the limitations of the existing guidelines and technical requirements that are currently available (§ 1.2.2). I conclude this section by emphasising on the interactions between the inclusive accessibility model and the dual category status model of deaf sign language users, as the paradigm that frames this present research (§ 1.2.3). Finally, in section 1.3, I present the structure of this article-based PhD thesis.

1.1 Sign Language Rights, Accessibility Rights and Human Rights

Media accessibility in the past few years has shifted from an exclusive to an inclusive model where access services are designed "for all". It aims to benefit not only traditional access service users, namely people with sensory disabilities such as deafness and blindness, but the general population as a whole. Accessible designs can improve the usability of media services and benefit people of all ages and abilities, since 80% of disabilities are acquired by people during their lifetime rather than at birth (Orero, 2016; Ellis, 2016). Hence under the scope of this paradigm, not only sensory disabled people are the target of accessibility but all people can benefit from the accommodations of a more accessible society.

The release of the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD) in 2006 was an important milestone in the paradigm shift from a medical and deficit model of disability to the human rights model. The UNCRPD General Comment on Article 9 formally recognised accessibility and access to information as a universal human right as well as an asset to promote inclusion to guarantee full participation in society and enabling informed decisions for all. Since, it is claimed that the right to accessibility is a human right per se. Moreover, accessibility can also be considered an instrument to achieve human rights for people since it is a necessary condition for people with disabilities to fully and equally participate in society (Greco, 2016). Regarding sign languages, the UNCRPD recognised that signed languages are equal in status to spoken languages and as such have equal rights (Article 2). Additionally, in Article 9(e) and 21, it requires governments to ensure the right to use a professional sign language interpreter as a measure to promote accessibility to information and communication.

The World Federation of the Deaf (WFD), and other national and international deaf advocacy groups, have argued that without sign language deaf people cannot be equal. Sign language rights are regarded as a basic linguistic right for deaf sign language users. Ultimately, sign language rights are interpreted to be inseparable form deaf people's human rights (WFD, n.d.). This is stated in the WFD report on "Deaf People and Human Rights":

> Article 2 of the Universal Declaration of Human Rights reads "Everyone is entitled to all the rights and freedoms set forth in this Declaration, such as race, colour, sex, *language*, religion, political or other opinion, national or social origin, property, birth or other status" (emphasis by Haualand and Allen). Neither the Declaration of Human Rights nor the CRPD declare access to a specific or individual language or sign language as a human right; they state only that discrimination on the basis of language is not permitted. Herein lies a premise that all languages are equal, and all languages and their users should be respected and protected in their own right. When Deaf people, whose natural language(s) are sign language(s), are denied the use of sign language in interaction with other people or experience discrimination in various areas of life because they use sign language, the consequence is violation of their human rights (Haualand & Allen, 2009: 9).

In 2019, the Charter on Sign Language Rights for All (CSLRA) was released by the WFD, who acknowledges that "deaf communities are part of a unique intersectionality of rights, belonging to both linguistic and cultural groups, and the disability movement". The introduction of the CSLRA (WFD, 2019) states that "deaf people are human rights holders entitled to equal opportunities to participate in society". Regarding accessibility, the text emphasises that the use of sign languages is crucial to guarantee that deaf people have full and effective equal access in society, "without discrimination, to ensure the full enjoyment of their human, civil, cultural and political rights". The charter recognises that all sign language users should have the right to benefit from full access to both "the Deaf Community and mainstream services through the use of sign language". The CSLRA also acknowledges that the development of Information and Communication Technologies (ICT) should be encouraged as a means of accessibility to create more inclusive sign language environments. The sign language-based human rights discourse has been adopted by the deaf advocacy groups and can be found in several documents released by the WFD and the European Union of the Deaf (EUD) (Murray, 2005).

In Europe, the implementation of the UNCRPD triggered several policies and programmes to help all signatory member states in complying with the international treaty and its Optional Protocol (United Nations, 2008b). As part of its work to meet the commitments and obligations of the UNCRPD at a European level, the European Parliament passed the European Accessibility Act 2015 (European Parliament, 2015) and the European Disability Strategy 2010-2020 (European Parliament, 2010a). The European Accessibility Act aims "to improve the functioning of the internal market [for accessible products and services] by removing barriers created by divergent legislation" (European Parliament, 2015). The European Disability Strategy 2010-2020 provides a framework for action outlining how the EU and national governments can commit to breaking down barriers for people with disabilities so they can enjoy equal rights with other EU citizens, ensuring for example better access to goods, services and assistive devices.

The EUD advocates for full accessibility of audiovisual media content and information. According to EUD Position Paper on Accessibility of information and communication, fully accessible audiovisual media content for deaf people means that users must be able to choose "sign language interpretation, subtitling or captioning, or a combination of both in their preferred language" (EUD, 2018).

The provision of accessible audiovisual media services in Europe is covered by the European Audiovisual Media Services Directive. Article 46 of the directive states that access to audiovisual media forms are part of the "right of persons with a disability and of the elderly to participate and be integrated in the social and cultural life of the Union" and specifies that "the means to achieve accessibility should include, but need not be limited to, sign language, subtitling [and] audio-description". Also according to article 7 of the Audio Visual Media Standard Definition (AVMSD), "Member States shall encourage media service providers under their jurisdiction to ensure that their services are gradually made accessible to people with a visual or hearing disability". It is then up to each member state to gradually make appropriate services available, with a view to reaching targets of 100% for subtitling of public-service broadcasting, and 10% for both audio description and sign language. Regarding sign language accessibility on television (TV), EUD advocates for full provision of signing services on TV and video on demand (VOD) provided by both private and publics broadcasters (EUD, 2018). However, on average, public broadcasters deliver sign language in 4% of programmes, mostly daily news (European Broadcasting Union [EBU], 2016). Both the report from the EBU (2016) and the report from the European Regulators Group for Audiovisual Media Services (ERGA, 2016) point towards the need to improve the current service standards.

Within this context, the European Commission has funded several research projects focused on audiovisual media accessibility, such as Digital Television for All (DTV4ALL, 2008-2010), Hybrid Broadcast Broadband for All (HBB4ALL, 2013-2016) and Easing the Access of Europeans with Disabilities to Converging Media and Content (EASYTV, 2017-2020) under the scope of the European Union's Horizon 2020 Research and Innovation Programme. These projects aimed to explore the possibilities of new technologies towards improving mature access services (namely, subtitling, audio description and sign language), advancing in personalisation options, and exploring innovative hybrid accessibility services (such as audio subtitling or easy to read subtitles).

This present PhD research is embedded in the signing services pilots within the European projects HBB4ALL and EASYTV led by the senior researchers of the group TransMedia

Catalonia Research Group in which I had the opportunity to work as a research assistant and learn from their expertise in the field of audiovisual translation and media accessibility. The former HBB4ALL project investigated accessibility services in the new hybrid broadcast-broadband TV (HbbTV) under the standard specification HbbTV 2.0.1 TS 102 796 V1.4.1 released in 2016 (HBB4ALL, 2016; Orero, 2016). The project had four pilots: subtitling, alternative audio production and distribution (including audio description), user interaction and signing services. The current EASYTV project aims to innovate and kick-start the development of new accessibility technologies including novel technologies to implement sign-translated information to break access barriers (EASYTV, 2017). Thanks to working in this academic environment I could get the access to the tools, guidance and support required to develop the necessary skills for my PhD research.

All the studies in this PhD research are conducted in Catalonia, specifically, in Barcelona and the surrounding area. Catalonia has a population of roughly 7.5 million citizens with 25,000 estimated Catalan Sign Language (*Llengua de signes catalana, LSC*) users, out of which 6,000 are deaf or deafblind (Cabeza & Porteiro, 2010). Sign language users as a group constitute

> La comunidad sorda como comunidad social, cultural y lingüística […] está formada principalmente por Personas Sordas que han aprendido la lengua de signos como nativa o adquirida y por personas oyentes (padres, familiares, amigos, profesionales, así como profesionales de la educación, psicología, medicina, logopedia..., todos ellos competentes en lengua de signos y con conocimiento profundo de las características de la comunidad sorda) (Frigola, 2010: 29).

In this dissertation, I will use the term *Deaf Community* with a more restricted meaning, following the current conventional use by the WFD, to refer to the deaf sign language users only. To refer to all sign language users as a group, including both deaf and hearing signers, I will adopt the capitalised term *Sign Language Community* from De Meulder, Krausneker, Turner and Conama to emphasise the language minority status of the group

(De Meulder, Krausneker, Turner & Conama, 2018; Harris, Holmes, & Mertens, 2009). Sign Language Communities around the world are cultural language minority groups that have traditionally been in a minority position by: number of members, social power, and access to resources (De Meulder, 2016; De Meulder *et al*., 2019; Murray, 2015). The Catalan Sign Language Community is a national human group with specific intersectional backgrounds and its own tradition to advocate for their rights, but it shares the tenets of the international deaf advocacy groups such as the WFD and the EUD regarding sign language rights (Jarque, Bosch-Baliarda & González, 2019; Muñoz, 2010; Quer, 2012).

1.2 Sign Language Interpreting Access Services on TV

The two most common access services for the Deaf and Hard of Hearing are subtitling and signing services. Traditionally, subtitling or captioning on TV programmes have been the main access services. In Europe, for example, public broadcasters deliver sign language in 4% of programmes on average, while subtitles are delivered on over 66% (EBU, 2016). Sign language made its appearance on TV around 1950 (Ladd, 2007; Stone, 2007) and is thus considered one of the three mature TV accessibility services along with subtitling and audio description (European Commission, 2010; European Parliament, 2010; European Parliament, 2015; Looms, 2009). Even though signing services on TV have been growing around the world for the past decades, the availability of broadcast signed content is still scarce (EBU, 2016; Haualand & Allen, 2009).

As deaf people have a wide range of abilities in different language modalities — signed, written and spoken—, “[t]elevision programmes and video adaptations for Deaf people may add layers of complexity by placing sign or text over the existing visual message. This creates interesting issues which are currently unresolved as to how to convey information with mixtures of signing, visual action, speech and text. […] Finding a balance in a single media is bound to be difficult” (Kyle, Reilly, Allsop, Clark & Dury, 2005: 57). Deaf sign language users perceive that the inclusion of the sign language on the screen makes the broadcast information too complex or even consider it is not appropriate for all

TV genres (Kyle, 2007; Allsop & Kyle, 2008; Serrat-Manén, 2011). This perception might be influenced by the lack of experience and poor usability of this type of access service.

Accessibility to TV programmes including sign language interpreting (SLI) may depend on several elements, namely:

(1) comprehension of the sign language produced: sometimes too fast and generally influenced by the spoken language when hearing non-native interpreters are employed (Allsop & Kyle, 2008; De Meulder & Heyerick, 2013; Duncan, 1997; Kyle, 2007; Kyle, Reilly, Allsop, Clark & Dury, 2005; Prillwitz, 2001; Serrat Manen, 2011; Stone, 2007a; 2007b; 2009; Wehrmeyer, 2014; Woll, 1991);

(2) screen readability: related to the overload of visual information on the screen, especially on news bulletins (Kyle *et al*., 2005; Gutermuth, 2011; Serrat Manen, 2011); or

(3) sign language legibility on the screen: influenced by size of the interpreter, the colours used or the position on the screen, among other formal features of presentation and video production determining the screen composition and layout of the sign language on the screen (Gil Sabroso & Utray, 2016; Kyle *et al*., 2005; Van der Graaf & Van der Ham, 2003).

There has been little research exploring how video production techniques and technical requirements can enhance the accessibility in the signing services by improving both the sign language legibility and readability of the visual images. In fact, both terms here are adapted from their common use for subtitling as two key features to assess quality in MA (Agulló, Matamala & Orero, 2018; Gambier, 2018). The HbbTV standard specification is developed to enable the interoperability of broadcast and broadband contents and improve the video user experience for TV consumers (HbbTV, 2019). The latest specifications, such as HbbTV 2.0, allow the customisation of content and in particular, open up new possibilities to deploy personalised, synchronised access services (including optional signing), which are crucial to grant accessibility to information broadcasting (Martín, Orero, Menéndez & Cisneros, 2015).

> A truly hybrid approach would involve the delivery of the programme via the broadcast network (e.g., digital terrestrial television or satellite), the delivery of the signing interpretation video via the broadband network and a hybrid terminal able to mix both video signals in a picture-in-picture function. This implementation would be very valuable since it would enable directly customisation options (position and size of the signing windows in the screen). However, it would require a double-decoder TV terminal and this is an optional feature in HbbTV specifications. (Martín *et al*. 2015: 2).

Although the advancements in consumer electronics to create a truly-hybrid sign language service have been developed, fully-customisable optional signing services are not widely available in the market. This kind of implementation displaying the sign language video signal on the main video signal requires a double video decoder in the TV receiver set. However, producing receivers with a double decoder is more expensive and increases the TV set price, making it less competitive. For this reason, it is not a convenient option for manufacturers. Current innovative customisable applications are computer-based because software development is more flexible and less costly. However, this option is not available to offer live broadcasts on the TV set with synchronised picture-in-picture sign language.

Future commercial uses of the SLI services on TV can only be fully accessible and guarantee equal rights in media accessibility for all sign language users through personalisation of the format features (EUD, 2018). However, it is still unclear which features are to be implemented to fully explore the possibilities of the service customisation. Research that can validate the optimal parameters and features is key to ensure best practice in future commercial use and to provide guidance to broadcasters deploying the services. This present research aims to make a contribution in elucidating this unsolved issue.

Sign languages can be included on TV using different formats, methods of delivery and styles. Signing services on TV are commonly provided in an open format, that is the signer is either shot together or mixed with the main programme and is visible to all viewers.

Closed format, in which the signed content is transmitted separately form the main programme, allows optional signing services mixed in the TV set.

According to the International Telecommunication Union (ITU), the implementation of close (or optional) signing services "would be the third most valuable access service for society as a whole, though technology is not yet standardized for this" (ITU, 2014a: 22). This format uses dual transmission streams and requires either two streams in broadcasting, or one in broadcasting and the other in broadband (ITU, 2014c). Even though some broadcasters provide close formats for signing services, these are still expensive and are not widely implemented due to synchronisation issues. Future HbbTV technologies are expected to allow more cost-effective customisable implementations and delivery options for optional signing services (Orero *et al*., 2014). As for the delivery options, signing services can be implemented using different methods: on the HbbTV receiver, using web-based applications, using catch-up or VOD TV applications or offered on a second channel (Martín *et al*., 2015).

1.2.1 Types of signing TV access services.

Concerning the style of presentation of the language on screen, it is generally accepted that there are two main styles of signed programmes: sign-presented and sign-interpreted programmes (EUD, 2018; ITU, 2014b; National Disability Authority [NDA], 2014; Office of Communications [Ofcom], 2015; 2017). Sign-presented programmes show sign language users as presenters, contributors, reporters or characters. In this case, sign language is the main language of the programme and appears as the main image.

Sign-interpreted programmes include sign language to make the content of speech or other sounds in the mainstreamed programmes accessible. A sign language interpreter may interpret live (from either the audio or teleprompter script) or translate a recorded programme. In these TV signing services, the interpreter is commonly included using picture-in-picture technology. It uses either a wipe style, superimposed on the main programme image, or an overlay style with a split screen format where the signer image does not cover any part of the main programme (ITU, 2014b). The terms *on-screen* or *in-vision* translator/interpreter are used to refer to the sign language professionals providing signing services that are edited on the TV screen taking up part of the screen of the original programme image (Duncan, 1997; Stone, 2007).

Traditionally, SLI has been the major (if not the only) type of TV access service in sign language (Centro de Normalización Lingüística de la Lengua de Signos Española [CNLSE], 2015; National Deaf Children's Society [NDCS], 2005). As in other areas where information and communication needs to be made accessible, SLI has been regarded as the main resource to attain language rights and accessibility rights for sign language users (De Meulder *et al*., 2019; De Meulder & Haualand, 2019; EUD, 2010 [2012]; Haualand & Allen, 2009; Murray, 2015). However, Ofcom's best pratice guidelines indicate that "[s]ign language users particularly appreciate programmes presented in sign language; young deaf children who are learning sign language find it easier to understand and enjoy programmes presented in sign language, than those interpreted into sign language" (Ofcom, 2015: 22; 2017: 24).

Typically, TV sign language interpreters have been hearing professionals, including both native and non-native signers, however deaf translators/interpreters have been provisioned too. Deaf translators/interpreters on TV can carry out several professional tasks between written and signed modalities, such as sight-interpreting from teleprompter scripts in live programmes or sight-translating. Additionally, they may function as relay interpreters between different sign languages or language varieties. Although, this more recent professional profile is not yet widely appointed by broadcasters, it has been argued that skilled deaf interpreters should be preferred over hearing interpreters for multiple social and political reasons, including that they provide a better cultural and linguistic match with the target audience and promote empowerment and awareness (Allshop & Kyle, 2008; De Meulder & Heyerick, 2013; Duncan, 1997; Stone, 2005; 2007).

1.2.2 Guidelines and technical requirements for SLI services.

Even though sign language made its first appearance on TV nearly 70 years ago (Ladd, 2007), signing services and, in particular, SLI services, are still underdeveloped and under-researched TV access services. On the accessible formats and language section of its position paper, EUD emphasises that “access services used to render audiovisual content accessible must be of high quality to ensure meaningful accessibility for the user” (EUD, 2018: 4). The European stakeholder considers that both the language and the format features used to deliver the message impact the quality of the AV access services (EUD, *ibid*.). Both factors have a central role in either enhancing or jeopardising the service usability and, ultimately, accessibility to information content.

Current guidelines on best practices for TV broadcasters provide recommendations related to these two quality factors. On the one hand, sign language presenters and interpreters working on TV must be appropriately qualified and trained; on the other hand, several technical specifications and metrics regarding the format features and formal parameters must be met (CNLSE, 2017; ITU, 2014b; 2014c; Independent Television Commission (ITC), 2010; NDA, 2014; Ofcom, 2015; 2017). In the available recommendations it is generally accepted that broadcasters should monitor the quality of the service by getting feedback from users and stakeholders. Even though most guidelines mention the importance of running service user tests, some regulators overtly recognise that the guidelines provided are not based on tested techniques and acknowledge that the recommendations are rather tentative and speculative (ITU, 2014; NDA, 2014; Ofcom, 2015).

Some of the existing guidelines for signing services on TV are based on best practice guidelines and metrics from other multimedia content access services such as video books production guidelines (Pyfers, 2000), web accessibility metrics (World Wide Web Consortium [W3C], 2016), video interpreting best practice (Ryan & Skinner, 2015) or computer hardware and software accessibility regulations (Oliver, Martín & Utray, 2009). Even though some of the multimedia guidelines might apply to TV access services, it is also expected that some requirements and metrics will be specific to each media.

1.2.3 Sign language rights through SLI access services.

The service user perspective on quality criteria has gradually been introduced with results coming from both focus groups and surveys with deaf audiences (DTV4ALL, 2008; Gil Sabroso & Utray, 2016; HBB4ALL, 2017; Kyle, 2007; Steiner, 1998; Stone, 2007; Verwey-Jonker, 2003; Wehrmeyer, 2013; 2014; Xiao & Li, 2013). At the same time, the field of media accessibility on sign language interpretation still lacks critical investigation on tested techniques to produce guidelines that can constitute best practice for both broadcasters and stakeholders. In this context, ITU technical report on production guidelines for sign language service on audiovisual content accessibility urges to run user tests with sign language users as the best way to assess the quality of the sign language. "Tests should aim to assess all of the important characteristics, including the level of understanding, accuracy, objectivity, completeness, helpfulness, timing, visual appearance, and suitability for the programme content and audience" (ITU, 2014c: 6).

Taking into consideration the above, my PhD research intends to fill this knowledge gap. My dissertation focusses on studying, through user-centred tests, the formal parameters and features used to design and produce sign-interpreted audiovisual content that make up the visual appearance of the SLI on TV screen. The formal parameters and lay-out affect the legibility of the sign language on the screen. Since, legibility and readability are key aspects of accessibility, ultimately this present research aims at both improving content accessibility and service usability of the SLI TV access services. The intention is to propose a sign language-friendly design for the TV screen towards equal language and access rights for deaf sign language users.

Although within the inclusive paradigm the general population is regarded as possible users of the singing services, including not only the actual but also the potential Sign Language Community members, the PhD research is centred in the core service users: deaf sign language users. Taking into account the above, this PhD thesis is framed within a paradigm that encompasses two complementary conceptual models. On the one hand, this research is situated within an inclusive model of accessibility as a human right. On the other hand, I assume the model ascribing a dual category status to deaf sign language users. In the dual

category model, deaf signers are regarded as both persons with a disability and as members of a Sign Language Community (De Meulder, 2016; De Meulder *et al*., 2019; WFD, 2019)
.

Figure 1.1. Deaf sign language users rights. Adapted from the EUD illustration "Sign Language Rights = Human Rights" in Wheatley & Pabsch (2010 [2012])

Several authors have explored the intersectionality of access rights and human rights (Berghs, Atkin, Graham, Hatton, & Thomas, 2016; Ewart & Snowden, 2012; Greco, 2017) and the human rights for deaf sign language users (Haualand & Allen, 2009; Murray, 2015; Storch, 2007; Wheatley & Pabsch, 2010 [2012]; WFD, 2015). Figure 1.1 illustrates the above-mentioned combination of paradigms in which access rights, sign language rights and human rights are inextricable to deaf sign language users rights in order to ensure equality and full inclusion in society and to prevent discrimination and exclusion.

1.3 The Structure of the PhD

This PhD thesis is article-based and includes three academic papers. Chapter 2 includes the theoretical and methodological frameworks. Chapters 3 to 5 present the articles as published or accepted for publication in the peer-reviewed journals from different fields, including deaf studies, audiovisual translation studies and a special issue on translation and media accessibility. The final published versions of Articles 1 and 3, the open access papers, are included in Appendix 3.1 and 3.3 respectively. The link to the final published version of Article 2 is included in the list below and in Appendix 3.2. The three articles can be read as stand-alone research papers. They are presented in chronological order according to the sequential phases of the instrument-development variant of the exploratory sequential research design (described in section 2.3.1).

- Article 1: Bosch-Baliarda, M., Orero, P. & Soler-Vilageliu, O. (2020). Towards recommendations for TV sign language interpretation. *SKASE Journal of Translation and Interpretation,* 13 *(2)*, pp. 38-57. http://www.skase.sk/Volumes/JTI19/pdf_doc/03.pdf

- Article 2: Bosch-Baliarda, M., Soler-Vilageliu, O. & Orero, P. (2019). Toward a Sign Language-Friendly Questionnaire Design. *The Journal of Deaf Studies and Deaf Education,* 24 *(4)*, pp. 333-345. https://doi.org/10.1093/deafed/enz021

- Article 3: Bosch-Baliarda, M.; Soler-Vilageliu, O. & Orero, P. (2020). Sign language interpreting on TV: A reception study of visual screen exploration in deaf signing users. In: Richart-Marset, Mabel & Francesca Calamita (Eds.) 2020. *Traducción y Accesibilidad en los medios de comunicación: de la teoría a la práctica / Translation and Media Accessibility: from Theory to Practice*. Mon-TI 12, pp. 108-143. https://doi.org/10.6035/MonTI.2020.12.04

Following the convention on academic authorship used in the field of psychology and other human and social sciences for article-based thesis, the three articles of this present PhD dissertation are signed in co-authorsip with my two supervisors. The intellectual content, research ideas, design of the work and interpretation of data exposed in the articles are my own. Therefore, only I am accountable for all aspects of the work content in the above-mentioned articles in ensuring that questions related to accuracy and/or integrity of any part of the work are appropriately investigated and resolved.

The first article (Chapter 3) corresponds to the first phase of the exploratory research design and aims to collect and analyse qualitative data from two stake-holding groups, namely, deaf sign language TV consumers and TV sign language professional interpreters. And includes tentative recommendations for professionals and broadcasters based on previous literature and the findings from the qualitative studies including, respectively, focus groups and semi-structured interviews.

The second article (Chapter 4) focuses on the instrument development phase that functions as an intermediate step between the two research phases.

The third article (Chapter 5) corresponds to the final quantitative phase and aims to collect and analyse quantitative data from the service end-users, deaf sign language TV consumers. The instruments used in this phase were eye-tracking measures and closed questions survey questionnaires.

After the academic papers I present the required summary of the present dissertation in English, Catalan and Spanish (Chapter 6).

The concluding chapter (Chapter 7) provides a general discussion of the findings, results, conclusions, reflections and limitations of the different studies within the thesis. It also presents the contributions to knowledge and some future directions and recommendations.

Chapter 8 includes the bibliography. This chapter presents all the updated list of the consulted literature using a unified citation style for the references included in the different academic papers (using various citation styles as required by each of the journals' style guide).

Finally, the Appendices include the academic articles, as published, the research materials and documentation that complement the articles, and two additional co-authored publications regarding the a pre-pilot test and the instrument design phase of the present research, respectively.

Chapter 2

Theoretical and Methodological Frameworks

2. Theoretical and Methodological Frameworks

In this chapter (Chapter 2) I address the theoretical and methodological frameworks of this PhD thesis. Section 2.1 frames my research within the field of sign language interpreting (§ 2.1.1), media interpreting (§ 2.1.2) and user-centred reception studies in audiovisual translation (§ 2.1.3). In section 2.2, I present the research aims and objectives. The last section (Section 2.3) develops the methodology including the research design, strategies, hypotheses (§ 2.3.1) and methodological challenges (§ 2.3.2). Finally, I present an overview of the methods within the articles (§ 2.3.3).

To avoid repetition of the literature review, this chapter includes only the main references and authors relevant to the theoretical framework and the methodology applied. Further references are provided within the articles (Chapters 3 - 5). Complementarily, Chapter 4 (Article 2: Bosch-Baliarda, Soler-Vilageliu & Orero, 2019) presents a more comprehensive literature review on the development of sign language questionnaires, which is not included here.

2.1 Theoretical Framework: SLI in Media Accessibility

This doctoral dissertation has been developed as part of the PhD programme in Translation and Intercultural Studies (*Doctorat en Traducció i Estudis Interculturals*) at the Department of Translation, Interpreting and East Asian Studies (*Departament de Traducció i d'Interpretació i d'Estudis de l'Àsia Oriental*) of the Universitat Autònoma de Barcelona. My research is situated within the disciplines of sign language interpreting (SLI) and sign language translation (SLT), within the broader fields of interpreting studies and translation studies. Overall, the study of SLI on TV in this PhD thesis is approached from the perspective of media accessibility (MA) within the subfield of audiovisual translation (AVT).

2.1.1 SLI in interpreting studies.

In this dissertation, I depart from Franz Pöchhacker definition of *interpreting* as a "form of Translation in which a first and final rendition in another language is produced on the basis of a one-time presentation of an utterance in a source language" (Pöchhacker, 2004: 11). This definition accommodates interpreting from, into or between different language modalities (signed, spoken, and written) and variants of interpreting such as sight translation/interpreting, live (audio) subtitling or live audio description for performance.

The development of the research on SLI has been closely related to the development field of deaf studies. The central role of sign language interpreters is to give access to information and provide cultural and language links whenever deaf signers engage with (hearing) non-signers in wider society (Bontempo, 2015). Spoken and signed language interpreting, even though they constitute two instances of the same research discipline, had "for a long time been parallel endeavours, without any systematic reciprocal reception" (Grbić & Pöllabauer, 2006: 250).

Although SLI is a relatively young research area, the number of studies has been growing exponentially for the past 35 years and has fostered as a sub-discipline of interpreting studies and translation studies. Nonetheless, SLI has frequently failed to fit into one specific category within interpreting studies theory. At the turn of the 21st century more SLI researchers have shifted focus to find parallels, commonalities and intersections between signed language and spoken language interpreting (Bontempo, 2015; Grbić, 2007; Hale & Napier, 2013; Metzger & Roy, 2014; Napier, 2010; Pöchhacker, 2004; Pöchhacker & Shlesinger, 2002; Roy & Napier, 2015).

2.1.2 Media interpreting and SLI on TV.

Within interpreting studies theory many terms are in use, such as *types*, *modes*, *fields*, *modalities* and *settings*, applied to different categories of interpreter-mediated events, with the purpose of both to establish a typology and to define the subject area of interest in a given research. These terms are not always used consistently among authors and in most cases the boundaries between the categories are not clear-cut (Grbić & Pöllabauer, 2006; Pöchhacker & Shlesinger (eds.), 2002). Throughout this dissertation I use the terms as defined by Pöchhacker (2004). According to Pöchhacker, the area of both theoretical and empirical research on interpreting studies can be mapped out following a set of eight dimensions: (1) medium, (2) setting, (3) mode, (4) languages, (5) discourse, (6) participants, (7) interpreter and (8) problem.

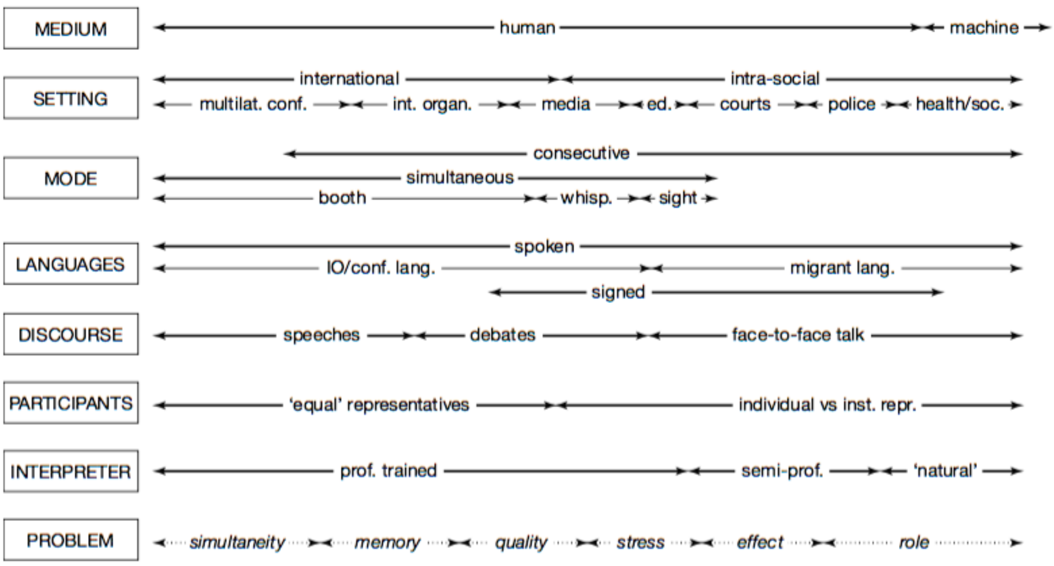

Figure 2.1 Domains and dimensions of interpreting theory (reproduced from Pöchhacker, 2004: 24)

In Figure 2.1, the author illustrates the broad spectrum of phenomena within interpreting studies. On the vertical axis the different dimensions suggest major subdomains of interpreting practice and theory, the horizontal axis includes different examples of major research concerns and is designed to exemplify the varied nature of interpreting (Pöchhacker, 2004: 23-25). In this dissertation, I adopt Pöchhacker's terminology on the domains and dimensions of interpreting theory to distinguish media interpreting from other subdomains and describe the common characteristics of a typical SLI TV access service, as compared to spoken-language media interpreting.

Firstly, regarding the setting, media interpreting is considered a hybrid form within the inter-social to intra-social continuum. Sometimes, it is classified differently according to the language modality involved. Although there is no agreement among authors, spoken-language media interpreting is generally regarded as a special type of inter-social (or a conference-like setting) involving personalities and content from the international sphere. Yet it has an intra-social (or community-based) dimension because it "is essentially designed to make foreign-language broad-casting content accessible to media users within the socio-cultural community" (Pöchhacker, 2004: 15).

Under the paradigm that considers Sign Language Communities cultural and language minorities, SLI can be considered a type of community interpreting (CI), since it provides language services for a minority group intra-socially. As a result, signed-language media interpreting is more frequently aligned with community-based settings. Nadja Grbić and Sonja Pöllabauer acknowledge that SLI "can take place in typical CI settings (e.g. medical, social, legal), but is also used in conference and media settings and in settings that are not quite as common for spoken language community interpreters" (Grbić & Pöllabauer, 2006: 252).

Secondly, SLI on TV services also contrast with spoken-language TV interpreting regarding language modalities combination and directionality. On the one hand, spoken-language media interpreting typically happens between two spoken languages within one language modality. Following the tradition of conference interpreting, the directionality is into the interpreter's A language, her/his native or best active language. On the other hand, in the prototype case of SLI on TV the hearing interpreter works in a cross-modal language combination from a spoken language into a sign language, the directionality is thus into the "B" language rather than the native language of the interpreter (Bontempo, 2015). This language directionality is also referred to as *A-to-B interpreting*, *return interpreting* or *retour interpreting* (Pöchhacker, 2004). In addition, signed-language media interpreting differs from spoken-language in the production of the media contents, which need to be adjusted to fit a visual language in an AV media.

Thirdly, considering the mode dimension, SLI on TV cannot be classified into a single category as it can include simultaneous and consecutive interpreting modes along with sight-translation and translation strategies. Taking into account various variables, such as the time of preparation, the language modalities and the number of renditions or edits that might be made to the target text in sign language, what is generally called SLI on TV could actually be categorised as different translational activities where the boundaries between interpretation and translation might not be clear-cut. At one end of the spectrum, it can be found a prototypical simultaneous voice-to-sign interpreting AV media service (typically featuring a hearing interpreter with a minimum preparation time and no written text support) or a short consecutive sight-interpreting (for example when using a tele-prompter script) for live programmes. Voice-to-sign translation or text-to-sign translation services can be found at the other end of the spectrum, including both deaf and hearing professionals.

According to Leneham (2007) the key to distinguish SLI and SLT processes are preparability, the potential of correction and that the target text is captured for posterity. Complementarily, De Meulder & Heyerick (2013), adopting Daniel Gile's effort model (Gile, 2004; 2009), distinguish between translating and interpreting in visual media by means of differencing the processes and cognitive efforts that take place rather than taking into account the modality of the source and target texts (written, signed or oral). Some of media translational activities align with these characteristics and should be approached in the research area of SLT within the field of SLI (Napier, 2010). Hence media signed language interpreting practices can constitute a hybrid between interpretation and translation.

The working mode continuum can range from purely simultaneous interpreting for live programmes with virtually no chance of revision of the target text to fully translated texts for non-live programmes. Recorded programmes introduce more preparation time and more chance of correction and revision. In addition, the source language text can be reviewed or replayed in non-live programmes and the target text can be recorded and edited more than once during the production process. This would be the case for non-live recorded programmes which may involve different source text modalities and different interpreting/translation modes, skills and processes. Alex McDonald (2012) studied on-screen SLI in television drama and concluded that both interpreters and broadcasters need to be aware that both translation and interpretation are required when making TV programmes accessible in a sign language. This hybrid nature of the signed-language AVT is present in other interpreting domains and settings such as theatre interpreting or sign singing (Napier, 2010).

Throughout this dissertation when referring to the formal parameters to introduce SLI on TV, I use the term *sign language interpretation* or *SLI* in the broad sense to refer to the different translational activities that result in the broadcast of an on-screen or in-vision professional sign language interpreter edited taking up part of the screen of the original programme image, regardless of the differences in mode. In fact, both the signed stimuli created for the instrument questionnaire and the quantitative study of this research are instances of sign translated texts (see Article 2 and Article 3).

2.1.3 Reception studies in audiovisual translation: a novel approach to sign language interpreting on television.

In order to investigate the formal parameters of the SLI access services on TV contents, it is necessary to select the type of reception study to be performed. Reception studies in AVT are user-centred studies that aim to describe the way in which audiovisual (AV) products, including access services, are "processed, consumed, absorbed, accepted, appreciated, interpreted, understood and remembered by the viewers, under specific contextual /socio-cultural conditions and with their memories of their experience" (Gambier, 2018: 18). Most studies on SLI on TV have been based on qualitative methods such as focus groups or interviews and quantitative methods such as questionnaire-based surveys or, more recently, the use of eye-tracking technologies in lab-conditions.

Previous studies on SLI and SLT on TV mainly focused on the sign language content and presentation particularly related to the language and cultural skills or the interpreting/translating skills and techniques of the sign language media professionals (Verwey-

Jonker, 2003; Isal, 2015). Within this area, most SLI/SLT researchers study the role of the deaf T/Is as the preferred, most effective and desirable solution for TV accessibility from an intra-social or community-based perspective (Allsop & Kyle, 2008; De Meulder & Heyerick, 2013; Duncan, 1997; Kyle, 2007; Kyle, Reilly, Allsop, Clark & Dury, 2005; Prillwitz, 2001 as cited in Pöchhacker, 2004; Stone, 2007a; 2007b; 2009; Woll, 1991).

Only a few have also included questions to gather information on the quality of the signing service regarding the technical aspects and the user preferences on the formal parameters used to include the on-screen signer (Gil Sabroso & Utray, 2016; Kyle, Reilly, Allsop, Clark & Dury 2005; Van der Graaf & Van der Ham, 2003). Few authors have included behavioural measures with eye-tracker in their reception studies (Gutermuth, 2011; Whermeyer, 2013; 2014; Xiao & Li, 2013). The findings of these studies indicate that there is an overload of visual information and that attention allocation is not distributed equally on the different on-screen components. Sign language users mostly focus their gaze on the face of the interpreter and, to a far lesser extent, to the written captions and scene images. These studies conclude that the news presenter is not relevant to the deaf viewer and that it may actually add unnecessary visual complexity. Hence they also propose that news broadcasts for deaf sign language users be edited using a sign-presented style where the sign language is displayed more prominently and bigger in size.

Most of the above research on SLI on TV has mainly been conducted on news broadcasts which present a high density of different contents and a rapid speech rate above normal pace (Serrat-Manén, 2009; 2011). Research in other TV genres is even more scarce, although a few exceptions exist (McDonald, 2006; 2012; Steiner, 1998). Ben Steiner (1998) investigated comprehension of different types of signed output (sign-presented, sign-interpreted and sign-translated) to make recommendations for broadcasters and sign language professional working on TV. In his research, Steiner used different authentic footage. Alex McDonald (2006; 2012) analysed interpreters' renditions of sign-interpreted/translated on TV drama including domestic, medical, detective and historical dramas. His results show that both interpreters and broadcasters need to understand the complex semiotic nature of SLI on TV assignments as a hybrid translational activity that needs to involve understanding of AV contents structure and production. The present study aims to contribute in this less explored TV genres, in particular it the experiments in lab conditions are conducted using footage from a documentary film.

Since SLI as a TV access service aims to facilitate access to AV media, SLI on TV studies are ascribed to the research area of MA (Díaz Cintas, 2005; Orero, 2005; Remael, Orero & Carroll, 2012) within the subfield of AVT, along with the two more researched services, subtitling and audio description (Gambier, 2003). Even though AVT and MA are relatively new research areas within TS, contributions in these areas have grown spectacularly in the past 16 years (Orero *et al.*, 2018). Nevertheless, the bulk of the literature concentrates on subtitling and audio description access services, and sign language research is still marginal.

This PhD thesis aims to contribute to this research area conducting user-centred studies on the reception of sign-interpreted TV contents. Rather than focusing on the interpreter performance (signed verbal contents) or the type of signing service presentation (sign -presented, -interpreted, -translated), this present study aims to explore the formal technical parameters (non-verbal) their effect on legibility of the AV contents measured through the user's performative and behavioural responses.

User-centred reception studies for signing access services are still scarce and more research is needed to provide guidelines for both professionals and broadcasters working on AV media. Overall, as there are currently no internationally accepted standards regarding the technical formal parameters and features used to include SLI on screen, a huge variety of lay-outs coexist among and within broadcasters (Redón, 2014).

In the next section I introduce the research questions, aims and objectives of this PhD.

2.2 Research Questions, Aims and Objectives

This PhD thesis, presented as a compendium of academic articles, aims to explore the relationship between the legibility of AV contents and the formal parameters of the on-screen interpreter's presentation on the TV screen. The premises of the research concern the idea that legibility of the broadcast sign language is a prerequisite to information accessibility, so that it is important to guarantee equal access and equal rights to media accessibility for sign language users. In particular, the goal of this thesis is to answer the following research questions:

- Question 1: What formal parameters affect the usability of SLI access services on AV broadcast contents?

- Question 2: Which on-screen design features of the SLI parameters facilitate screen legibility and provide deaf sign language users with better access to AV content?

In order to answer both research questions and break down the research process into steps, one aim for each of the questions is put forward:

- Question 1 Aim 1 - To identify the SLI on-screen parameters and their relevance to content accessibility and SLI service usability.

- Question 2 Aim 2 - To explore the reception and processing of different split screen composites including sign-interpreted content —combining two variables— by deaf sign language service users in a documentary film.

For the purpose of defining the focus of the study and to help identify the variables to be measured, two specific objectives are set to bring about the first research question aim on SLI access service parameters and content accessibility.

- Objective 1 - to collect user preferences in relation to SLI on-screen presentations in order to establish which SLI on-screen parameters are more relevant to content accessibility.

- Objective 2 - to select two SLI formal parameters that might have an impact on content accessibility to be investigated in the quantitative phase.

Once identified the variables to be measured, the second question research aim is broken down into two specific objectives to establish the limits of the study on the reception of four different split screen formats implementing SLI access service. The four studied formats result from combining two conditions of the two selected variables.

- Objective 3 - to measure the deaf signing users' behavioural patterns of screen exploration using eye-tracking technology to assess whether attention allocation changes depending on the variables in the four different screen compositions.

- Objective 4 - to measure the deaf signing users' processing of content to evaluate accessibility to the documentary contents using linguistic comprehension and recall questionnaire scores for both language and scene information in the four different screen compositions.

In order to meet the above specific objectives, it is necessary to select appropriate research methods within a given methodological framework. In the following section, I present the design of my research based on quantitative and qualitative methods within a mixed-methodology approach.

2.3 Methodology

The literature survey reviewed in the theoretical framework section shows the exploratory nature of the present research. In order to achieve the main objectives, a mixed methodology was established based both on the exploratory nature of the PhD research question and on pragmatism, as the philosophical foundation for mixed methods research (Creswell & Plano Clark, 2007 [2011]; Tashakkori & Teddlie, 1998; 2003).

Within the areas of AVT and MA research, it has become commonplace to implement mixed methods designs to conduct user-oriented reception studies. “AVT scholars now regularly employ conventional questionnaires alongside psychometric methods such as self-rating scales and physiological instruments like eye-tracking, electroencephalography, electrodermal measures and heart-rate monitors” (Orero, Doherty, Kruger, Matamala, Pedersen, Perego, Romero-Fresco, Rovira-Esteva, Soler-Vilageliu, & Szarkowska, 2018: 106). Within this field area, the main researchers’ reason behind selecting these kind of mixed methods approaches is the triangulation of results seeking to find corroboration or correspondence of results from different studies (Orero *et al.*, 2018). It is generally accepted that by mixing both quantitative and qualitative approaches researchers try to overcome the particular limitations of each method (Creswell, 2014; Creswell & Plano Clark, 2011).

2.3.1 Research design, strategies and hypotheses.

The main reason underlying the choice of mixing methods for this present research was *development*. “Development seeks to use the results from one method to help develop or inform the other method” (Creswell & Plano Clark, 2011: 62). Within this framework, an instrument-development variant of the exploratory sequential design was selected. The rationale behind selecting this type of design was related to the scarcity of previous research implementing physiological quantitative methods to study the formal parameters of SLI on TV and the need to develop a valid instrument to conduct the quantitative study.

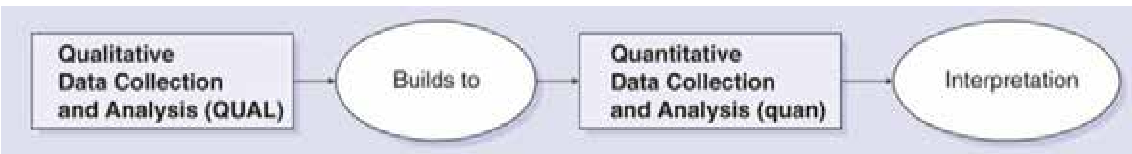

Figure 2.2 Prototypical exploratory sequential mixed methods design (reproduced from Figure 10.1 Three Basic Mixed Methods Designs in Creswell (2014: 270)

Figure 2.2 illustrates the phases of the exploratory sequential design using the mixed methods notation to convey the research strategies and procedures. Capitalisation indicates that a method is prioritised or emphasised, while lower case indicates lesser emphasis (Creswell, 2014). The prototypical exploratory design includes an initial prioritised qualitative phase (*QUAL*), typically within a constructivist paradigm foundation, designed for the purpose of collecting information and building on into the second and secondary quantitative phase (*quan*), with a post-positivist orientation (Creswell & Plano Clark, 2011). Such an approach allows for greater insight into the topic, increases the validity of the conducted studies and the reliability of the results. The design choice for my studies was based on the premise that an exploration was needed for at least two reasons:

- a research instrument was to be developed (because there were none available), and
- the relevant variables to study quantitatively were unknown and needed to be identified.

According to Creswell and Plano Clark (2011), "[i]n the instrument-development variant, the initial qualitative phase plays a secondary role [qual], often for the purpose of gathering information to build a quantitative instrument that is needed for the prioritized quantitative phase [QUAN]" (p. 90). In my research design each of the research questions and aims were addressed in one of the research phases or strands.

The initial qualitative phase (*qual*) was designed to answer the first research question (Question 1) and develop the necessary procedures to undertake the first research aim (Aim 1). This first phase aimed to provide results that could build on the second prioritised quantitative phase (*QUAN*), since the instrument development and the variables to be studied during the quantitative strands depended on the results from the prior qualitative phase. Another expected outcome from the qualitative data was to develop hypotheses that might be tested in the quantitative experiment, once the relevant variables to be studied had been selected. The second phase, including the quantitative strands, had the purpose to expand on the second research question (Question 2) and aim (Aim 2). Overall, the methodological strategies followed a deductive approach most typically used in quantitative research.

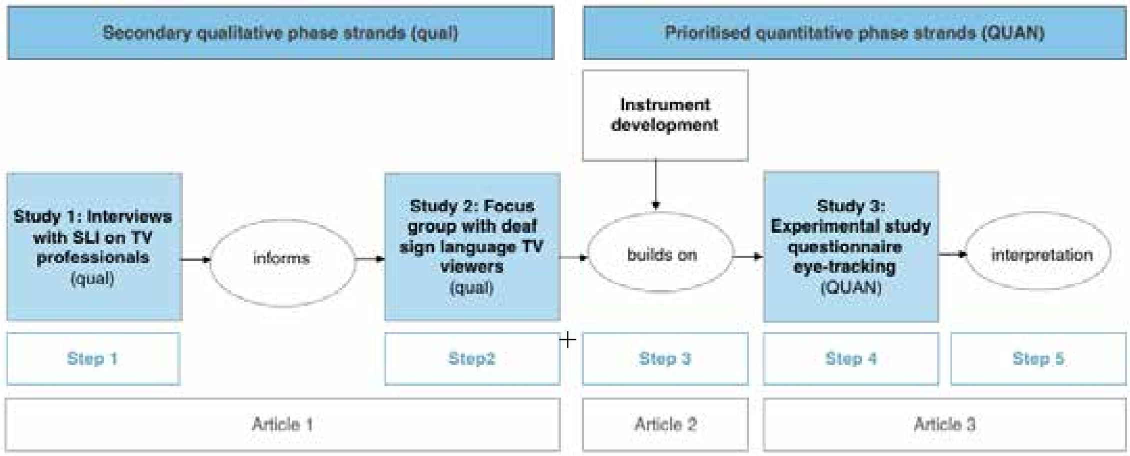

Figure 2.3 Visual model of the PhD research strategy implementing an instrument-development multiphase variant of an exploratory sequential mixed methods design

As illustrated in Figure 2.3, my PhD research was designed following a multi-step process within the exploratory model: qual qual QUAN. Concerning the initial exploratory phase, it was designed to include two different studies implementing different qualitative data collection methods to gather open-ended information from two relevant stakeholder groups. The first one included semi-structured interviews with professional sign language interpreters working on TV; the second included a focus group with deaf sign language participants that were SLI TV access service users. The interviews with the professional TV interpreters constituted a preliminary study used as a strategy to make informed choices and prepare the focus group session with the service users.

Both data collection methods aimed to deploy research Objective 1 —to collect user preferences in relation to the SLI on-screen presentations in order to establish which SLI on-screen parameters are more relevant to content accessibility— and Objective 2 — to select two SLI formal parameters that might have an impact on content accessibility to be investigated in the quantitative phase. The latter (Objective 2) constituted the primary mixing strategy within the mixed methods design as it interconnects the qualitative and the quantitative strands.

The detailed methods description used in both qualitative studies, including sampling strategies, materials, as well as the main findings of this research phase are subsumed in Chapter 3 (Article 1: Bosch-Baliarda, Orero & Soler-Vilageliu, 2020). Table 2.1 at the end of this chapter (§ 2.3.4) summarises the type of data, participants and main materials of this research strand. In the Appendices I annexed the following relevant research documents and materials: the questions for the semi-structured interviews (Appendix 1.1); the outline design to conduct the focus group (Appendix 1.2); Image release form (Appendix 1.3); Informed consent (Appendix 1.4); Written demographic questionnaire (Appendix 1.5).

After the initial qualitative phase, two variables were selected and they were operationalised with two conditions to produce four possible split screen formats to be tested in the experimental study designed for the quantitative research strand:

- Variables and conditions:

- Size of the SLI window: Small (1/5 of the screen width); Medium (1/4 of the screen width)
- Position of the SLI window: Right; Left

- Split screen formats:

- Format of SLI:
  - Small/Right (format 1, see Figure 5.1);
  - Small/Left (format 2, see Figure 5.2);
  - Medium/Right (format 3, see Figure 5.3);
  - Medium/Left (format 4, see Figure 5.4)

As mentioned above, the quantitative phase had the purpose to expand on the second research question (Question 2) and aim (Aim 2). The emphasis of the research strategy was placed on this latter phase, including the experimental reception study designed to accomplish Objective 3 and Objective 4.

- Objective 3 - to measure the deaf signing users' behavioural patterns of screen exploration using eye-tracking technology to assess whether attention allocation changes depending on the variables in the four different screen compositions.

- Objective 4 - to measure the deaf signing users' processing of content to evaluate accessibility to the documentary contents using linguistic comprehension and recall questionnaire scores for both language and scene information in the four different screen compositions.

The research hypotheses were set in relation to these specific objectives and tested with two different measurement tools: questionnaire and eye-tracker. The hypotheses are formulated here and discussed in detail in Article 3 (Bosch-Baliarda, Soler-Vilageliu & Orero, 2020).

- Regarding user behaviour in attention allocation (Objective 3),

- Hypothesis 1: there will be a difference in the number and duration of fixations and visits (eye tracking measures) between the two parts of the split screen;

- Hypothesis 2: the number and duration of fixations and visits (eye tracking measures) will be higher on the SLI screen than on the documentary scene screen;

- Hypothesis 3: there will be no significant differences in eye tracking metrics between the four formats;

- Hypothesis 4: the position will have an effect on the distribution of visual attention between the dominant and non-dominant sides of the SLI.

- Regarding user performance (Objective 4),

- Hypothesis 5: the size of the SLI screen stimuli will produce differences in user information recall measures;

- Hypothesis 6: users will obtain different visual recall scores when the scene screen is located in the right visual field or the left visual field;

- Hypothesis 7: the format of the split screen composite will produce differences in user information recall measures.

An experimental study in lab conditions was carried out in order to meet the above objectives and test the research hypotheses. The experimental study encompassed two quantitative data collection methods designed to collect close-ended information from a sample of the deaf sign language service users. One instrument gathered information online as the users were watching the clips in the different formats on behaviour, specifically attention allocation and eye movement measures. The second data collection method was a questionnaire designed to collect responses offline, after viewing each of the stimulus clips. This cross-modal bilingual questionnaire was centred on user performance and measured comprehension and recall scores.

The detailed description of the methods used for the experimental quantitative study is presented in Chapter 5 (Article 3), including participants and ethical procedures, apparatus, stimuli design, a detailed research design and procedures. The questionnaire design and development are presented and discussed in detail in Chapter 4 (Article 2). Table 2.1 below (§ 2.3.4) summarises the type of data, participants and main materials of the studies in the quantitative strand. In the Appendices I have included the following relevant research documents:

Image release form (Appendix 2.1); Informed consent (Appendix 2.2); Sample items of the cross-modal questionnaire (Appendix 2.3); Full written questionnaire (Appendix 2.4).

2.3.2 Methodological challenges.

This methodological approach to address reception studies in SLI on TV posed some difficulties. Since the preliminary stages of the dissertation proposal, my main methodological concerns were researcher bias and instrument validity.

2.3.2.1 Methodological challenge 1: Researcher bias.

Regarding researcher bias, the first issue that I encountered was how to overcome the issue of being a non-deaf researcher, that is, a hearing researcher and non-native sign language user within the Catalan Sign Language Community. De Meulder and collaborators state that “As a guideline, it has now become an internationally accepted standard that research on sign languages and S[ign] L[anguage] C[ommunitie]s should take place with strong involvement of, if not led by, deaf researchers” (De Meulder, Krausneker, Turner & Conama, 2019: 218).

From a sociopolitical perspective, my dissertation envisaged three social outcomes:(1) to make a relevant research for the Catalan Sign Language Community, (2) to contribute to knowledge transfer between researchers, broadcasters and stakeholders and, ultimately, (3) to advocate for the rights of Sign Language Communities to access information in their language. Accordingly, one important target of this PhD thesis was to control the cultural bias and incorporate a deaf-friendly perspective. A comprehensive literature review on deaf-friendly research methods is included in the literature review of Article 2 of this dissertation (Chapter 4).

Even though this research does not follow a participatory action methodology, some of the ethical principles and considerations of this model were adopted to help control this type of researcher bias (Chevalier & Buckles, 2013). With the intention to integrate engagement of the Catalan Sign Language Community, one of the measures was to make the research visible and open to suggestions from the stakeholders, specially before and during the qualitative phase. Following this principle, before the PhD research project was presented to the PhD commission, I participated in the *V Seminari de la LSC* in 2014. This first presentation was intended (1) to make the signing pilots from the HBB4ALL project visible to the Catalan Sign Language Community, (2) to arise interest in the research area of MA in sign language within the community, (3) to promote engagement between the researchers and this central stakeholder.

This initial participation had two positive outcomes: it proved very useful to get feedback from the participants and it was the first step towards establishing a collaboration with the national association of the deaf in Catalonia, FESOCA (*Federació de Persones Sordes de Catalunya*). During the initial qualitative phase, FESOCA helped disseminate the signed video messages with all the project's information, including the future users' tests, through its mailing list and social media. Besides, both the national association of sign language interpreters (ACILS, *Associació d'intèrprets de llengua de signes i guia-intèrprets de Catalunya*) and several local deaf associations were contacted pursing to enhance the awareness on the HBB4ALL project and the different pilot studies significant to deaf sign language users. Thanks to the support of FESOCA several deaf research facilitators from both the national and the local associations collaborated and helped me reach groups within the LSC community beyond my own personal and professional contacts, from different age ranges and social backgrounds. One of the unexpected outcomes was that deaf members of the Sign Language Community (not only from my acquaintances) started to send me related news and screenshots of different SLI on TV formats via personal video and text communications through the social media.

In fact, all the initial qualitative phase of the research design was included as a research strategy to allow the social needs and points of view of the Catalan Sign Language Community to shape my subsequent reception study. Rather than choosing two random variables to be tested in the quantitative phase or making an informed choice based on previous literature only, the methodological choice was to include the two data collection methods to allowed 'deaf voices' to build on into my research.

Throughout the qualitative and instrument design phases of the PhD, different presentations to disseminate both the research findings of the future quantitative phase were held in 5 local associations of the deaf within the area surrounding Barcelona: Centre d'Estudis de la Llengua de Signes Catalana (ILLESCAT), Llar de Persones Sordes de Badalona, Associació de Persones Sordes de Sabadell, Centre de Persones Sordes del Maresmes a Mataró and Agrupació de Persones Sordes del Ripollès. These on-the-road presentations proved to be very valuable to promote trust and engagement, as some of the participants later showed up as volunteers for the quantitative phase.

At a state level, while my data collection phases were still ongoing, I also participated in the *Congreso CNLSE* in 2014, 2015 and 2016 to make the preliminary results of my research public to the academia and the stakeholders. During this period, I also had the opportunity to be part of the expert group working towards producing guidelines to implement Spanish Sign Language on TV, directed by María Luz Esteban Saiz, the President of CNLSE (CNLSE, 2017). This also constituted an opportunity to get expert feedback on the qualitative phase findings from the different stakeholders.

Engaging in all these academic and non-academic activities for and within the deaf organisations helped me shape and develop my role as a researcher in the Catalan Sign Language Community and, hopefully, helped me blend deaf perspectives into my PhD research and minimise the bias of being a non-deaf researcher.

2.3.2.2 Methodological challenge 2: Instrument validity.

As mentioned in the above sections, one of the challenges of this research arose from the lack of standard instruments for the quantitative study. Within the field of AVT research, the development of standardised instruments is a constant need (Orero *et* al., 2018). Under the scope of the HBB4ALL project, and due to time and human resources constraints, the stimuli and questionnaire contents were adapted from the tests developed for the subtitling pilot in the HBB4ALL project (HBB4ALL, 2017; Oliver Moreno, 2017).

The content of the stimuli was taken from the documentary "Joining the Dots" by Pablo Romero-Fresco (2012). The central part of the documentary is an interview with Trevor, a man who became blind in his sixties. He explains his experiences and the importance of audio-description to access TV, cinema and theatre performances. The 4 stimuli video clips for the sign language pilot were created from the 11-minute documentary. In order to produce four different clips that would create similar conditions to test the four on-screen variables, several criteria were considered: duration, narrative content and linguistic content. A more detailed description on the clip design and adaptation is presented in Chapter 5 (Article 3).

The contents of the questionnaire items to assess user performance on reception were adapted from a previous subtitling pilot study. This study tested the user's reception in different devices, using the same documentary for the stimuli video clips. Oliver Moreno (2017) explains how the questionnaire items were created:

> To evaluate the different aspects […] we prepared a 10-question questionnaire with two different sections. 5 questions were related to the textual content of the clip and 5 to the visual content. The textual questions of the questionnaire were based on the content of the subtitles. For the visual questions, a previous study was conducted to establish the salient aspects of the clip. 32 participants saw the clips and after each one they wrote down five objects or visual clues that they remembered. The questionnaire was developed based on the frequency with which each object appeared. We followed this methodology based on the procedure used by Lavaur and Bairstow, (2011) (Oliver Moreno, 2017: 54).

To carry out the present PhD research the items of the questionnaire were adapted and translated and a web-based tool was developed to implement the sign-language translated questionnaire to enhance its validity. The cross-modal bilingual questionnaire developed was innovative because it used sign language as the main language for accessing, understanding and evaluating the information. The tool was designed to avoid subordination of sign language with respect to the written language so that the same social and linguistic statuses were given to both modalities in the experiment materials. Additionally, this design enhanced content validity of the results because it didn't require the participants to sight-translate the questionnaires in situ. It also gave a much more accurate and consistent variety of language use between participants and throughout the experiment, thus making it possible to obtain more reliable results.

On balance, the decisions taken considered several methodological criteria including both scientific rigour, accessibility issues and effective communication with the Catalan Sign Language Community members. The instrument went through several refinements during the instrument development. A description on the questionnaire design and translation/adaptation process is presented in Chapter 4 (Article 2). This chapter presents the ethical and methodological considerations attended to develop the questionnaire tool. It includes a comprehensive review of the existing tools to implement deaf-friendly questionnaire-based survey studies and presents the sign language friendly design developed in collaboration with the engineering team from the Polytechnic University of Madrid (*Universidad Politécnica de Madrid*, UPM). Appendix 2.3 includes different screenshots showing sample question designs and formats from the developed instrument. Appendix 4.2 includes the co-authored article "Design and development of sign language questionnaires based on video and web interfaces" (López *et al.*, 2019) detailing the technical aspects of the questionnaire design. The following section summarises how the different methodological aspects are addressed in the articles.

2.3.3 Overview of the methods within the PhD structure.

As described in the above sections, the three articles included in this PhD form a unified whole connected by having one develop and build on the other using different qualitative and quantitative methods. Each of the articles explores a different phase of the research design aiming building towards the final quantitative study to test the impact of the formal features used to broadcast sign language interpreted TV programmes on content accessibility to grant quality sign language access services and equal rights in media accessibility for sign language users.

To conclude, Table 2.1 provides a summary of the different research strategies and methods used in the articles presented in the following chapters (Chapters 3 - 5).

	Article 1 (Chapter 3)		**Article 2 (Chapter 4)**	**Article 3 (Chapter 5)**
Research questions and aims	Question 1 - Aim 1		Question 2 - Aim 2	
Research Objectives	Objective 1 Objective 2		Objective 3 Objective 4	
Research phase design	Qualitative phase		Instrument development phase	Quantitative phase
Data	Study 1 Literature review; Interviews with TV interpreters	Study 2 Focus groups with service users	Study 3 Literature study	Study 4 Experimental study
Participants	12 professional interpreters	8 deaf sign language users	none	32 deaf sign language users
Material	Screenshots from SignLang TV (Redón, 2014)	Screenshots from SignLang TV (Redón, 2014); Selected sign-interpreted video clips; Screenshots from Catalan professional SLI on TV	Video clips from the documentary film “Joining the Dots” (Romero-Fresco, 2012); Written recall questionnaires (HBB4ALL, 2017; Oliver Moreno, 2017)	Video clips from the documentary film “Joining the Dots” (Romero-Fresco, 2012); Sign language-friendly recall questionnaire Eye-tracker

Table 2.1. Research strategies and methods used in the PhD articles

Chapter 3

Towards Recommendations for TV Sign Language Interpretation

3. Towards Recommendations for TV Sign Language Interpretation[1]

Marta Bosch-Baliarda, Pilar Orero, Olga Soler-Vilageliu
Universitat Autònoma de Barcelona, Spain

Abstract: Sign language interpreting (SLI) on TV is still in need of basic research to support video production guidelines, a complex matter given the variety of sign language styles and screen layouts adopted by international broadcasters. The current paper aims to draft recommendations regarding the formal parameters for displaying SLI on TV. First, it offers an overview of current SLI access services. Second, it proposes a set of variables to be further studied. Third, it reports on feedback gathered from stakeholders. The article concludes with a list of recommendations that may be applied by broadcasters offering SLI access services.

Key words: sign language interpreting, accessibility, deaf TV service users, media interpreting, audiovisual translations.

3.1 Introduction

Sign language interpreting (SLI) on TV is one of the three major TV accessibility services, along with subtitling and audio description (European Parliament, 2010a; European Parliament, 2010b; European Parliament, 2015; International Telecommunication Union [ITU], 2014a; Looms, 2009). SLI access services need to improve both in terms of quantity and quality. On the one hand, affordability of the services should go beyond the amount of current broadcasting time (European Broadcasting Union [EBU], 2016; European Regulators Group for Audiovisual Media Accessibility [ERGA], 2016; Office of Communications [Ofcom], 2017; Haualand & Allen, 2009). On the other hand, the quality of the

1. This research has been conducted in the Department of Translation and Interpretation in the Autonomous University of Barcelona (UAB) within the PhD program in Translation and Intercultural Studies. This research has been partially funded by the H2020 projects ImAc grant no. 761974 and EasyTV grant no. 761999. All authors are TransMedia Catalonia members (2017SGR113, 2017).

SLI service may depend on various factors such as the language and interpreting skills of the interpreter, or the technical requirements impacting legibility of the signed content. "Television programmes […] may add layers of complexity by placing sign or text over the existing visual message. This creates interesting issues which are currently unresolved as to how to convey information with mixtures of signing, visual action, speech and text" (Kyle, Reilly, Allsop, Clark & Dury, 2005: 57). Hence, the importance of studying which formal parameters and layouts affect on-screen sign language legibility and overall screen readability. Both legibility and readability may impact on service usability and, ultimately the service user experience.

Previous studies, mainly from the past EU funded project DTV4ALL, indicated that users prefer an inversion of the content priority where SLI has (visual) priority over the broadcast content as can be seen in Figure 3.1 (DTV4ALL, 2008; Gutermuth, 2011; Kyle, 2007; Wehrmeyer, 2014).

Figure 3.1. SLI in the Danish broadcaster DR (reproduced from DTV4ALL, 2008)

While former research indicates that the screen composition as shown in Figure 3.1 is the preferred format for the inclusion of SLI on TV, these findings have not translated into standardised guidelines (Independent Television Commission [ITC], 2010; Esteban-Saiz, 2017; National Disability Authority [NDA], 2014).

The overarching aim of the present paper is to identify the best screen composition for broadcasting SLI on TV. In order to identify which formal features could be recommended to include SLI on the screen, we have conducted a qualitative analysis of current SLI practice. First, we analysed the screen compositions applied by 42 international broadcasters (section 3.2), to identify the variety of formal features that may occur. Second, we gathered feedback from stakeholders in Catalonia —SLI interpreters and deaf signing TV consumers— in order to evaluate the formal features identified in the previous phase and shortlist what features enhance user experience and usability (section 3.3). The hypothesis is that the preferred screen composite layout identified in previous research (see Figure 3.1), is influenced by the TV genre most widely available to deaf signing TV consumers, namely news broadcasts. Language information in news programs is more relevant than visual information, especially when the regular presenter is on the screen. This could explain why the interpreted sign language content is given a more prominent position than the broadcast content. Based on the findings from sections 3.2 and 3.3, section 3.4 offers a series of recommendations for the inclusion of SLI on TV broadcasts. Finally, discussion and conclusions are presented (section 3.5).

3.2 Data Collection from BroadcastersAcross 42 Countries

The first stage of the research was to understand which formal features could impact the reception of SLI on TV. To this aim, screen compositions were collected from different international broadcasters, offering an overview of the formal features applied by broadcasters within and outside of the EU. The first data were collected from the online platform Sign Language Television for the Deaf[2]. This platform includes different accessible TV programmes from broadcasters in 42 countries. From this website 100 screen shots were retrieved with the aim to classify the many features and formats used when presenting sign-interpreted programmes on TV (Redón, 2014). The Redón (ibid) data were analysed further, taking into account some of the common variable formal parameters and features

2. http://signlangtv.org/

previously described in the literature (Gil-Sabroso & Utray, 2016; Kyle, Reilly, Allsop, Clark & Dury 2005; Van der Graaf & Van der Ham, 2003). The selected parameters were: on-screen video production composition (Table 3.1), shot size (Table 3.2), interpreter clothing colour (Table 3.3), interpreter on-screen size[3] (Table 3.4), interpreter location on the screen (Table 3.5). Tables Table 3.1 - 3.5 present the different features analysed for each of the listed formal parameters.

Table 3.1. ***On-screen video production composition***

Picture-in-picture box	49%
Split screen	27%
Chroma (silhouette)	24%

Table 3.2. Shot size

Long shot (LS)	30%
Medium long shot (MLS)	7%
Mid shot (MS)	49%
Medium close-up (MCU)	14%

Table 3.3. Interpreter's clothing colour

Plain light-colour	14%
Plain dark-colour	62%
Patterned	24%

3. The features small/medium/big used for the size parameter correspond to
    - small size: less than 1/4 of the screen width;
    - medium size: between 1/4 and 1/3 of the screen width;
    - big size: more than 1/3 of the screen width.

Table 3.4. Interpreter's on-screen size

Small	24%
Medium	44%
Big	32%

Table 3.5. Interpreter's location on the screen

	Bottom	Centre	Top
Right	40%	21%	3%
Left	17%	19%	0%

Table 3.1 - 3.5. Formal features from 100 screen compositions including SLI from 42 broadcasters

The collected data analysis shows a great deal of variation among different broadcasters. It also shows an incongruity between the majority of screen compositions, and the user preferred option as shown in Figure 3.1. From the data collected in Redón (*ibid.*) the stereotyped format of SLI is: a female interpreter, wearing plain dark-colour clothes, filmed using a mid-shot and inserted on the screen within a medium-sized sub-screen on a bottom right location. Figure 3.2 illustrates this common format.

Figure 3.2. Common format of SLI on TV derived from the data analysed

The abstract common composition (Figure 3.2) versus the preferred composition (Figure 3.2) differ largely. These differences affect the prominence of the interpreter in both relative size and the on-screen video production composition. The most common format shows a medium size window inserted using picture-in-picture technology, including a medium-sized mid-shot interpreter, either side-by-side or overlaying on the news content. This contrasts with the preferred user format: a prominent interpreter in a foreground position inserted in a layer in front of the broadcast news content, with mid-long shot, occupying a third of the screen width (DTV4ALL, 2008; Kyle, 2007; Wehrmeyer, 2014).

Variation in formats is not only found among broadcasters from different countries within and outside the EU (EBU, 2016) but also sometimes within the same broadcaster. A second data collection process was designed in order to discuss the observed variation and understand which of the described formal parameters and features are perceived to affect legibility of the SLI on the screen the most. Information was gathered from two groups directly involved in sign language production and reception on TV: sign language interpreting professionals who currently work or have worked on TV and signing deaf people. For each group a different qualitative data collection method was designed and developed.

3.3 Collecting Data from Service Providers: TV Sign Language Interpreters

Sign language communities are a minority group. They include not only signing deaf people but also their families and the professionals who take an active role in their cultural and linguistic daily life (De Meulder, Krausneker, Turner & Conama, 2018; Harris, Holmes, & Mertens, 2009). Before SLI studies became part of mainstream education programmes, sign language interpreters were normally signing hearing children of deaf parents. Even today some professionals are CODAs (Children of Deaf Adults) or their relatives (Bontempo, 2015). In Catalonia (7.5 million citizens) there are some 25,000 Catalan Sign Language *(Llengua de Signes Catalana*, LSC) users, out of which 6,000 are deaf or deafblind (Cabeza & Porteiro, 2010).

3.3.1 Professional interpreters' interviews: Method.

We interviewed TV sign language interpreters to collect qualitative data. Sign language interpreters can both provide professional first-hand information and report specific feedback from their Deaf consumers. This method was selected to allow an interaction with the professionals on the pre-selected format features.

3.3.1.1 Participants.

Currently there are ten professional TV sign language interpreters in Catalonia working for both local and national broadcasters. These ten professionals were contacted through the Association of Sign Language Interpreters and Guide-Interpreters of Catalonia[4], (*Associació d'Intèrprets de Llengua de Signes i Guies-Intèrpret de Catalunya*, ACILS), and the Catalan Federation of Deaf People[5] (*Federació de Persones Sordes de Catalunya*, FESOCA). All potential participants were contacted either by phone or email.

Finally, a total of 12 professionals agreed to participate in the research, including nine active professionals and three professionals no longer working for TV (9 female and 3 male). The median age of the participants was 38 (ages raging from 30 to 46). All participants were certified interpreters. Six participants who received their qualifications after 2000 had a level 5 diploma in sign language interpreting and guide-interpreting. The other six participants had other qualifications and accreditations (four of them were CODAs). All the interpreters had at least 3 years of work experience on TV. On average, interpreters had 4 years of prior professional experience in different settings, other than TV.

3.3.1.2 Materials.

During the interview a personal computer was used to take notes and display a selection

4. www.acils.org

5. www.fesoca.org

of screenshots collected from the online platform Sign Language Television for the Deaf. The semi-structured interviews were designed in five sections: 1) personal and professional information, 2) professional experience with TV interpreting, 3) on-screen insertion formal features (including screen-shots when available), 4) feedback from Deaf consumers regarding on-screen insertion formal features, and 5) open questions about other professional and formal aspects not asked in previous sections. Sections 1 to 4 consisted of a series of pre-determined, open-response questions that all interviewees answered in the same order.

3.3.1.3 Procedure.

Prior to the interviews, a written questionnaire including the demographic information and outline of the pre-determined sections of the interview was sent to all participants. Respondents were asked to send screen-shots of their professional work in TV interpreting, if available. The preferred method of carrying out the interviews was face to face. Interviews were held in both public and private locations according to the interviewees' preferences to facilitate participation. Due to geographic distance and personal availability, one interview was conducted via video call and two via phone call. Due to time constraints one phone call participant did not finish all 5 sections. They were completed a few days later and sent via email. The interviews lasted from one to up to three hours. No participant was excluded.

All interviews started with sections 1 to 4. In section 3, if the professionals could not provide a screen-shot of their own on-screen insertion composition, they were asked to describe it, paying special attention to all the formal features. After the interview participants browsed the different screenshots collected from the online platform Sign Language Television for the Deaf. This was aimed to elicit further comments on formal features of SLI insertion. After the interview, the notes were sent via email to each participant to check its content. The implementation of this in-depth, qualitative research was spread over two months.

3.3.2 Professional interpreters' interviews: Results.

Interview results show that according to interpreters, both professional and signing deaf, the most important on-screen formal feature is size —provided that other more basic technical requirements are met (i.e. lighting techniques). Sign language on-screen size mainly depends on two formal features: sub-screen size and shot size. Although some broadcasters have an online feedback service, suggestions and complaint forms are rarely used. According to the public Catalan Corporation of Audiovisual Media (*Corporació catalana de mitjans audiovisuals*, CCMA) Accessibility and Audience Feedback Services, only 6 people contacted asking about the sign language service between 2015 and 2018 and none made reference to formal requirements (CCMA, personal communication, April 2, 2019). Frequently, deaf TV consumers address their feedback through direct contact with the TV sign language interpreters via personal and informal ways. This information was one of the results from the interviews. When discussing user feedback, interpreters mention that deaf consumers mostly complain about the sub-screen size being too small. Whenever changes are introduced, i.e. a bigger on-screen appearance, user feedback is always positive. Interpreters also note that shot size also influences the overall size perception. Feedback from the consumers point to a medium long shot as the preferred format. That is just a bit shorter than a knee shot, with some space above the head to allow signs in that region to be clearly seen.

However, interpreters working on TV sometimes need to adapt. When the sub-screen is too small interpreters ask cameramen for a shorter shot so the hand-size on screen is relatively bigger. Even though using a mid-shot imposes restrictions on the language signing space, it is always preferred to having a longer shot because it makes hand size look even smaller. During the interviews, interpreters mentioned that they always tackle these technical issues during their TV assignments, while broadcasters are generally unaware of them.

Background colour was the second on-screen preferred formal feature, and the feedback varies greatly. Reported colours went from plain white to grey, orange, all shades of blues and black, or even dotted or patterned backgrounds. This formal variation is due to aesthetic criteria to match or contrast with the general on-screen composition for a given TV programme. SL legibility on-screen partly depends on the colour contrast between the background and the interpreter skin and clothing colour. Colour combination contributes to the attractiveness and the visibility of the language presentation (World Wide Web Consortium [W3C], 2016). The interpreters also reported that service users mention that background colour not only affects legibility but also eye fatigue. SL interpreters in Catalonia tend to wear dark plain clothes, and in formal assignments black colour is always preferred over alternatives. All interpreters currently working on TV said they wear black clothes and mentioned that users tend to accept this as part of their uniform. Most users complaining about colour contrast would rather change the background colour than the clothing colour. The last formal feature is speed. This feature was not in our original list, but was brought up by professionals in their interviews as one of the most influencing factors to ensure communication. Most TV interpreters work on news programmes and speech rate tends to be higher than normal speech rate. According to Serrat-Manén (2011) CCMA news interpreted into sign language show a rate of 2.8 words per second. This result is very high compared to signing news produced by deaf people at Gallaudet university in Washington DC. Professionals found difficult to convey every single word. Common interpreting strategies to compensate high-speed rate are to paraphrase, compress or omit some information such as transitions between news or greetings (see Isal, 2015 for an analysis on the sports news in the Catalan broadcaster). Also reported by interpreters are the reading difficulties when finger-spelling names, especially for uncommon longer names in foreign languages. An interesting solution reported was to buffer TV reception to allow for personalised speed. It is worth mentioning that apart from a few exceptions all TV interpreters have worked in news broadcasting, and only three in other TV genres. One had also worked on a children's shows at CCMA and the two Catalan professionals working for the Spanish commercial TV channel *La Sexta* have also interpreted some films.

Both interpreters at *La Sexta* also mentioned negative feedback from deaf users about the interaction between subtitles and the interpreter sub-screen. In *La Sexta* subtitling, interpreting, and the digital on-screen graphics share the same bottom of the screen-area. From time to time these different layers of information overlap.

Consumers suggested that interpreting and subtitles should not be at the same on-screen level.

There was general agreement that the most frequent end-user feedback is on language features and content rather than on formal requirements. A common occurrence for interpreters is to be contacted about the use of regional dialectal signs or neologisms; also regarding the general linguistic skills and performance of the interpreter (either to praise it or to suggest improvements).

3.4 Collecting Data from Service Users: Signing Deaf TV Consumers

According to the European Broadcasting Union (EBU) report on accessibility services, public European broadcasters deliver sign language on 4% of programmes on average (EBU, 2016; ERGA, 2016). Although sign languages are under-represented in mainstream media, deaf signers are expert users on TV accessibility services and have an opinion. To determine key formal features and their hierarchy, it is important to gather their views. To this aim a focus group was designed as the primary qualitative data collection method.

3.4.1 Focus group with deaf users: Method.

In order to raise interest in the topic within the Catalan Sign Language Community, we contacted the National Federation of Deaf People of Catalonia (FESOCA). Contacts were also made by participating in the 5th Catalan Sign Language Seminar (Barcelona, 2014), which is a social and scientific event organised especially for LSC teachers and other members of the Sign Language Community in Catalonia. In this event we were invited to give a 40-minute presentation about the HBB4ALL project. Regarding the sign language pilot, we presented the data included in section 3.2. After the presentation, many deaf people showed interest and were willing to share their opinions with us. We also recorded a recruitment video message in LSC asking for collaboration in a focus group to discuss the on-screen sign language formal features. FESOCA sent the video message to all the local associations, the majority of signing deaf people associations in Catalonia. The local associations then forwarded the information to their members.

3.4.1.1 Participants.

The recruitment video message had 184 views and a total of 13 users contacted to participate. A total of 8 participants took part across the 2 sessions, (7 female and 1 male). The participant median age was 43. The first session grouped older deaf people (with a participant median age of 63, ages ranging 50-72) whereas the second gathered younger users (with a participant median age of 23, ages ranging 22-38). This distribution was accidental, as users chose either session voluntarily.

All participants were deaf people from the Barcelona region, and part of the Sign Language Community. They all had either or both attended a deaf education center and were active members of a local deaf association. All were profoundly deaf, either congenitally deaf or deaf before the age of 3. They all reported LSC as their first language. Three of the participants were born to signing deaf families and 5 were born to hearing families, one of which reported to use sign language within the family occasionally.

In regard to TV and access services habits, they all reported having consumed both subtitled and interpreted TV contents when available. All but one of the participants mentioned they like to use both access services. 3 participants reported to have watched interpreted contents during the past 24 hours prior to the focus group session.

3.4.1.2 Materials.

The focus groups were conducted in a meeting room in Casa del Mar, a public venue close to a deaf high school in Barcelona used to host Catalan Sign Language Community events. The room was equipped with an overhead projector, a screen and a desktop computer. During the focus groups session different screenshots and video clips were displayed showing different screen formats and on-screen compositions.

The 4 participants were placed at two different tables in a V-shape facing the screen and the interviewer. Three different cameras were used simultaneously to record the session. Apart from the researcher two other people were present: a research assistant and cameraperson, both fluent signers. Three written forms were administered: an informed consent form, an image release form, and a questionnaire. To fill in the relevant forms and complete the last task of the session there were pens, paper, coloured pencils, and crayons. The questionnaire had two parts: the first part was designed to collect demographic information including hearing status, language use and social participation in the Sign Language Community. The second part of the questionnaire gathered information about the habits of the participants as TV and accessibility service consumers.

3.4.1.3 Procedure.

LSC was the language of communication throughout the focus group discussion. At the beginning of the session the participants were welcomed and informed about the procedure and expected duration of the session. The three written information and consent forms were handed out. Both the researcher and the sign language research assistant helped to translate and answered questions about the content of the forms when needed. The focus groups aimed at discussing all the formal features of on-screen interpreting previously described in the initial data collection phase (see section 3.2) and those discussed on the interviews with the SLI professionals (see section 3.3). Results from the interviews were the starting point for the group discussion.

After gathering all the filled in forms, the group discussion began. From the beginning of the sessions it was stressed that the goal of the focus group was to discuss the formal features affecting sign-interpreted broadcasts, as opposed to discussing the interpreting skills and language skills of the SLI professionals.

Both focus group sessions followed a structured outline and made use of the same input materials. The session was organised in seven sections designed to provoke discussion on two topics: the formal features of SLI insertion on broadcast news, and different TV programme genres.

To focus the discussion, previous research within the HBB4ALL project was presented. All the analysed features of SLI on-screen observed in the first data collection process were summarised. Then 4 video clips (approximately 10 seconds each) were shown to illustrate different on-screen interpreting by the Catalan or Spanish broadcasters. The third section introduced the results from the interpreter interviews. The following sections aimed to introduce other formal features not previously discussed and not analysed with the previous data collection methods. To wrap up this first part of the session, ten screen shots showing a wide variety of formal characteristics of SLI on-screen were selected and displayed. They illustrated several compositions of the shown formal features and elicited new feature discussion. The participants were encouraged to add more formal features not previously described. The final section was oriented towards rating the formal features most and least important for accessibility. To close the session participants were asked to draw two TV screens on DIN-A4 white paper and depict the best and the worst screen compositions.

After each session we took notes to summarise the main issues discussed. The videos recorded during the sessions were edited to show all participants simultaneously using picture-in-picture. The relevant parts of the videos were transcribed using glosses for further analysis.

3.4.2 Focus group with deaf users: Results.

The results from the focus groups with the end-users are consistent with the feedback reported by the interpreters. The most important on-screen feature to grant accessibility was considered by all participants to be the size of the interpreter. Most agreed that approximately a third of a vertically split screen and use of MS/MLS would be best. Participants also agreed that different types of TV genres should present sign language interpreters using different compositions and formal features. They acknowledged that the only interpreted TV programme that they could access regularly in LSC was news broadcast, and they would need more experience and time to find the best composition for each TV genre. Regarding size, for example, most mentioned that for films or TV series they would prefer a smaller interpreter. They also mentioned the possibility of adjusting clothes and colours according to the target audience and content. Some suggested that for interviews, or some reality shows, more than one interpreter could be used in different parts of the screen to match speaker location.

Deaf users also considered colour contrast to be one of the most important features. However, they did consider the possibility of interpreters wearing colours other than black, as a way to prevent eye-fatigue and provide colour contrast. The participants also mentioned the need to be consistent in the future if colours and the interpreter dress code matched the type of programs and their targeted audience. The suggested colours for the interpreter clothing showed a wide range of preferences including: light, dark, bright, and the classic black. They all seemed to prefer plain colours with no patterns. There was no consensus regarding the background colour beyond contrast with clothing and skin colour. This was suggested to highlight linguistic details and to prevent eye-fatigue. Regarding colour contrast and the screen composition, most participants considered that embedding the interpreter in a framed sub-screen, rather than using chroma was a better way to guarantee contrast. Some participants mentioned that the contrast between the interpreter sub-screen and the screen should also be considered.

Deaf consumers also discussed the overlaying (or even overlapping) of subtitling and the digital on-screen graphic with interpreting on the screen. They all agreed overlapping should be avoided. Given the subtitles bottom screen display most participants agreed to place in a central position the sign language sub-screen. However, there was no consensus regarding the right/left location. However, participants agreed that the position parameter affected the overall screen readability. Interestingly, some said it was more comfortable to start by viewing the sign language on the right and then continue reading the subtitles whereas others argued the opposite.

When asked about the signing speed, most did not feel it was a feature that could be altered and would not elaborate further on this. They seemed to accept that news is delivered at a rapid pace of speech and that it is the interpreter's job to keep up with it, regardless of the challenges posed. They did point out that having the option to slow down the speed would make the content accessible for more people.

All the other features such as: gender, age, appearance or position, were considered irrelevant to accessibility. However, the groups agreed that certain aesthetics are important to appear on TV and always stressed the importance of interpreting skills, and cultural background. Further results and comments that arose during the focus group sessions are included in the next section as recommendations.

3.5 Recommended Features for Sign Language Interpreting Broadcasting on TV

In addition to the commonly agreed criteria mentioned in sections 3.2 and 4.2, in both sets of interviews additional criteria were proposed. The provisional recommendations for SLI broadcast we suggest in this section encompass our findings from the qualitative studies with previous guidelines for including a sign language in the video stream or in other multimedia content access services (for guidelines on TV see Centro de Normalización de la Lengua de Signos Española, (CNLSE), 2017; ITC, 2010; ITU, 2014b; NDA, 2014; Ofcom, 2015; for web-accessibility metrics see W3C, 2016; for signing video books see Pyfers, 2000; for video interpreting see Ryan & Skinner, 2015; and for hardware and software see Oliver, Martín & Utray, 2009). Finally, the recommendations on size and position of the interpreter on the screen are partially supported by the results from experimental tests using eye-tracking and recall measures (Bosch-Baliarda, Soler-Vilageliu & Orero, forthcoming).

3.5.1 Signer filming signer filming.

Lighting is crucial for sign language articulators to be clearly seen with no shadows or dark parts on or around the signer. It is especially important to control the signing space, the shot size and the eye-line. The signing space is the area in front of the signer, and is used to articulate all the signs. This is very important because sign language is a three-dimensional language using different active articulators: in the head, torso and arms including face, lips, tongue and eyes, shoulders and arms, hands and fingers (Pyfers, 2000). All these body articulators should be in shot at all times. Another important issue is that the signing space may vary from language to language, signer to signer, or even within different registers.

When filming the signer:

a. Check the lighting
b. When framing the shot: check the size of the signing space with the signer
c. Use a medium long shot to film the signer
d. When framing the signer: leave some room above the signer's head and on both sides
e. Use an eye-level camera angle with the signers' head at the level of the focus
f. Use a frontal or a semi-profile shot
g. Maintain the shot

Additionally:

h. Avoid shadows on or around the signer
i. Avoid long shots or close-ups
j. Avoid cut-offs
k. Avoid using different shot sizes
l. Avoid high and low camera angles

3.5.2 Interaction with the visuals and screen layout.

Sign language on-screen implies the presentation of a visual language on visual media. One of the key concepts to bear in mind is split or divided attention. Deaf signers need to attend to both the signed input and the visual media, broadcasting visual content. Not only promoting positive interaction with the on-screen visual information but also, avoiding negative interaction is fundamental to screen readability. The signer creates a positive interaction when relating the signing discourse to the visual information on screen. This is performed by pointing to the visuals or incorporating the visual properties of the objects on the screen into the signed discourse. On the other hand, negative interaction is created whenever blockages or obstructions occur. On some occasions, visual information blocks the signer, such as: digital on-screen graphics, on screen texts or subtitles. A fundamental requirement is to not obstruct the interpreter facial expressions or the hand-shapes. On other occasions, it is the signer who blocks, completely or partially, other on-screen visual information.

When designing the screen composition:

a. Facilitate positive interaction between the signer and the on-screen visual information
b. Provide the interpreter with all additional visual information prior to the interpreting/translation service (i.e. clips, graphics, tables)
c. Let the signer know where the visual information will appear on the screen prior to the interpreting/translation service (i.e. presenters, interviewers/interviewees, clips, graphics, tables)
d. Allow time to attend to all the visual information on the screen

Additionally:

e. Avoid any visual, on-screen information blocking the signer
f. Avoid the signer blocking any of the visual information on the screen
g. Avoid overlapping of the signer's "box", when using picture-in-picture or chroma key technology

3.5.3 Colour combination.

Colour contrast and combination are important to grant accessibility of sign language on screen. Three different aspects can impact colour interactions: background colour, the colour of the signer's clothes, and the signer skin colour. The colour combination can affect perception, legibility, and thus accessibility. Negative colour interactions can produce eye fatigue. Colour contrast and combinations have an even greater impact on accessibility for deaf-blind users. Deaf-blind people who typically use sign language services are congenitally deaf people who have acquired blindness later on in life; often they are not completely blind but have low vision, different eye conditions or are partially sighted.

Regarding colours:

a. Provide the signer with clothes that contrast with their skin colour
b. Provide the signer with one-colour plain clothes with no patterns
c. Use a plain, patternless background for the signer that contrasts with the signers skin
d. Use a dark blue plain background to grant accessibility to the deaf-blind users

Additionally:

e. Avoid multi-coloured or patterned clothes
f. Avoid multi-coloured or patterned background
g. Avoid dark spots or shadows on or around the signer

3.5.4 Shape and size of the sign language on screen.

Deaf signers normally mention the size of the signer to be the most important feature affecting legibility. It is important for older and deaf-blind users. The size and shape of the signer also reflect and affect the language status on broadcast media. The recommended minimum size established in earlier guidelines for picture-in-picture interpreters was at least one-sixth of the picture area, roughly 1/3 of the width screen, based mostly on news broadcast (ITC, 2010; Ofcom, 2015). However, this might not be optimal for other TV genres (Bosch-Baliarda, Soler-Vilageliu & Orero, 2020).

Regarding size and shape:

a. Present a "human-sized" signer

b. Use a rectangular-shaped signer's box, when using picture-in-picture technology

c. Provide a box at least 1/4 of the width of the screen

Additionally:

d. Avoid miniaturised signers

e. Avoid using circular or egg-shaped boxes when using picture-in-picture technology

3.5.5 Position of the sign language on screen.

The on-screen position of the interpreter is determined in terms of left and right along the horizontal axis, and top, central, and bottom along the vertical axis. The most common location is bottom-right. However, it seems there could be cultural differences or learning effects regarding side preferences. Whereas British (Ofcom 2015), Spanish (Gil-Sabroso & Utray 2016) and German deaf viewers (HBB4ALL 2017) prefer the signer to be placed screen-right, Catalan deaf viewers did not show a clear preference when it comes to the horizontal location of the interpreter. Similarly, Van der Graaf & Van der Ham (2003) showed that Dutch deaf viewers preferred the screen-right position (coinciding with the common broadcast format) but considered the screen-left area appropriate too. Results from the experimental reception tests indicate that left position might enhance overall readability (Bosch-Baliarda, Soler-Vilageliu & Orero, 2020).

On the vertical axis, central positions seem to facilitate reading the different visuals on the screen and to allow positive interaction with the subtitles. Position choice made by broadcasters is dictated by design criteria rather than accessibility criteria.

News broadcasts is the genre commonly chosen by broadcasters for signing services. Screen composition for news broadcasting includes the visual information, the hearing presenter and the sign language presenter or interpreter. Eye-tracking studies have shown deaf people do not observe the hearing presenter (Gutermuth, 2011; Wehrmeyer, 2013; 2014). Rather they concentrate their attention on the signer and sometimes attend to the main visual information on the screen.

Regarding the screen position:

a. Use a central position of the screen to present the sign language
b. Contact your national association of the deaf to know if they have a preferred position.
c. Choose preferably a left position and use it throughout your broadcast programs
d. Place the visuals between the signer and the news presenter

Additionally:

e. Avoid top and bottom positions
f. Avoid using different positions for different programs
g. Avoid placing the news presenter between the visual information and the signer

3.5.6 Recruitment of sign language professionals.

Broadcasters should employ qualified interpreters. It is important that broadcasters hire experienced interpreters, who have worked in a variety of interpreting settings, and have been exposed to different sign language users, so they can adjust to a wide range of registers, according to the programs and target audiences. Moreover, media interpreters need to be highly skilled interpreters. They should have native-command of the national sign language of the country and they should also have an updated knowledge of neologisms and terminology of current events.

Media interpreters should be highly skilled in their linguistic abilities, and also in their interpreting skills and strategies. They have to be suitably trained for TV interpreting, that is, they should be familiar with using a teleprompter, signing in front of the camera and having no feedback from users. These are some characteristics that novice interpreters might not be familiar with.

Recruiting sign language interpreters (including both deaf and hearing):

a. Contact the national association to learn about the sign language qualifications and training in your country
b. Hire only qualified, accredited or registered interpreters
c. Hire signers with native-command of their national sign language(s)
d. Hire experienced interpreters
e. Hire highly skilled interpreters
f. Offer training for signers and interpreters (media technologies)
g. Always ask for expert advice when casting or recruiting new signers/interpreters always ask for expert advice

Additionally, you should:

h. Avoid hiring novice interpreters
i. Avoid hiring untrained or unqualified signers

3.5.7 Preparation time and materials.

Service preparation time is crucial to grant interpreting quality in the visual media. The interpreter should have time prior to the actual interpretation in order to prepare the service. During this preparation time, the visual materials should be provided: the script, the step outline and/or the video clips that will be used in the program. Sign language is a visual language and the interpreter should interact positively with the visual media.

Before the sign language interpreting/translation service:

a. Provide all the audio-visual materials (clips, graphics, etc.)
b. Provide the script or step-outline
c. Allow sufficient time for preparation

Additionally:

d. Avoid introducing new visual materials without letting the signer know

e. Avoid hiring the signer only for the time of the assignment

3.6 Discussion and Conclusion

Our findings suggest that both target groups consider size of the signer and signing speed the two most important formal features determining accessibility. These findings are consistent with previous research for other sign languages. For sign language users size and speed are as important as the language contents, interpreters language skills, and interpreting skills (Steiner, 1998; Wehrmeyer, 2013; 2014; Xiao & Li, 2013 as cited in Wehrmeyer, 2014). Findings from the focus groups also suggest that the minimum size of the interpreter or the interpreter's box should be at least one-fourth of the total screen width regardless of the TV genre. This finding suggests a relatively big SLI. Previous guidelines suggested a minimum size of at least one-sixth of the picture area and were mainly based on news broadcasts (ITC, 2010, Ofcom, 2017). However, deaf SLI service users agreed that bigger signers such as those described as the preferred deployment in earlier literature would be appropriate for news broadcasts but not for other programme genres (as reported in section 3.4.1).

Another finding in our study is that miniaturised interpreters not only affect accessibility but also the language social status. Broadcasting small interpreters might have a negative impact on the TV providers reputation within the Sign Language Community. Deaf signing TV consumers seem to assume that deploying miniaturised signed content is a strategy used by broadcasters to comply with accessibility policies without providing actual access. Hence, customisation of size seems to be one of the formal parameters to be prioritised in future deployments.

Regarding the position of the interpreter or the interpreter's box on the screen, our findings show a greater variation. Previous literature suggests that users preferred a right-hand-side position (DTV4ALL, 2008; Gil-Sabroso & Utray, 2016; Kyle, 2007; Ofcom, 2015; Van der Graaf & Van der Ham, 2003; Whermeyer, 2014). However, the results from the focus groups show that users either preferred a left position or considered a right/left compositions to not impact on the accessibility of the service. However, the experimental tests using eye-tracking and memory measures indicate that there are significantly better results with screen composition designs presenting the interpreter on the left with a medium size (Bosch-Baliarda, Soler-Vilageliu & Orero, 2020).

In any case, both individual and cultural differences may exist due to a learning effect. Since the Catalan national broadcaster is currently deploying this access service using a left-central, on-screen position, Catalan deaf signers may have been influenced by their TV consumption habits. This contrasts with the interpreted content broadcasts in Spanish Sign Language or LSE (also available to Catalan deaf signers): According to Gil-Sabroso & Utray (2016), 90% of the interpreted broadcasts in LSE implement a bottom-right location. Regarding the vertical position, users also commented that they preferred a more central position to avoid negative interaction with the subtitles. Although studying the interaction between access services, subtitling and signing was clearly not our goal, we detected that deaf users exploit both services in many different ways according to availability, literacy skills, type of programme genre and personal preferences (Bernabé & Orero, 2019; Gaerts, Cesar & Bulterman, 2008; Kurz & Mikulasek, 2004).

In a similar unforeseen way, participants in both sets of interviews and focus groups pointed out that broadcasters deploying sign-interpreted contents tend not to have sufficient knowledge about the Sign Language Community as a language minority. According to the participants, some broadcasters still think that subtitling can grant full accessibility to all deaf people, regardless of their primary language of communication and thus think that SLI provision is redundant or unnecessary (see Neves, 2007 for a discussion on the divide between subtitling and sign language on TV). Additionally, lack of awareness of the sign language modality particularities sometimes leads to misconceptions and prejudices that can affect sign language representation on the screen. More specifically, interpreters report that broadcasters are not familiar with the professional role of the SLI or the existing technical guidelines to broadcast SLI. This unawareness can impact negatively on the service quality and might explain why this access service is still not widely deployed.

The results of our research are preliminary. This initial probing of the current practice is a first step towards further investigation into the issues of sign language interpreting and its TV presentation. The main limitation of our findings is the number of participants, which is quite low, as with most research in Media Accessibility (Orero et al. 2018). Our tentative recommendations should be further validated by more experimental research methods, like the ones used in studying size and position.

Given the new ways of customising accessibility services on TV (Mas & Orero 2018), there are various areas of research worth pursuing, including viewers' preferences regarding sign language presentation depending on the TV genre, the implementation of formal features or interaction between different accessibility services. We are at an important time since legislation, research and technology are joining forces to guarantee equal access to media. The social and personal inclusion rights should be equal across groups of disabilities, and that includes deaf TV consumers who are Sign Language Community members.

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Chapter 4

Towards a Sign Language-Friendly Questionnaire Design

4. Towards a Sign Language-Friendly Questionnaire Design

AUTHORS: Marta Bosch-Baliarda, Olga Soler Vilageliu, Pilar Orero

AFFILIATION: Universitat Autònoma de Barcelona

MAILING ADDRESS

Marta Bosch Baliarda

Edifici MRA 126 - Campus UAB

08193 Bellaterra

Barcelona, Catalonia

Spain (EU)

Authors' note

All authors are TransMedia Catalonia members (2017SGR113, 2017). This research has been conducted in the Department of Translation and Interpretation in the Autonomous University of Barcelona (UAB) within the PhD programme in Translation and Intercultural Studies.

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Abstract

The United Nations Convention on the Rights of Persons with Disabilities requests "Nothing about us without us." User-centered methodological research is the way to comply with this convention. Interaction with the deaf community must be in their language; hence sign language questionnaires are one of the tools to gather data. While in the past interacting with an online video questionnaire was out of the question, today it is a reality. This article focuses on the design of an interactive video questionnaire for sign language users. From a historical review of the existing literature on research methods and previous sign language questionnaire, the article examines the design features affected in the process of making accessible questionnaires with sign language videos: format and layout. The article finishes with the solution developed toward mainstreaming sign language questionnaires in order to contribute to a diverse and inclusive society for all citizens..

Keywords: sign language questionnaire, deaf-friendly data collection methods, video-CASI, accessibility, computer-based and web-based questionnaire

Questionnaires are a common instrument used for research. A set of questions extracts relevant information given to a sample of respondents to complete (Harkness, 2008). They are used in research over other data collection methods and frequently have standardized answers that provide easy to compile and analyze data. They are relatively cheap to implement, compared to other surveying or assessment instruments, such as interviews or focus groups (Survey Research Center, 2016).

As with any research instrument involving deaf participants, questionnaires need to incorporate a deaf-friendly perspective toward equity for the deaf population in both surveys and testing research. Questionnaires are frequently administered through the official, written languages and rarely present accessibility features, such as using Easy to Read (Bernabé & Orero, 2019). Cultural and linguistic lack of perspective in instrument design has a negative impact on both the appropriateness of the instrument itself as well as the validity of the results (Freeman, 1989). More recently, accessibility through computerized video technologies in questionnaire designs has promoted the possibility of incorporating sign languages. The application of information and communication technologies (ICTs) allows for deaf-friendlier design and also to implement translation protocols toward access to information for all users (Fontaine, 2012; Young & Hunt, 2011; Young & Temple, 2014). Moreover, designs are crucial when creating a fully accessible questionnaire to develop robust instruments to collect data on sign language from sign language users, within the sign language communities (De Meulder, Krausneker, Turner, & Conama, 2018; Harris, Holmes, & Mertens, 2009).

In this article we review the evolution of methods in filmed-based approaches that include sign language to make questionnaires accessible. Specifically, we look into the language accessibility features, design features, and administration modes implemented in previous approaches. We present our own methodological approach to create a sign language-friendly questionnaire design, taking into consideration time-efficient and cost-efficient limitations. The implementation is a computerized video questionnaire fully accessible in sign language that can robustly deploy a small-scale, research-oriented, sign language recall and comprehension test.

4.1 Towards a Deaf-Friendly Questionnaire Design

Fully accessible questionnaire designs in sign language are important to guarantee the reliability of the research and the validity of the results. They are also relevant both to protect ethical standards in human subject research within the deaf population and to promote accessibility to comply with the new, inclusive "human right" paradigm (Berghs, Atkin, Graham, Hatton, & Thomas, 2016; Ewart & Snowden, 2012). This is not only to control the bias that may arise from the lack of linguistic and cultural concordance between the researchers and the signing deaf participants (McKee, Schlehofer, & Thew, 2013) but also to promote inclusive research that undertakes and integrates the diversity inherent within the Deaf communities, especially regarding language accessibility: language choice and literacy (Guardino & Cannon, 2016).

4.1.1 Deaf-friendly research methods.

The literature for sign language research methods tackles specific knowledge areas in both theoretical and applied sign language linguistics (Meurant, Sinte, Vermeerbergen, & Van Herreweghen, 2013) such as sign language acquisition (Baker, van den Bogaerde, & Woll, 2006), sociolinguistics (Lucas, Mirus, Palmer, Roessler, & Frost, 2013), and sign language assessment (Haug, 2011). Both hearing and deaf researchers have focused on ethical considerations when conducting research within the deaf communities, particularly on communication accessibility, truly informed consent, and anonymity (Baker-Shenk & Kyle, 1990; Benedict & Sass-Lehrer, 2007; Gutman, 2005; Harris et al., 2009; McKee et al., 2013; Pollard, 2002; Singleton, Jones, & Hanumantha, 2012; Singleton, Martin, & Morgan, 2015; Sign Language Linguistics Society, 2016). Accessible communication and informed consent should be a priority for researchers. Additionally, privacy issues may arise from the fact that it is almost impossible to separate the video-recorded sign language data from the participants' identity; hence signed, accessible image release forms should be provided.

Some of these ethical considerations and guidelines on deaf-friendly research have been compiled by Orfanidou, Woll, & Morgan (2015) in their handbook Research Methods in Sign Language Studies: A Practical Guide. This text is a landmark on sign language research devoted to data collection methods and new instruments and tools for sign language research in different fields of linguistics, paying special attention to ethical considerations. Unfortunately, deaf-friendly questionnaire design using sign language as a mode of administration is not discussed. More recently, Cawthon & Garberoglio (2017) edited the text Research in Deaf Education: Context, Challenges, and Considerations, featuring an array of diverse research methodologies for the Deaf community. This volume includes a chapter on accessible, large-scale survey design in education (Cawthon, 2017). The chapter describes some considerations when developing large-scale surveys in deaf education, for example, how to control the heterogeneous demographics within the Deaf communities or how to enhance the recruitment process. In the section on accessible survey designs, the author argues that dual-language designs not only provide better access but also promote engagement within the deaf community. Although she advocates the use of technology platforms that fully support dual-language/dual-modality surveys is a requirement, technical design features are not further discussed.

A number of authors have included deaf-friendly methodological approaches and good practices in their research to promote cultural and linguistically adequate research methods. This means involving members of the Deaf community in the research process in meaningful ways following emancipatory or transformative paradigm approaches, not only as research participants (Harris et al., 2009; Mertens, 2005, 2010; Munger & Mertens, 2011; Mertens, Sullivan, & Stace, 2011). The participation of deaf native signers and deaf organizations in research teams is subsequently regarded as a key concern. Research teams should include different roles such as deaf researchers, deaf research assistants, deaf research facilitators, deaf interpreters or support communicators, and deaf-signing models (Ladd, 2003; McKee et al., 2013; Pollard, 2002; Singleton et al., 2012, 2015).

On the other hand, developing deaf-friendly research methods involves merging accessibility and communication best practices with different research materials, documents, and the dissemination of research projects and results. The potential of eAccessibility through ICT for social inclusion, and participation of all citizens, is increasingly allowing full integration in everyday life for all (Orero, 2017). The use of video protocols in computer-based technologies is an opportunity to represent the modality-specific visual features of sign languages (Haug, 2011, p. 46). Video technologies have also had an impact on the type of data and data collection methods for research involving sign language users, such as face-to-face video chatting or user-generated video sharing (Lucas et al., 2013, p. 548).

4.1.2 Language accessibility in questionnaire designs.

The language and culture of the participants can affect their perception of questions and therefore their answers (Choi & Pak, 2005). Ethnic minority groups have a higher rate of nonrespondence (Erens, 2013). This can be related to "language barriers, lack of trust, wariness of government authorities, perception that the research is unimportant or that their contribution is unimportant, reluctance to have their information written down, and a feeling that they have been over-researched" (Erens, 2013, p. 59). Similar factors have been described for signing deaf participants, though their low participation may be partially linked to participant fatigue (Cawthon & Garberoglio, 2017).

In this article we examine traditional monolingual-written text questionnaires using signing participants, because they are widely used in many research fields with sign language users. Hearing researchers may be unaware of the cultural and linguistic characteristics of the deaf community and vice versa. Understanding questions will depend on the respondent's literacy skills that can lead to uncontrolled variation in question misunderstanding bias and participant cognitive burden. Adequate language options and question wording are important toward the validity of the questionnaire design. Questions must be phrased appropriately for the target audience with the information acquired avoiding ambiguity and connotative meaning (Boynton & Greenhalgh, 2004). Even though it is still not common practice, our literature review includes several examples on explicit explanations, or overt discussion, on how data collection instruments and materials are made available to signing deaf participants and the language choices in which data and questions are presented.

4.1.2.1 Translation procedures in questionnaire design.

Most research is still developed in written languages. Translation should be performed according to standards to guarantee the quality of the instrument and to control the effects of translation (Harkness, 2008). The process of preparing, performing, reviewing, and assessing translated questionnaires is thus quite complex and costly (Erens, 2013).

There are different translation procedures and protocols devised to control translation quality and minimize translation bias that may jeopardize research results. One of the early documented translation approaches in sign-translated questionnaires is back translation. Back translation was a recommended standard for translating survey instruments (Erens, 2013; Survey Research Center, 2016). This procedure involves a specialist translating the text into the target language, which is then independently translated back into the source language. The original and back translated source language texts are compared to check if there are any translation issues in the target text. Even today, back translation is one of the most common translation techniques. Some of the reviewed questionnaires for deaf populations included professional sign language interpreters and/or signing deaf research team members carrying out the role of back translators in the development of the target video sign language questionnaires (VSL questionnaire; Brauer, 1993; Cohen & Jones, 1990; Goldstein, Eckhardt, & Joyner, 2004; Lipton, Goldstein, Fahnbulleh, & Gertz, 1996; Rojba, 2016).

Nowadays, best practices and guidelines recommend team translation approaches for survey instrument production. Currently, the common best practice in survey translation is the five-phase iterative team approach model called translation, review, adjudication, pretesting, and documentation (TRAPD; Harkness, 2008). The TRAPD method involves several translators, survey experts, and consultants and is pretested with a small-scale target population group before producing the final translation. The team members involved may take on one or more roles as translators, reviewers, or adjudicators. During the first stage, translators produce initial parallel translations independently. Then an expanded team including the translators and a reviewer go through the draft translations, discuss the versions, and agree on a review translation.

Adjudicators decide if the reviewed version moves to pretesting. Adjudication may take place at the review session, or at a different meeting between the reviewer and the adjudicator. All steps are fully documented. Documentation is a monitoring tool for quality assurance that provides information for further analysis. For example, team members take notes on compromised decisions, unresolved issues, or consultant feedback. The procedures are partially iterative. For example, pretesting may trigger further modifications of the translation before the adjudicator decides on the final version for fielding (Harkness, 2008; Survey Research Center, 2016).

4.1.2.2 Adaptation in sign language questionnaire design.

Sign linguists in the field of sign language tests have addressed methodological issues concerning translation and adaptation procedures to develop reliable and valid assessment instruments (see, e.g., Enns & Herman, 2011; Haug, 2011, 2015; Haug & Mann, 2008; Hermans, Knoors, & Verhoeven, 2010). Within the field, the term adaptation is used to emphasize that the goal is to create a test in the target language that parallels the source test not only in its language contents but also in its functionality. Although the translation process is assumed to be centered in faithfully rendering the source contents into the language of the target test, the adaptation process involves more flexibility in test construction and may introduce further alterations according to the cultural and social needs of the target language users (Haug & Mann, 2008, p. 139).

The goal of adaptation in cross-cultural questionnaire design is to match the needs of the target population, also known as "localization" in translation studies, as is the case in Pollard, Dean, O'Hearn, and Haynes (2009) for health education material for deaf audiences.The modifications "may be made to the content, format, response scale, or visual presentation of any part of the question, questionnaire, or instrument" (Survey Research Center, 2016). Sign language linguists have outlined several phases in the adaptation process of sign language assessment tests to ensure the standardization of the developed tools. These adaptation protocols aim to guarantee the validity and reliability of the test instrument (Enns & Herman, 2011; Haug, 2011; Hauser et al., 2016; Mann, Roy, & Morgan, 2016).

4.1.2.3 New language approaches in sign language questionnaire designs.

More recently, Cawthon (2017) suggests the inclusion of bimodal–bilingual for the development of research materials. The author favors a dual-language development process rather than designing survey items in the written form and the implementation of translation or adaption procedures. “Beginning the development of survey items with an understanding of how they may be represented in different linguistic formats holds promise in making large-scale surveys more accessible by design” (Cawthon, 2017, p.31). Dual-language development of survey items would only include concepts that are equally easy to express in both languages. They would control potential sources of bias and also provide a more accessible design for all participants.

A different innovative language approach to survey item development has recently been designed and implemented by Napier, Lloyd, Skinner, Turner, and Wheatly (2018), targeting multilingual deaf signers using multiple national sign languages from various European countries. Their goal is to implement a large-scale survey to engage a larger number of international participants from a broader range of linguistically diverse signing backgrounds. Because of time and cost restrictions, the authors choose to use International Sign Language for those users who lack literacy or prefer to use a signed language as opposed to a multicultural multilingual approach including many national sign languages. This solution also avoids prioritizing certain national sign languages over others, potentially excluding users of minority sign languages (Napier, et al., 2018, p. 104).

On balance, time and cost constraints will greatly influence the choice of language approach, translation, and adaptation protocols and procedures, as will study specifications such as sample size and standardization (Kappelhof, 2015). Adaptation and translation procedures may be determined according to the nature of the material being implemented and the project characteristics. Lastly, a successful questionnaire translation is expected to keep the content of the questions semantically similar or maintain the same stimulus and measurement options. It should also keep the question format similar between the source and target questionnaires, within the bounds of the target language (Survey Research Center, 2016). For sign languages that differ greatly in modality and have no established written form, much more research is required.

4.1.3 A Review of the Literature on Deaf-Friendly Questionnaires

Computerized sign language implementations for questionnaire research have rapidly changed, thanks to the advances of new technologies especially in the development of video technology and online survey platforms (Lucas et al., 2013, p. 54). When reviewing early research methods in sign language studies linguists often relied on written-only questionnaires for data collection on sign language structure and use. To present sign language stimuli, written forms of the signs or sign structures being analyzed were used in paper format questionnaires (see, e.g., Woodward, 1973, and Woodward & DeSantis, 1977). During the following decade, video protocols were introduced using the different video formats available. Early video implementations involved a written questionnaire with a video-taped sign-translated version that was played alongside (Brauer, 1993). Although this solution would give access to the content, the signed and written versions differed largely in format and layout.

The first attempt of a self-administered sign language questionnaire that did not require literacy was the Interactive Video Questionnaire, developed to question deaf people about drug abuse (Lipton et al., 1996). The questionnaire was implemented using a Laserdisc player on a standard television monitor displaying questions in American Sign Language. In Phase I of the study, the participants had a bar code reader that served to scan the responses and add them on the paper questionnaire answer sheet. In Phase II, touchscreen technology for automatic data capture and storage was used, which proved to be a simple mode of administration. Responses were recorded directly to the hard disk and then downloaded to a cassette tape.

For interviewer-administered tests, Haug (2015, p. 45), in his exploratory study based on an international survey on the usage of ICT for sign language test delivery, listed different test modes of administration including noncomputerized and computerized formats. Noncomputerized formats included, for instance, videotape (VHS and other formats) or DVD either with or without an accompanying booklet. Haug (2015) also listed some computerized modes of administration, for example, web-based tests or sign language tests implemented into existing learning tools such as Moodle.

There are many deaf-friendly designs implementing video protocols in order to give full access to signing participants. The term VSL questionnaire is used to refer to all instrument designs and modes of administration using video protocols that grant accessibility in sign language to a certain extent. This includes both computerized and noncomputerized modes of administration that have used different video protocols and technologies available since the 1980s.

There are three types of computerized survey instruments classified according to their mode of administration:

- Computer-assisted surveys using video clips are called video computer-assisted personal interviews, or video-CAPI. This is when a physically present interviewer administers the questionnaire and enters the answers on a computer or similar device.
- A video computer-assisted self-administered interview, or video-CASI, is when the respondent enters the answers on a computer provided by an interviewer who is physically present.
- Computer-assisted video interviewing, or CAVI, is when the communication between the interviewer and the respondent is established remotely via video chat.

In addition there are other terms that have been used in the literature to refer to video questionnaires specifically designed to include the use of sign languages as the language of interview administration. These video questionnaires are listed here in chronological order: interactive video-questionnaire (Lipton et al., 1996); animated questionnaire for deaf and hard of hearing (DHH) people, or ANIMAQU (Gerich & Lehner, 2006); dual-mode (CATI/CAPI) survey-computer-assisted telephone interview/computer-assisted personal interview (Sloan, Wright, & Barrett, 2012); virtual video survey (Lucas et al., 2013); and dual-language, dual-modality survey (Cawthon & Garberoglio, 2017).

In this article, the term used is VSL questionnaire to refer to the computerized deaf-friendly questionnaire designs implementing full access in sign language using video protocols. When it is necessary to distinguish between the modes of administration we use the short forms VSL-CASI and VSL-CAPI, for convenience.

In the 21st century, sign language assessment tests have been another important source of advances in computer- and web-based video sign language implementations (Enns et al., 2016; Haug, 2011; Haug, Herman, & Woll, 2015; Haug & Mann, 2008; Hauser et al., 2016; Herman, Holmes, & Woll, 1999; Hermans et al., 2010; Lara-Escudero, 2017; Mann et al., 2016). New methodologies have started to adopt VSL questionnaires as a mode of administration, such as sign language comprehension and video quality evaluations on technological devices (Cavender, Ladner, & Riskin, 2006; Tran, 2014; Tran, Kim, Riskin, Ladner, & Jacob, 2011; Tran, Riskin, Ladner, & Wobbrock, 2015) including synthesized sign language played by signing avatars or animations (Huenerfauth & Kacorri, 2015). Other VSL questionnaires are described in some research-led surveys and tests in different fields, such as Deaf education and sign language teaching applications (Hansen et al., 2018; Higgins, Famularo, Bownman, & Hall, 2015; Hussein & Al-Bayati, 2009), cross-modal language user tests (Lucas et al., 2013), cross-cultural social surveys (Fontaine, 2012), sign language teaching surveys (Pyfers, 2017), sign language interpretation (De Wit, 2011; Lang, 2015), or accessibility services and use of technology (Maiorana-Basas & Pagliaro, 2014; Napier et al., 2018), among others. Even though all these researchers acknowledged the use of a computer-based VSL questionnaire, the technical design of the implementations varies greatly, ranging from specially created, interactive applications to the use of existing online survey platforms that play video sign language content alongside it.

Moreover, for self-administered interviews, participants should go back-and-forth between the two versions, which would increase both time burden and cognitive burden, and therefore affect response time and nonresponse rate. Together with participant burden, this mode of administration still required some degree of literacy to match the sign language to the written in order to submit the responses. The written source questionnaire was laid out in a clear manner, containing not only the source language but also the main language of interaction with the test platform. The sign language version contained an additional target language with a less prominent or lower position, thus subordinating sign language to the official written language.

Nowadays, new technologies have allowed sign language interlocutors to interact virtually using their own language (Lucas et al., 2013). Deaf community members have rapidly become extensive users of mobile and computer applications that implement video technologies, such as video telephones, video chats, video calls, video blogs, video messages, or video sharing. At the same time, computerized, web-based instruments containing sign language have started to become more frequent. New technologies not only introduce the possibility of embedding video clips to develop web-based questionnaire application, but also existing online survey platforms (such as MonkeySurvey or Google forms), which introduce the possibility of inserting videos from video-sharing platforms (such as YouTube) and upload user video files in their features. These platforms and applications allow sign language on-screen setups following different technical designs that directly impact accessibility features, language status, and usability.

4.1.3.1 Accessible technical designs: question format and layout.

Most studies including a computer-based VSL questionnaire do not provide detailed descriptions, if any at all, particularly in regard to technical design, delivery format, and usability of the instrument. Some exceptions are Gerich and Lehner (2006), Haug et al. (2015), Lipton et al. (1996), Napier et al. (2018), and Samar, Barnett, Oyzon, Mowl, and Sutter (2012). After conducting a survey among sign language test developers, Haug (2015, p.37) acknowledges that none of the studies that had a computerized format addressed the usage of ICTs for sign language test development. According to the language of on-screen presentation, we distinguish two types of VSL questionnaires: One-clip VSL questionnaires and multiclip VSL questionnaires.

4.1.3.1.1 One-clip video sign language questionnaires.

One-Clip VSL-questionnaires show a written online survey with one video screen embedded, showing a videoclip of the sign-translated version (see Figure 4.1). Videoclips contain both questions/stimuli and answers in a single video sequence. Answers can be identified by using numbers, letters, vertical or horizontal lists. In order to make the videoclips and question sequence more usable in the signed version, some authors use one clip per questionnaire item: only one item is shown on screen at a given time (Barnett, Matthews, Sutter, DeWindt, Pransky, O'Hearn, & Pearson, 2017; Goldstein et al., 2010; Pyfers, 2017; Tran, 2014; cf. Huenerfauth & Kacorri, 2015 simultaneously display four questions and their response items on one screen).

Figure 4.1 One-clip layout for cross-modal bilingual VSL- questionnaire

The common layout shows the video at the top of the screen with the text version at the bottom or on the left. Typically, responses have to be submitted using the written format. For closed-ended questions the answer has to be selected from a set of predefined written responses, for example, yes/no or multiple choice. For open-ended questions, frequently, a text box requires the participant to write the answer (see, e.g., Fontaine, 2012; Goldstein et al., 2010; Huenerfauth & Kacorri, 2015; Pyfers, 2017). As with the noncomputerized video-taped questionnaire in Brauer (1993), this is an accessibility option that adds too much strain to the signing participant, as it only translates the linguistic content but not the format of the questionnaire. Additionally, it requires literacy and has limited interaction features with the signed video version. This might affect usability in an attempt to remove written language literacy requirements and enhance accessibility.

Some studies have used color codes and symbols instead of written options to submit responses in multiple choice and Likert scale answers (Gerich & Lehner, 2006; Kipp, Nguyen, Heloir, & Matthes, 2011; Napier et al., 2018; Pardo-Guijarro et al., 2015

4.1.3.1.2 Multi-clip video sign language questionnaires.

The second type of VSL questionnaire format is multiclip VSL questionnaire, which displays a combination of more than one set of videos simultaneously to present both the question and the selected answers in separate video sequences. Multiclip layout designs aim to reproduce standard, computerized written instruments, both in content and in layout to provide better adaptations.

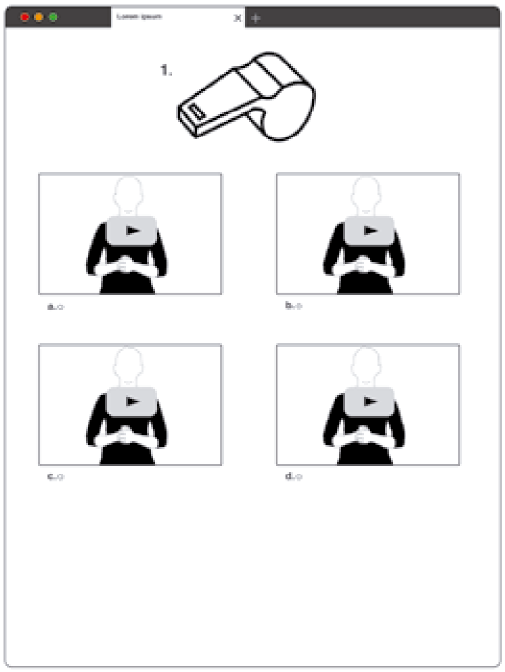

Figure 4.2 Multi-clip layout monolingual VSL-questionnaire

One of the most prominent advantages over other designs is that they are fully accessible in sign language and do not require written language literacy. Multiclip VSL questionnaires can implement monolingual questionnaires in the signed modality. Thus, they can provide improved reliability and validity of the survey or research instrument for sign language users, especially in the case of language assessment tests. Furthermore, multiclip formats are a way of implementing fully translated bilingual questionnaires, where sign languages can be laid out in a prominent on-screen position, removing the hegemonic subordination to the written formats.

Similarly, developing multilingual cross-modal questionnaires allows one to implement visual communication systems toward universal design. They grant access to a greater number and a wider range of potential deaf respondents within the diverse deaf population and their language choices in a number of ways (Graybill et al., 2010; Napier, et al. 2018; Tran, 2014). Multiclip formats present not only advantages but also limitations. Among the former they can reduce burden and nonresponse in questionnaires targeting deaf populations by offering choice of language and mode of questionnaire completion that might suit groups with differing communication skills. They may help to solve the issue of underrepresentation of the signing Deaf community in general population surveys. Finally, they provide better representation of languages in the signed modality and promote equality. Regarding limitations, they commonly display only one item—one question and the set of responses—at a time. Thus, they cannot provide an equivalent format for standardized questionnaires that present a whole set of questions (Dillman & Christian, 2005, as cited in Gerich & Lehner, 2006, p.271). Be that as it may, using computer-assisted VSL questionnaires has the potential to create better questionnaire adaptations and enhances accessibility for sign language users[1].

4.2 Implementing Accessibility and Usability Features in Sign Language Friendly Questionnaires

Our multiclip video sign language questionnaires were first developed withn the HBB4ALL project funded by the European Commission (CIP-ICT-621014; 2013-2016) as a web-based data collection tool for sign language interpretation pilot tests. The tests aimed to collect data about perception and processing of information of the contents, usability, and user preferences regarding size and position of the sign language interpreter on TV in four different screen configurations. The detailed design and procedures, results, and findings of the experimental pilot tests

1. See Gerich & Lehner (2006) and Haug (2015) for a review of the advantages and disadvantages of Video-supported CASI compared to traditional non-computerized data collection methods in the context of the research in sign languages.

are further presented in Bosch-Baliarda, Soler-Vilageliu, and Orero (2019). For the purposes of this paper we will first briefly describe the experimental procedure to provide a context to the questionnaire and later focus on the description of the design and development of the tool itself.

4.2.1 Experimental settings.

Participants in the pilot test were 32 deaf users (16 men/16 women) from the metropolitan area of Barcelona in Catalonia (Spain). Their ages ranged from 17 to 76 years (mean, 40 years). They were recruited through the Catalan Federation of the Deaf (Federació de Persones Sordes de Catalunya, FESOCA). All of them use Catalan Sign Language (LSC) to communicate in their everyday lives and have self-identified as being proficient signers.

The experimental task consisted of watching four clips extracted from the documentary "Joining the Dots" (Romero-Fresco, 2012). Each clip was displayed in a different screen configuration and an Eye tracker Tobii 60, controlled by a Toshiba Portable personal computer recording participant's eye movements.

Users were individually tested in different local Deaf association offices. After being welcomed, they had to fill out the consent and image release forms and answer the demographics questionnaire. Following these preliminary steps, the experimental procedure began. Each participant watched one clip and answered three questionnaires immediately after a visual recall test, a language recall test, and a user experience test to tackle usability and user preferences for each screen configuration. We did not include any questions to gather data regarding the usability of questionnaire itself. All tests were administered and recorded on a MacBook Air personal computer. This process was repeated four times, one for every clip.

4.2.2 Questionnaire design.

The design approach to develop the target questionnaires was a mixed mode. The source questionnaires were first created in written Spanish and were later translated into LSC for the target questionnaire. The initial approach in question design involved asking the same questions and translating, or the ASQT approach. The questionnaires developed for captioning user tests were taken as the source question sets. Later some questions were adapted to the visual culture of the Deaf community in Catalonia and others had to be newly created to address specific features of the sign language interpreter on screen presentation (asking different questions, or the ADQ approach; Harkness, 2008; Survey Research Center, 2016).

The translation/adaptation was dealt with in a one-team framework by a small team comprised of three members: one deaf native signer and two hearing nonnative signers. The deaf team member was a highly skilled sign language teacher for sign language interpreters and communication support workers. She has a vast experience as a deaf consultant in research and in creating and adapting educational materials into LSC. The second team member was a certified hearing sign language interpreter with more than 15 years of intensive working experience in many areas and skilled areas, such as TV. The third member of the translation team was the bilingual bimodal researcher assistant, trained in deaf studies, sign language linguistics, and sign language interpretation.

The translation procedures included two translations from the hearing team members reviewed by the deaf consultant. She fine-tuned the translations and also pointed out which questions should be further adapted. The final translation was thus collaborative and agreed on by the three team members. The team translated both the video clips for the stimulus and all the questionnaire items. The signing model for the translated documentary clips was down to the input of the professional hearing interpreter, providing a parallel input to the most frequent use of sign language on TV, whereas the signing model for the questionnaire items was the deaf signer, in order to provide a native input. Special care was taken when creating the linguistic recall questions to use the same lexical items in both the interpreted clips and the questionnaire items, questions and responses. Thus, the linguistic input was controlled in both dialect and phonological variation of the targeted signs. Failing to do so would make the evaluation of the participants' performance impossible to evaluate and would have compromised the validity of the results. Finally, all questionnaire items were video-recorded using a chroma key. A video protocol was the selected format so that the questionnaire input, accuracy, and consistency could be guaranteed throughout the pilot test.

4.2.2.1 Technical design features implemented in HBB4ALL questionnaires.

Even though the test was designed to be conducted with a small sample of 32 participants, the research team wanted to create a technical instrument design that allowed full accessibility of the questionnaire contents in sign language. The researchers wanted, on the one hand, to create a sign language-friendly data collection tool that could include video protocols to enhance validity and reliability of the instrument, especially for the sign language recall test. On the other, they wanted to create a deaf-friendly instrument that would enhance research engagement and usability of research tools by the targeted respondents, deaf sign language users. Additionally, we aimed to design a web-based on-screen layout that would attribute the same social and linguistic status to both language modalities, LSC and the written languages of the territory, namely Spanish and Catalan. This methodology was innovative because it had never been used in the country before nor in the field of accessibility research.

Because no existing online survey platforms allowed multiclip layout customization for the different types of questions (multiple choice, yes–no, etc.), the technical team members developed a multiscreen, computer-assisted data collection program that could implement the desired features. Both local and online versions were tested in the different pilot tests. Even though developing tools that allow implementations of questionnaires fully accessible in sign language was more time- and cost-consuming, it was an effort that was not to be avoided to grant research standards. For a more detailed description of the technical platform implementation, question technical designs, and technical formats see López et al. (2019).

Regarding language on-screen presentation, we wanted the research tool to be fully accessible in both signed and written modalities. The aim was to improve its usability within the diverse deaf signing communities, from skilled deaf signers regardless of their literacy levels to nonnative deaf signers that may rely on the written form or that prefer the written form to access certain questionnaire items, especially in the demographic questions. The platform was designed so that it could include a computerized sign language version of the informed consent and image release forms, so that these crucial aspects of the research tools were also accessible to signers who preferred this modality. Both forms were played or read before conducting the test and answering the questionnaires.

As in most of the previous multiclip VSL questionnaire designs, only one question was displayed on-screen at a time so that no scrolling was necessary. The multiclip question layout was designed to make LSC prominent on the screen (see Figure 4.3). The video clips for the questions were placed top center of the screen, and the different possible responses were displayed horizontally underneath. Each answer video clip was identified with a thumbnail showing the fingerspelling hand shapes for A, B, C, and D, respectively—or number hand shapes in the Spanish Sign Language test—to make them visually more distinct from the question video clips and to provide consistency throughout the different question designs. The written versions were displayed under each video clip.

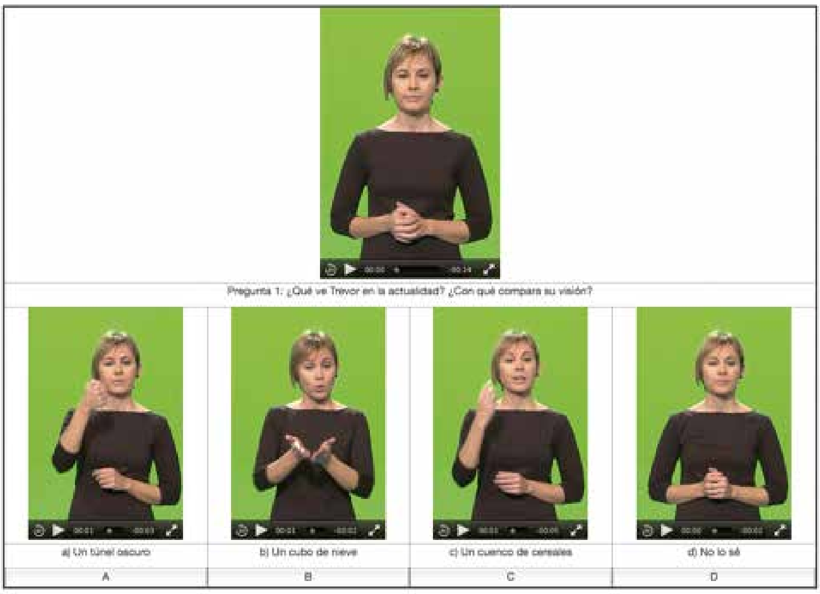

Figure 4.3 Screenshot of the multi-clip layout design from the Catalan Sign Language HBB4ALL cross-modal bilingual questionnaire.

To give the same status to both language modalities in the technical design we introduced an innovation for submitting the answers. As mentioned in Implementing Accessibility and Usability Features in Sign Language-Friendly Questionnaires section, most VSL questionnaires require participants to submit their responses using the written items, generally by a single click on the selected response or a bullet in line with the response item. In our questionnaire we wanted sign language to be the language of interaction too, so that both language modalities could play the same central role. To select the desired answers, participants could click on the video clip. Once the answer was selected, a blue frame would appear and the next button would be enabled. See Figure 4.4.

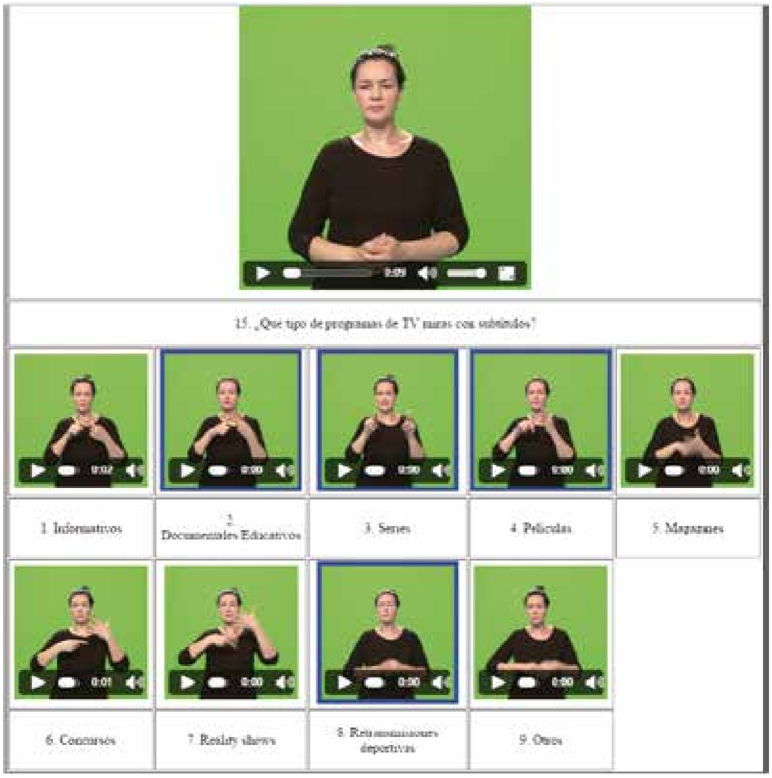

Figure 4.4 Screenshot of a multiple choice question design with 4 answers selected for submission in the Spanish Sign Language HBB4ALL cross-modal bilingual questionnaire.

Thus, participants' responses would not rely on their literacy, and they could avoid going back and forth between the written and signed versions of the questionnaire items in order to respond. This innovation was designed not only to improve the language status but also to reduce cognitive burden, response time, and overall time, which was one of our concerns regarding test duration.

A reproduction feature to allow "skimming" and "scanning" the videos was designed. The function was to make the user experience more comparable within the two languages in the fully cross-modal bilingual questionnaire. By swiping on the available answers the video clips were played automatically. Both the question and answer clips could be replayed, paused, forwarded, and rewound by clicking on the symbol buttons in a standardized video player bar.

Other features were introduced to improve the experience of older users, blind or partially sighted signers. For example, the speed rate and size of the video clips could be adjusted according to the user needs in order to improve usability and accessibility. Each video clip item could be played full-screen if selected.

4.2.3 Results

The participants acknowledged that it was the first time they had used a questionnaire fully accessible in sign language and positively valued the language choice offered in the bilingual–bimodal approach. They also valued the use of deaf signers. Although we did not include any formal controlled questions to gather feedback on the strategies used, some were discussed informally at the end of the test. All participants used both language modalities to some extent when completing the questionnaire. Participants with higher literacy skills skipped most of the video items, especially in the demographic and user experience tests, because it was much faster than going through the response items. However, they all watched the sign language version for the recall tests. Strategies regarding the language chosen to access the questionnaire items differed greatly. Some participants first read the written items and used the signed version to double-check comprehension, whereas some used the opposite strategy. For example, some users would watch the video first and then read the responses to "learn" the words for some of the signs they did not know previously. However, the signed version was mostly used for response submission.

The "skimming" feature was used both to previsualize the possible responses and to double-check the response before submitting the final choice. Younger participants exploited this feature more than older subjects, which helped them going much faster through the tests. Additionally, three older participants asked the interviewer to help them submit the responses, because they were not confident enough to interact with the computerized interface.

The other built-in accessibility features were scarcely used. None of the participants used the speed adjustment, and only one used the full-screen video feature in two questionnaire items. The size and color contrast of the filmed items was considered to grant accessibility to the signed content.

The web-based questionnaire design allowed automatically saving the results on the server. However due to server connectivity issues 5 recall test responses and 11 individual response items were not saved automatically.

4.2.4 Discussion of the current approach.

The present questionnaire design aims to encompass previous findings in the method designs developed for sign language assessment tests and in deaf-friendly surveying instruments. The resulting interface is an appropriate tool that can successfully implement a cross-modal bilingual questionnaire design. It not only is fully accessible in both sign language and in writing, but also provides a similar status of the two language modalities in both their on-screen representation and in their functionality, such as allowing participants to submit their answers through the interactive signed version of the responses. It has shown to be a valid research tool to implement an interviewer-administered sign language recall test that can match the modality representation of the stimuli, the questions, and the response items, and thus enhances the reliability of the results.

However, schedule and budget limitations together with the scope of the study impeded the implementation of more features that have been described for deaf-friendly surveying instruments, such as offering choice from different signing models using a wider range of sign language styles or other accessibility features in the written versions such as including Easy to Read. Similarly, other customization features such as offering background color choice were discussed but could not be implemented in this prototype version. Still, background color is a feature that could both reduce eye fatigue and improve accessibility and readability among signers with different sight status.

As already mentioned, computerized, sign-friendly questionnaires are the most affordable and reliable mode of administration that give access to sign language as a prerequisite to comply with ethical standards and achieve human rights for sign language communities in research. Nevertheless, this mode of administration holds some disadvantages when compared to traditional, written paper-and-pencil questionnaires. Namely, there are at least three major drawbacks: they are more expensive to produce, they are bound to technical malfunctioning, and sometimes there is increased time burden, as they take longer to be conducted.

Regarding the detrimental time factor, Graybill et al. (2010) acknowledge that access to answer choices in a sign language survey is necessarily sequential, unlike what occurs in a written survey. Participants in a written survey have a near-simultaneous access to all response items. They are able to scan and skim answer choices and reread them repeatedly, in any order, before making a final choice, whereas respondents to a VSL questionnaire have to watch and consider each answer in turn before selecting a response or replay any of the answer video clips. These authors admit that the modality differences greatly affect the experience of completing a survey, although VSL questionnaires would be more comparable to the experience of a telephone survey.

When designing our interface, we discussed some features in the questionnaire design to reduce the overall interview time. On the one hand, reducing time burden was one of the arguments for choosing a cross-modal bilingual design for all the questionnaire sets over a monolingual sign language design. This option clearly reduces time burden but introduces new sources of uncontrolled bias among and within participant responses.

Furthermore we wanted to implement some technical innovation that would allow simultaneous access to all the video responses. A first attempt in the design displayed all the signed response items playing simultaneously, nonstop along with the written items. However, this version produced too much noise and was not deployed. In this same direction, we finally implemented the “skimming” function that had to be activated by the respondent. This feature helped manage the sign-based version faster.

4.3 Conclusion

This article revised existing literature toward the design of a new sign language questionnaire. From the revision, the first recommendation is that data collection from end users should be performed in their preferred language and language modality. This is the safest way to avoid any polluted resulting data due to misunderstanding, biased replies, and lack of participation. Moreover, dealing with deaf sign language users means combining the language and culture minority paradigm of the sign language communities. Including sign language in all steps of research to grant full accessibility is a requirement to comply with the human rights of this minority group. In the human rights paradigm, authors generally agree that accessibility plays a central role, either as a human right per se or as an instrument for the fulfillment of human rights (Greco, 2016).

Therefore, removing communication barriers and granting accessibility to question content in sign language is a prerequisite in order to conduct ethical research with signing deaf individuals. Yet it is not enough to meet research standards. Specifically in questionnaire-based research, such as surveys or tests, it is equally important to develop robust instruments in terms of question design, format, and mode of administration to reduce affliction and participant burden and measure effects due to the language visual modality. Although the production of video sequences is time-consuming and costly (Gerich & Lehner, 2006), this is a prerequisite for result validity and reliability.

We have argued that multiclip VSL questionnaires are currently the best mode of administration for sign-friendly video-CASI. These questionnaires can deliver adapted designs for both signed monolingual and cross-modal bilingual tools. Whereas instruments fully implementing a sign language are necessary when carrying out sign language testing. Further adaptations may be necessary when the questionnaire is designed for surveying a wider range of deaf populations with different communication needs and language preferences. Deaf-friendly research instruments are crucial to any survey research within the social sciences that target a more general population. Deaf-friendly questionnaires should capture the inherent heterogeneity within deaf populations regarding the diversity of communication and literacy skills along with language choice and preference. Failing to do so would entail underrepresentation of deaf people, both due to noncontact (such as in telephone surveying) and a higher rate of nonresponse.

The literature review led to the finding that most VSL questionnaires happen in very specific field areas, such as health surveys or sign language testing. VSL questionnaires are not mainstreamed across any democratic citizen participation portal or any general topic. Moreover, differences are even greater when we have a look at the sign languages that have been implemented. The vast majority of computerized VSL questionnaires have been developed in American Sign Language, and just a few are sparsely found in other national sign languages: de Wit (2011) for Dutch Sign Language, Fontaine (2012) for Belgium Sign Language, Gerich and Lehner (2006) for Austrian Sign Language, Kipp et al. (2011) in German Sign Language, Pardo-Guijarro et al., 2015 for Spanish Sign Language, Napier et al. (2018) and Pyfers (2017) in International Sign System, or our questionnaires developed in LSC and Spanish Sign Language. An encouraging exception is found in the field of sign language assessment tests, where the collaboration between researchers and a well-documented tradition of procedures in test adaptation have favored the development of tools in multiple sign languages[2].

Cross-modal VSL questionnaires, displaying both a written language and a signed language, enhance the linguistic and social status of both languages represented, thus raising the status of the minority language. Additionally, they introduce new possibilities for universal design questionnaires that can simultaneously include different forms of communication. Cross-modal bilingual designs can thus provide better language accessibility and language choice and avoid or bridge literacy requirements. In fact, advances and innovations on computerized VSL questionnaires are promising and can benefit not only sign language users and researchers. Offering the possibility to choose and combine one screen several language variants, language modalities or other adapted visual communication systems, is a benefit not only for the diverse deaf population but also for the diverse general population.

2. Visit Sign Language Assessment Instruments hosted by Tobias Haug at http://www. signlang-assessment.info for a fully comprehensive resource; see Lara-Escudero, 2017, for an updated short list of the languages available.

However, there is still much need for research, collaboration, and development. Haug (2015) acknowledged that exploring ICT for sign language testing is a barely researched and indeed almost neglected area. This is still applicable to surveying and general questionnaire design in other field areas too. In our pilot questionnaires we implemented skimming advance and other customizations such as size and speed of the video. These are examples of better adaptations aiming to reduce both time and cognitive burden. However, more research is needed to promote new advances related to video processing and usability for video questionnaires. These advances should be widely available through cost-efficient technological platforms that should be developed collaboratively in research teams involving deaf professionals and consultants at all stages. All advances toward mainstreaming sign language-friendly and deaf-friendly questionnaires will thus contribute to a more diverse and inclusive society not only for deaf populations but also for all citizens.

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Chapter 5

Sign Language Interpreting on TV: A Reception Study of Visual Screen Exploration in Deaf Signing Users

5. Sign Language Interpreting on TV: A Reception Study of Visual Screen Exploration in Deaf Signing Users

Marta Bosch-Baliarda
Marta.Bosch@uab.cat
Olga Soler-Vilageliu
Olga.Soler@uab.cat
Pilar Orero
Pilar.Orero@uab.cat
Universitat Autònoma de Barcelona

ABSTRACT

We studied how sign language users responded to a screen composition including a larger screen for the content and a smaller screen for the sign language interpreter. 32 deaf users participated in this experiment, watching four similar clips with four different screen compositions. We registered the pattern of screen exploration with Eye Tracker, and we assessed content recall with two questionnaires. Our results show that sign language users mainly look at the sign language interpreter screen. Participants tend to look more often and for longer time at the SLI side closer to the main screen. Results are interpreted in terms of perceptual strategies developed by Sign Language users.

RESUM

Hem estudiat com els usuaris de llengua de signes (LS) exploren una composició de pantalla formada per una pantalla gran per al contingut i una de petita per a l'ILS. 32 usuaris sords han vist quatre clips similars amb quatre composicions de pantalla diferents. Hem registrat l'exploració de pantalla amb Eye Tracker i avaluat el record amb dos qüestionaris. Els resultats mostren que els usuaris miren principalment la pantalla de l'ILS i tendeixen a mirar més sovint i més estona el costat de l'ILS més proper a la pantalla principal. Els resultats s'interpreten en termes d'estratègies perceptives desenvolupades pels usuaris de LS

Keywords: Sign language interpreting. Accessibility for the deaf. Access in HBBTV. Service quality. Eye-tracking.

Keywords: Interpretació en llengua de signes. Accessibilitat per a sords. Accessibilitat en la televisió connectada. Qualitat dels serveis. Moviments oculars.

5.1 Towards the Accessibility of Sign Language in Media Platforms

Sign language interpretation (SLI) made its appearance on TV around 1950 (Ladd, 2007) and is thus considered one of three mature TV accessibility services along with subtitling and audio description (European Commission, 2010; European Parliament, 2010; European Parliament, 2015; Looms, 2009). There are also some newer, hybrid accessibility services, such as audio subtitling, and easy to read subtitles or audio description, often offered with personalisation options (Bernabé & Orero, forthcoming). Some more recent accessibility services to arise include clean audio and the numerous possibilities offered through personalisation options (Mas & Orero, 2018). Technology and end user lobbying are the two forces behind the development and mainstreaming of accessibility services.

The latest technological advances have contributed to an increase in informative, social and cultural content, transmitted through various media platforms. The new TV formats (Digital TV —DTV— and more recently Hybrid-Broadcast-Broadband —HbbTV or Smart TV) are mixed formats that combine TV broadcasting with Internet broadband access. These more recent formats allow the customisation of content and in particular, open up new possibilities to deploy personalised, synchronised access services, which are crucial to grant accessibility to information broadcasting (Martín, Orero, Menéndez & Cisneros, 2015). Validating the optimal parameters for any personalised access service implementation is key to ensure best practice in future commercial use and to provide guidance to broadcasters deploying the services. However, as for SLI it is still unclear which formal parameters are to be implemented to fully explore the possibilities of its customization, that grant quality sign language access services and equal rights in media accessibility for sign language users.

The provision of accessible audiovisual media services in Europe is covered by the European Audiovisual Media Services Directive. Article 46 of the directive states that access to audiovisual media forms part of the "right of persons with a disability and of the elderly to participate and be integrated in the social and cultural life of the Union" and specifies that "the means to achieve accessibility should include, but need not be limited to, sign language, subtitling [and] audio-description". Also according to article 7 of the Audio Visual Media Standard Definition (AVMSD), "Member States shall encourage media service providers under their jurisdiction to ensure that their services are gradually made accessible to people with a visual or hearing disability". It is then up to each member state to gradually make appropriate services available, with a view to reaching targets of 100% for subtitling of public-service broadcasting, and 10% for both audio description and sign language.

5.1.1 Sign language interpreting on television.

Stakeholders have devoted many efforts towards attaining information access (Orero et al, 2014). Deaf and hard-of-hearing people are active advocates of their language and cultural rights. Pursuing this goal and promoting development and improvement of services to access audio-visual content —namely, subtitling and sign language services. Traditionally, broadcasters preferred subtitling over sign language, arguing that it was more cost effective and that it allowed them to reach the entire target group of deaf and hearing-impaired persons (Grbic, 2002 as cited in Kurz & Mikulasek, 2004: 83). However, sign language communities strove (and are still striving) for their language rights; to grant full accessibility and the provision of access to media in sign language too. In Europe, a present example of this long advocating tradition can be found in the ongoing European Disability Strategy Survey organised by the European Union of the Deaf to gather information from different deaf associations within the EU (EUD, 2019). The survey tackles specific questions on the provision of sign language in public websites, public TV channels and TV programmes. The goal is to create a document for the European Commission detailing the real implementation of the strategy for deaf people as is actually experienced by deaf communities across the EU.

There are different ways to include sign language in TV programmes: sign-presented programmes, or programmes showing deaf sign language users as presenters, contributors or characters; and sign-interpreted or sign-translated broadcasts, as two ways to make the content of speech or other sounds in the programmes available to sign language users (National Disability Authority, 2014). Traditionally, media sign interpreters have been native and non-native hearing professionals, however deaf translators/interpreters have been provisioned too, providing a better cultural match with the target audience (Allshop & Kyle, 2008; De Meulder & Heyerick, 2013; Duncan, 1997; Stone, 2007; Stone & West, 2012). Most broadcasters provide access through sign language interpreting services on screen (CNLSE, 2015: 15; NDCS, 2005: 5). Even though SLI made its first appearance on TV nearly 70 years ago, it is still an underdeveloped and under-researched access service.

The report from the European Broadcasting Union (EBU, 2016) and the report from the European Regulators Group for Audiovisual Media Services (ERGA, 2016) point towards the need to improve the current standard of the service. On average, public broadcasters deliver sign language in 4% of programmes, mostly daily news (EBU, 2016: 40-41). When an accessibility service has a limited number of broadcast hours, as is the case with sign language services, it is important to prioritise the genre of the programme since it has social implications and secures the full participation of citizens in society and the fulfilment of equal rights (Geerts, Cesar & Bulterman, 2008; Mäkipää & Hämesalo, 1993: 9; NDCS, 2005; Seleskovitch, 1997: 562; Steiner 1998). The Council of Europe recommends that "information on daily politics, state developments and news should be made available to sign language users. This should be secured by in-vision sign language interpreters and subtitling in television; and/or by creating broadcasting formats/media (on TV or the Internet) made by sign language users in sign language(s)" (Krausneker, 2008:35).

Furthermore, not all broadcasters observe the compliance norms determined by the governments. Public broadcasters are obliged to offer their services to all citizens yet SLI is still not a mainstreamed accessibility service for broadcasters when compared to subtitling (Kurz & Mikulasek, 2004). For example, in Spain the General Law on Audio-visual Communication (Spanish Parliament, 2010) determines that Spanish public TV broadcasters must offer at least 10 hours/week of sign language, and commercial broadcasters must offer at least 2 hours/week. Although the number of hours, and number of broadcasters offering sign language access services has grown since the law was passed, the minimum of sign language broadcast hours have not yet been reached (CNLSE, 2015; CNLSE, 2017: 6; Utray & Gil Sabroso, 2014). Therefore, the targets concerning the quantity of SLI access services on TV have not yet been met, but more crucially the quality of accessible content in sign language in terms of on-screen representation has not been met either.

5.1.2 Sign language interpreter on-screen format.

In addition to the limited broadcast time and variety of TV genres offered in sign language, best practise guidance based on test results for this access service is also limited. Although some guidelines for broadcasters are available, (CNLSE, 2017; Independent Television Commission, 2010; National Disability Authority, 2014; Ofcom, 2007) they are somewhat tentative and sometimes created from parallel issues that have been recognised for other content access services rather than research on sign language on TV (National Disability Authority, 2014). Nonetheless, ITU In this respect, there are still central questions to be answered in order to find quality criteria , which will establish a good standard definition of SLI and offer an optimal service to the signing audiences. Which parameters are chosen by different broadcasters to deploy the SLI service? How can we define them? And, which are the best to deploy an optimal service?

In a survey carried out at our university, Redón (2014) found remarkable differences between 100 different broadcasters all over the world regarding size, shape and position on screen of the sign language interpreter. Soler-Vilageliu, Bosch-Baliarda & Orero (2015) identified within this sample several format parameters that differed among broadcasters: type of on-screen insertion (picture-in-picture / half screen (split screen) / Chroma key);

shot size (long shot / medium long shot / mid shot / medium close-up; interpreter's clothing colour (plain light colour / plain dark colour / patterned or multicoloured); size of the interpreter's screen (small / medium / large); on-screen positioning of the interpreter (right / left, top / centre / bottom); position of the interpreter (standing / seated).

Subsequently, these authors surveyed two focus groups in order to find out which parameters were relevant for the consumers of TV sign language interpreting (Bosch-Baliarda, Orero, Soler-Vilageliu, forthcoming). The participants were deaf sign language users that belonged to various Catalan Deaf Associations. All participants felt that sign language access services on Catalan/Spanish TV did not meet quality standards, as they understood them, in order to guarantee accessibility. It was their belief that Spanish broadcasters simply included sign language in their programmes in order to to comply with regulations but had no interest in providing accessibility to sign language users.

This survey clarified the relevance of some parameters, while others were considered irrelevant in terms of usability and quality of the SLI access service. For example, users considered gender, age, appearance and position of the interpreter to be of least importance. Whereas speed, size and colour combinations were the parameters that had a greater impact on screen legibility. In order to guarantee a good contrast with the background, most participants considered embedding the interpreter in a sub-screen with borderlines to be better than chroma keying. Using this technique, the background colour can be set to contrast with clothing and skin colour so that all three-dimensional language details can be perceived accurately, prevent eye-fatigue and enhance legibility.

All participants considered that the most important on-screen parameter to grant accessibility was the size of the interpreter's window. Most of them agreed that taking roughly a third of the split screen and using a medium shot or a medium-large shot would be ideal for news broadcasts. However, they acknowledged that it would not be appropriate for other television programmes, such as interviews, films or documentaries where a larger scene screen was preferred.

There was no agreement among the participants regarding the on-screen position of the interpreter: some participants indicated that they did not consider it to be an important parameter, some preferred left positioning over right. This result contrasted with previous findings in which users reported to prefer the interpreter to be located on the right side of the screen (DTV4all, 2008; Gil Sabroso & Utray, 2016). These contrasting results could be due to frequency of exposure or the viewers' habits. According to Gil Sabroso and Utray, Spanish TV on-screen presentation is in the bottom right position in 90% of programmes, whereas the Catalan public broadcaster inserts the SLI screen in a left position for its daily news programme. Catalan signers could therefore be accustomed to reading the split screen including the SLI in both on-screen positions. This result raised the question of whether on-screen position user preferences were influenced by culture and consumption habits or by more general, visual attentional behaviours. This information was used to set up our experiment, which we describe in section 5.2. Before that, we report briefly on previous research into eye movements and visual attention in sign-language users.

5.1.3 Information processing in sign language perception.

Watching TV with a split screen for SLI is a demanding task requiring skilled, divided attention, that is, distributing attention between the two simultaneous stimuli (Nebel et al., 2005: 760). Visual attention not only needs to be distributed between the two composites of the split screen, but also within the SLI screen. Sign languages embody a complex, visual language input using different body parts as active articulators to convey meaning, namely the hands, facial features, the head and movable upper body parts (Sandler, 2013). The existence of two identical, active articulators is a unique characteristic of the sign language modality. However, the hands exhibit different articulatory behaviours and do not tend to act independently. One hand is the dominant hand and is used as the manual, active articulator in one-handed signs an in two-handed signs in which only one hand moves. The dominant hand is generally the preferred hand of the signer. The other hand, commonly referred to as the non-dominant hand, may concur in the signal with different linguistic domains (Sandler, 2013). When used as a phonological unit in two-handed signs, the non-dominant hand is either redundant or largely restricted in the hand-shapes and movements it can exhibit (Battison, 1978). Therefore, the most visually salient articulators attracting visual attention would be the face and the dominant hand.

As Siple (1978) noted in her seminal paper 'Visual constraints for Sign Language Communication', sign language users tend to fixate on the face of their interlocutor. Although the hands carry the main lexical information in sign language, the face conveys very important cues to convey meaning in signed utterance (Siple, 1978: 96). Thus, according to Siple, signers look at the face during their communication and follow hand movements with peripheral vision. Later research in the literature was consistent with Siple's previous reports. Bavelier's (2001) research supported the idea that deaf individuals rely more heavily on monitoring peripheral, visual space to detect new information in their environment. Her results showed that deaf individuals displayed a bias towards better performance in the peripheral field than the central field, whereas hearing controls and hearing signers displayed the opposite bias (Bavelier et al., 2001: 8934).

Another visual processing feature that constitutes a specific, visual exploration pattern for the deaf is found in the lateralisation of motion processing. Bavelier et al. (2001) research showed left-hemisphere enhancement in the deaf. Behavioural studies of motion processing indicated that deaf individuals performed better in the right visual field (left hemisphere) than the left visual field (right hemisphere), whereas hearing individuals showed the opposite pattern (Bavelier et al, 2001: 8937).

More recent papers using eye-tracking devices also confirm Siple's observations. Agrafiotis, Canagarajah, Bull, & Dye (2003) studied the eye movements of 11 British Sign Language users while watching four short narratives. Their goal was to optimise the signal coding of the interpreter's recording by reducing the bit rate needed to transmit the video signal. They found that users consistently focused their attention on the face and mouth of the interpreter and did not focus on their hands. This finding helped them to adopt a foveated approach to sign language video coding that prioritises the quality of the important areas (the interpreter's head and mouth) and diminishes the bit rate of the surrounding areas. Left-hemisphere superiority was also reported for peripherally presented stimuli (Parasnis & Samar, 1985)

The finding of Agrafiotis et al. (2003) has been replicated by some other studies. Letourneau and Mitchell (2011) compared the ocular fixations of hearing people and deaf people, who tried to identify identity and emotions on expressive faces. They were presented complete faces as well as upper halves and lower halves of faces. These authors found that hearing people devoted more attention to the upper halves in order to identify identity and emotion, but deaf people devoted an equal amount of attention to the upper and lower halves of the faces. Therefore, they concluded that deaf people develop a specific visual exploration pattern.

This finding has been replicated in a recent study by Dye, Seymour and Hauser (2016), who pointed out that sign language users' attention shifts to the lower part of a visual scene. In their paper, the authors re-analysed the data from a former experiment (Dye et al., 2009). Dye et al. (2009) found evidence that both deaf adults and children (7-10 years of age) direct their visual attention to the periphery of the visual field. The new data analysis of 2016 suggests that users of a visual-gestural language (both deaf and hearing), favour a redistribution of visual attention to the inferior half of the visual field. The authors claim that this redistribution of visual attention is an adaptation that allows signers to focus their attention to the face in order to gather important information about meaning and intention of the utterances while, simultaneously following the information conveyed by the signing hands with peripheral vision.

However, these studies did not address the specifics of signing individuals watching contents with a split screen. Wehrmeyer's research (2014) pioneers the use of eye tracking metrics. Her study describes the viewing patterns of deaf and hearing users whilst they watch news broadcasts in a split screen showing both sign language, in a right position, and subtitles, in a central bottom position. As a main finding, her data indicates that deaf sign language participants focus their attention primarily on the interpreter and secondly on the imagery footage, but that they do not use subtitles or lip-reading to access the news contents.

5.1.4 Study overview

The goal of this present research is to contribute towards establishing quality criteria to help advance the deployment of SLI access services on TV in terms of perception and usability. The study explores whether or not there is an on-screen format, regarding size and position of the SLI split screen, that can enhance screen legibility and content comprehension, or one that is preferred or perceived as optimal by the users. To study this particular situation in sign language, users could contribute to bettering the development of sign language services offered by broadcasters.

This experiment is part of the sign language pilot tests developed within the European project Hybrid Broadcast Broadband for All (HBB4ALL) on media accessibility. Our experiment was designed to parallel the pilots with user tests on subtitling within the project (HBB4ALL, 2017; Oliver Moreno, 2017). In our experiment we wanted to explore whether watching SLI in different, split screen configurations has any effect on information access.

In the experiment the signing users watched four different parts of a documentary film that were edited using four controlled formats of split screen configuration. The different formats varied on two counts regarding size and position of the SLI sub-screen as independent variables: two sub-screen sizes (Small: 1/5 of the screen width; Medium: 1/4 of the screen) and two positions (right/left). See Figures 1 - 4 below.

In addition, we recorded participants' eye movements in order to collect data from deaf signing users' behavioural patterns regarding attention distribution, perception and information processing of stimuli on a split screen displaying two types of information on each screen: (1) The sign language interpreted, textual content on a sub-screen, and (2) the documentary scene with non-verbal content on the main screen. After each clip participants responded to three sets of questions on visual, verbal memory (language recall), visual, non-verbal memory (scene recall) and user preferences. The scope of this present article focuses on the results from the eye tracking measures and the recall tests only.

With these questionnaires we wanted to test user comprehension and recall of language content and visual information from the clips, and check if screen configuration had any effect on them. Is there any difference regarding visual exploration and attention allocation on the screen in the four different conditions? Do differences in attention allocation affect visual recall results (both language and scene)? Do SLI size and/or position affect how users read the on-screen sign language or comprehension and recall tasks? Are user preferences affected by visual exploration behaviours?

Regarding eye tracking measures, we want to investigate if there are any differences in visual behavioural patterns (number and duration of fixations and visits), and in turn, between the four format conditions (size and positions). We predict that there is a difference in the eye tracking metrics between the two parts of the split screen, SLI and Content screen. As previously found in Wehrmeyer (2014), we predict that deaf users will focus their attention primarily on the interpreter. Thus, the number and duration of fixations and visits will be higher on the SLI screen than on the documentary scene screen. As for the format conditions, we do not expect to find significant differences in eye tracking metrics between the four formats; in this respect our study is exploratory.

Although previous literature shows that attention is focused on the face and meaningful information is accessed from the hands through peripheral vision (Dye et al., 2009), we want to explore whether the visual, attentional patterns within the SLI area differ in the right and left position conditions. Left and right positions do not differ in the relative distance between the scene and the face, as a source of linguistic information. However, when a right-handed interpreter is displayed on the right side of the screen, their dominant hand (the right hand) is more proximal to the scene screen whereas the left hand is more proximal in the left conditions. We hypothesise that this will have an effect on the distribution of visual attention between the dominant and non-dominant sides of the SLI. If the professional interpreter is right-handed, we hypothesise that the number and duration of fixations and visits will be higher on the ipsilateral SLI area, the side of the body including the dominant hand (or H1).

Regarding the information recall measures, we want to explore if the recall tests produce different scores, according to the different conditions. We hypothesise that the size of the stimuli will produce differences. Our study is exploratory on this matter.

As for the on-screen position, we hypothesise that there will be a difference in recall scores between right and left positions. We predict that our participants will obtain higher visual recall scores when the scene screen is located in the right visual field. This would be consistent with the reported enhanced performance during motion visual tasks in the right visual field, left-hemisphere bias (Bavelier et al., 2001).

5.2 The Experimental Reception Study

5.2.1 Method.

5.2.1.1 Participants.

Participants in this study were 32 deaf sign language users (16 men/16 women) from the metropolitan area of Barcelona. Their ages ranged from 17 to 76 years (mean 40, STDEV 15). All of them reported using Catalan Sign Language (*Llengua de signes catalana, LSC*) to communicate in everyday life. They were recruited through the mailing list and social media of the National Association of the Deaf (*Federació Catalana de Persones Sordes, FESOCA*) via a written and signed video message with the help of deaf research facilitators. Two users were removed from the experiment due to technical malfunctioning.

5.2.1.2 Material.

5.2.1.2.1 Apparatus.

An eye tracker, a Tobii T60 integrated into a 17-inch monitor run by a Toshiba Portable personal computer was used to display the stimuli and record the participants' eye movements while watching the four picture-in-picture sign language video clips. The Tobii T60 screen has a resolution of 1280x1024. It has a sampling rate of 60Hz. The Tobii Pro Studio software for screen-based eye trackers was used to prepare, administer and record the experiment and for calculating eye tracking metrics and statistics. For statistical analysis and data preparation we used SPSS.

In the analysis, two areas were taken into account in the eye tracking (ET) metrics for the full duration of the clips: the area of interest (AOI) was drawn on the full SLI rectangle area and the remainder of the screen was considered scene (Not AOI). The SLI screen AOI was further divided into symmetrical areas on a vertical axis, either side of the interpreter: namely the ipsilateral side of the torso for the dominant side (H1) and the contralateral side of the torso for the non-dominant side (H2).

Additionally, a MacBook Air personal computer was used to administer and record the cross-modal, bilingual questionnaires.

5.2.1.2.2 Stimuli.

Four clips were extracted from the English documentary film "Joining the Dots" by Pablo Romero Fresco (2012). The rationale behind this choice was that all selected clips would have a similar format, the same subject, and the same characters. Each video clip lasted between 2 and 3 minutes (see Table 5.1). The clips were selected on the basis of meaningful content in the scene. The translation/adaptation of the language content into LSC was carried out by a small team which comprised three members: a deaf native signer and two hearing, non-native, qualified signers. The Spanish subtitles created for the subtitling pilot were used as the source text for the translation/adaptation into LSC to allow full access to all team members (See Oliver Moreno (2017: 55) for a full description of the settings and design parameters for the source subtitles).

The translation procedures included two translations made by the hearing members which were later reviewed by the deaf consultant, who fine-tuned them and indicated which clips should be further adapted. The final edit was approved by all three members. The signing model for the translated documentary clips was a professional hearing interpreter, and a hearing signer, to parallel the most common use signed content on TV. The sign language clips were filmed following professional studio standards by the partner project organisation RTVE (*Corporación de Radio y Televisión Española*, the Spanish public broadcaster). The signed version of the clips was recorded over the voiced version of the subtitles to control the signing pace and later help with synchronisation in post-production.

Clips	**Start and end times**	**Duration**	**Number of words**	**Number of subtitles**	**Words per subtitle**	**Words per second**
clip 1	00:00 - 03:10	03' 08" (188")	297	47	6,31	1,58
clip 2	03:10 - 05:50	02' 40" (160")	328	46	7,13	2,05
clip 3	05:50 - 08:50	03' 00" (180")	289	45	6,42	1,61
clip 4	08:50 - 11:10	02' 20" (140")	227	36	6,31	1,62

Table 5.1. Stimuli clips design from the documentary "Joining the dots"

The UPM partner team edited the clips and synchronised the sign language interpretation clip with the documentary scene clip. Later they generated the 16 different clip stimuli combining the four split screen configuration formats (see Figures 5.1 - 5.4) for the four video clips.

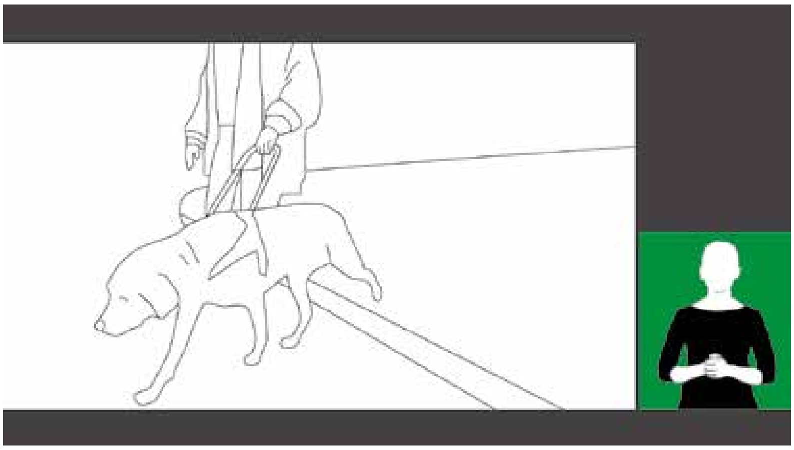

Figure 5.1. Illustration of the split screen configuration small size (1/5 of width screen) and right position of SLI (format 1)

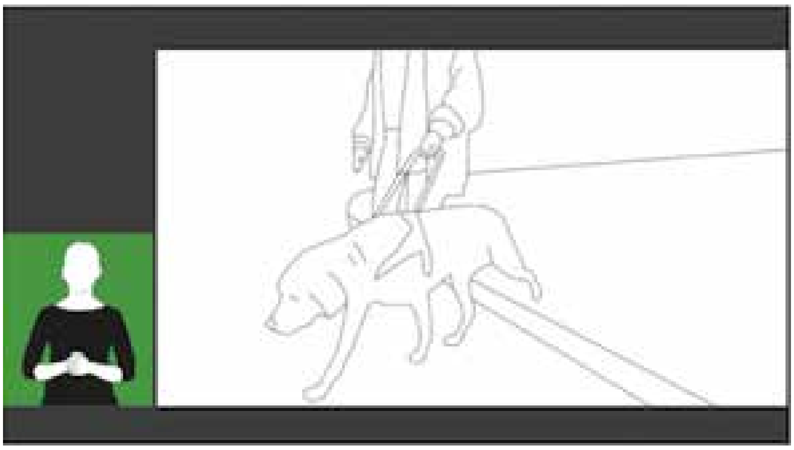

Figure 5.2. Illustration of the split screen configuration small size (1/5 of width screen) and left position of SLI (format 2)

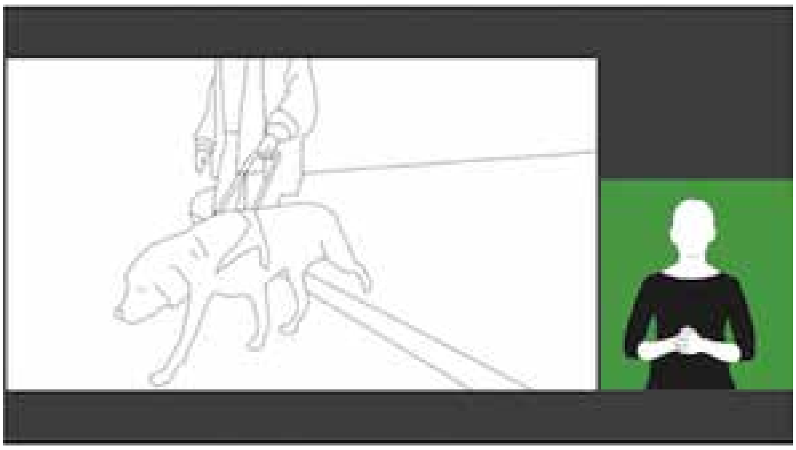

Figure 5.3. Illustration of the split screen configuration medium size (1/4 of width screen) and right position of SLI (format 3)

Figure 5.4. Illustration of the split screen configuration medium size (1/4 of width screen) and left position of SLI (format 4)

5.2.1.2.3 Other.

Informed consent forms and image release forms were available in video format in LSC signed by a deaf, native signer to grant accessibility and in writing (Catalan and Spanish versions available) to be signed by the participant.

Four cross-modal, bilingual questionnaires (LSC / written Spanish) were designed to be administered by the interviewer, using an innovative web-based application developed in collaboration with the UPM partner team (see Figure 5.5). This data collection tool was innovative because it used sign language as the main language for accessing, understanding and evaluating the information. The cross-modal, bilingual questionnaire was designed to avoid subordination of sign language with respect to the written language so that the same social and linguistic statuses were given to both modalities in the experiment materials. Additionally, this design enhanced validity and reliability of the results because it didn't require the participants to sight-translate the questionnaires in situ. It also gave a much more accurate and consistent variety of language use between participants and throughout the experiment, thus making it possible to obtain more reliable results.

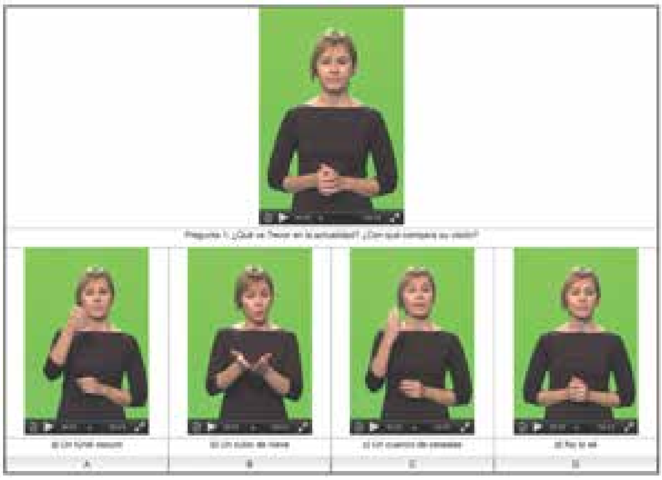

Figure 5.5. Screenshot of a multiple-choice question from the web-based, cross-modal, bilingual questionnaire.

The four questionnaires included: (1) the demographic data questionnaire, including basic personal information, and data on language skills and TV access service uses; (2) the sign language recall test (visual verbal memory), including five questions on sign language content comprehension and recall for each of the clips; (3) the scene/pictorial recall test (visual non-verbal memory), including five questions on the content recall of the documentary film imagery scene for each of the clips; and (4) user preference test, including questions about the usability and user experience of each of the conditions. The contents of the questionnaires were adapted from the subtitling pilot tests within the project (HBB4ALL, 2017; Oliver Moreno, 2017). The translation/adaptation approach for the questionnaire items was a mixed approach similar to the one described for the stimuli. However, the signing model for the LSC was the deaf member of the translation team in order to provide a better cultural and language concordance with the target language users. For a more detailed description of the questionnaire design and the translation and adaptation approach of the survey items, see Bosch-Baliarda, Soler-Vilageliu & Orero (2019).

5.2.1.3 Design.

In this intra-subject study, each participant was shown four video clips from a set of sixteen. The four clips were presented in the four conditions. The order of presentation was varied randomly for the different participants, following a latin-square design. After watching each clip, the participant was asked to fill out three questionnaires: two on the clip information contents —one on the clip scene contents for visual non-verbal recall; and another for the sign-interpreted, textual contents for visual verbal recall— and one for users' preferences. The eye movements of the participants were recorded for the duration of the documentary clips in the different conditions.

The tested independent variables and conditions were:

- Screen area: SLI versus Main Screen
- Size of the SLI AOI (small = 1/4 of the total screen width; medium = 1/5 of the total screen width)
- Position of the SLI AOI (right; left)
- SLI screen format combination (format 1: small/right; format 2: small/left; format 3: medium/right; format 4: medium/left)
- Split SLI screen side: H1, H2
- The dependent variables used were:
- ET measures within the SLI AOI (number of fixations, number of visits; mean duration of fixations, mean duration of visits)
- Visual recall measures (score on language recall; score on scene recall)

5.2.1.4 Procedure.

Users were individually tested in different local deaf association offices. In every interview room there was a table and two chairs (one for the interviewer and one for the interviewee). The participants were first welcomed by one of the bilingual researchers. She outlined the test components and objectives. Next, the consent form was signed and the demographics questionnaire completed using the cross-modal, bilingual, web-based questionnaire on a laptop computer. The participants sat in front of the eye-tracker at roughly 60 cm from the screen. After the standard 9-point calibration procedure, participants were asked to watch the clips. After each visualisation they answered both the linguistic and the visual memory questionnaires. The whole procedure carried out on each participant lasted about one hour.

5.2.2 *Results.*

In order to analyse our data, we mainly used General Linear Models with repeated measures, that allowed us to compare the effect of different screen settings on Eye tracker recorded measures (Fixation Count, Fixation Duration Mean, Visit Count and Visit Duration Mean), on the Linguistic and Visual accuracy of recall (tested with questionnaires).

5.2.2.1 ET measures.

5.2.2.1.1 Effects of screen format and AOI on ET measures.

This analysis explores the effect of Format (format 1: SLI screen size 1/5; right, format 2: SLI screen size 1/5; left, format 3: SLI screen size 1/4; right, and format 4: SLI screen size 1/4; left) and Area: SLI area (AOI) and Scene screen area (Not AOI) on the above-mentioned ET measures. A summary of the data can be found in Table 5.2.

	Fixation Count SLI	**Fixation Count Not AoI**	**Fixation Duration Mean SLI**	**Fixation Duration Mean Not AoI**	**Visit Count SLI**	**Visit Count Not AoI**	**Visit Duration Mean SLI**	**Visit Duration Mean Not AoI**
Format 1 Small/Right	181,3	101,7	,56	,18	28,0	28,4	6,64	1,35
Format 2 Small/Left	184,6	100,0	,43	,18	28,5	28,7	4,53	1,33
Format 3 Medium/Right	164,1	107,8	,58	,19	27,8	28,0	4,95	4,01
Format 4 Medium/Left	189,5	91,9	,46	,19	26,8	27,1	5,31	1,12

Table 5.2. Mean values of ET measures for SLI screen and Scene screen (Not AOI) according to Format.

The repeated measures analysis shows that the different formats do not have any effect on the measures Fixation Count ($F_{(3,81)}$=342, p=.795; Partial Eta squared= .12); Fixation Duration Mean ($F_{(3,81)}$=1.485, p=.225; Partial Eta squared= .52); Visit Count ($F_{(3,81)}$=.090, p=.965; Partial Eta squared= .003) nor on Visit Duration Mean ($F_{(3,81)}$=.674, p=.570; Partial Eta squared= .024).

However, there are significant differences for all ET measures in the two areas (SLI screen /Scene screen): Fixation Count ($F_{(1,27)}$ =23,231; p=.000; Partial Eta Squared= . 462); Fixation Duration

Mean ($F_{(1,27)}$ =39,131; p=.000; Partial Eta Squared= . 592); Visit Count ($F_{(1,27)}$ =18,875; p=.000; Partial Eta Squared= . 411) and Visit Duration Mean ($F_{(1,27)}$ = 11,935; p=.002; Partial Eta Squared= . 307). No interactions of Format and Area were found for any of the measures.

5.2.2.1.2 Effects of size and AOI on ET measures.

As our findings did not show an effect on format, we decided to explore the two components of Format separately: Size of the SLI screen (Medium and Small) and Position of the SLI screen (Right or Left with respect to the Scene screen). A summary of this data can be found in Table 5.3 below.

		Fixation Count SLI	**Fixation Count Not AoI**	**Fixation Duration Mean SLI**	**Fixation Duration Mean Not AoI**	**Visit Count SLI**	**Visit Count Not AoI**	**Visit Duration Mean SLI**	**Visit Duration Mean Not AoI**
Size	**Small**	182,9	100,9	,49	,18	28,2	28,5	5,60	1,34
	Medium	176,8	99,8	,52	,19	27,3	27,5	5,13	2,56
Position	**Right**	173,0	104,7	,57	,19	27,9	28,2	5,83	2,63
	Left	187,0	96,0	,44	,18	27,7	27,9	4,91	1,23

Table 5.3. Mean values of ET measures for SLI screen and Scene screen (Not AoI) according to Size and Position.

The repeated measures analysis did not show any effect of SLI Size on the measures Fixation Count ($F_{(1,29)}$=.141; p=.710;Partial Eta Squared= .005); Fixation Duration Mean ($F_{(1,29)}$=.139; p=.712;Partial Eta Squared= .005); Visit Count ($F_{(1,29)}$=. 937; p=.341; Partial Eta Squared= .031) nor on Visit Duration Mean ($F_{(3,81)}$=.347, p=.561; Partial Eta squared= .012).

The impact Area made was significant in all measures: Fixation Count: $F_{(1,29)}$=21.028; p=.000; Partial Eta Squared= .420; Fixation Duration Mean: $F_{(1,29)}$= 37.999; p=.000; Partial Eta Squared= .567; Visit Count: $F_{(1,29)}$= 12.293; p=.001; Partial Eta Squared= .353; and Visit Duration Mean: $F_{(1,29)}$= 15,833; p= ,000; Partial Eta Squared=,298. No interactions between Size and Area were found for any of these measures.

5.2.2.1.3 Effects of position and area of interest on ET measures.

The analysis of the effect of Position of the SLI screen regarding the Scene screen did not show any significant differences in ET measures: Fixation Count: $F_{(1,31)}$=.006; p=.931, Partial Eta Squared=.000; Fixation Duration Mean: $F_{(1,31)}$= 3.262; p=.081, Partial Eta Squared=.095; Visit Count: $F_{(1,31)}$= .002; p=.961, Partial Eta Squared= .353; and Visit Duration Mean: $F_{(1,31)}$=2.266; p=.142; Partial Eta Squared= .068. Area had a clear effect on all measures: Fixation Count: $F_{(1,31)}$=22.984; p=.000, Partial Eta Squared=.426; Fixation Duration Mean: $F_{(1,31)}$=37.137; p=.000, Partial Eta Squared=.545; Visit Count: $F_{(1,31)}$=19.821; p=.000, Partial Eta Squared=.390; and Visit Duration Mean: $F_{(1,31)}$= 14.477; p=.001; Partial Eta Squared= .318. No interactions between Position and Area were found for any of these measures.

5.2.2.1.4 Dominant hand and Position effects within the SLI screen on ET measures.

In order to examine visual attention given to the dominant hand on the visual exploration of the screen, we split the SLI screen into ipsilateral (the dominant hand side) and contralateral (the non-dominant hand) areas and compared the ET measures obtained for both sides in relation to the position of the SLI screen with respect to the Scene screen.

The repeated measures analysis did not show significant differences for Fixation Count according to Position ($F_{(1,30)}$=.174; p= .680; Partial Eta Squared = .006) nor Dominant Hand side ($F_{(1,30)}$= . 544; p= .467; Partial Eta Squared= .018). No interaction can be reported either.

Similar results are obtained for Fixation Duration Mean, according to Position ($F_{(1,30)}$= .084; p=.774; Partial Eta Squared= .003) and Dominant Hand side ($F_{(1,30)}$= ,337; p= ,566; Partial Eta Squared= ,011). No interaction was found either.

However, the analysis of the differences in Visit Count did show the statistical significance of Position ($F_{(1,30)}$=4.375; p=.45; Partial Eta Squared= .127). No effects were found concerning the Dominant/Non-dominant Hand side ($F_{(1,30)}$= .009; p=.924; Partial Eta

Squared= .000), but there was a significant interaction between Position and Hand Side ($F_{(1,30)}$=4.710; p=.038; Partial Eta Squared=.136). The Dominant hand side received more visits when it was placed at the Right of the Scene screen, while the contrary was found for the Non-dominant hand side. This interaction is depicted in Figure 5.6.

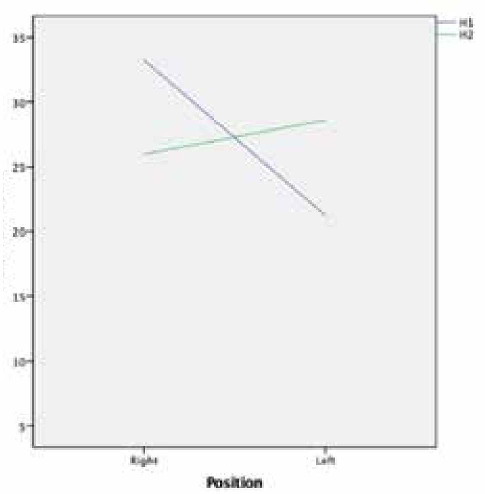

Figure 5.6. Interaction between position of the SLI and visits received by each hand-side.

No effects were found for the Visit Duration mean measure, nor for Position ($F_{(1,30)}$=1.345, p=.255; Partial Eta Squared=.043), nor Hand ($F_{(1,30)}$=1.558; p=.222; Partial Eta Squared=.049.

5.2.2.2 Effects of format on language and scene recall results.

A General Linear Model with repeated measures was carried again to test the effects of the screen format on the scores obtained in both recall questionnaires. Values can be seen on Table 5.4.

We did not find effects of Format on Recall: $F_{(3,84)}$= 1.921; p=.132; Partial Eta Squared=.064, but we did find significant effects of type of recall: $F_{(1, 28)}$=10,783; p=.003; Partial Eta Squared= .278.

Format	f1: Small/ right			f2 small/ left			f3 medium/ right			f4 medium/ left		
	Mean	St Dev	Valid N	Mean	St Dev	Valid N	Mean	St Dev	Valid N	Mean	St Dev	Valid N
Language Recall	2.19	1.45	31	2.60	1.10	30	2.45	1.36	31	2.34	1.15	32
Scene Recall	1.52	1.06	31	1.73	1.28	30	1.94	1.21	31	2.34	1.18	32

Table 5.4. Mean scores obtained for the scene recall and language recall according to the different screen formats.

Since scene recall and language recall are different, according to the repeated measures analysis, we carried out planned comparisons between both scores in each format. The results point out that mean scores for the scene recall and the language recall are significantly different for f1($t_{(30)}$=2.358; p=.025) and for f2 ($t_{(29)}$=3.432; p=.002), in which language recall is better than scene recall. For the scene recall in format f3 and f4, however, differences are not significant (f3: $t_{(30)}$=1.609; p=.118; f4: $t_{(31)}$=.000; p=1).

We also carried planned comparisons within each type of test to compare the results obtained for each format. T-tests show significant differences between Scene recall scores obtained with Format 1 and Format 4 ($t_{(30)}$= 3,233; p=.003) and a trend of significance between Format 3 and Format 4 ($t_{(30)}$=1.995; p=.055). That is, Format 4 (medium/left) produces significantly better results of the scene recall than Format 1 (small/right) and Format 3 (medium/right). No significant differences were found for Language recall across formats.

5.3 Discussion

Even though sign language access services on TV target hours have not yet been met, SLI service broadcast hours have been growing over the past few years. The goal of our study, under the scope of the HBB4ALL project, was to provide experiments to support recommendations for broadcasters regarding size and position of the SLI on screen.

In this reception study we researched the user's visual behaviour and information processing of sign-interpreted TV access service while watching video clips in different split screen configurations. We recorded participants' eye movements and scored their performance on memory questionnaires about the language and scene content. Our purpose was to explore if different split screen formats elicited differences in the way information content on screen is processed. Although our experimental reception study is largely exploratory we found some interesting findings that we discuss later.

We also carried planned comparisons within each type of test to compare the results obtained for each format. T-tests show significant differences between Scene recall scores obtained with Format 1 and Format 4 ($t_{(30)}$= 3,233; p=.003) and a trend of significance between Format 3 and Format 4 ($t_{(30)}$=1.995; p=.055). That is, Format 4 (medium/left) produces significantly better results for the scene recall than Format 1 (small/right) and Format 3 (medium/right).

Turning first to the ET data, regarding screen exploration in the four different formats, we found that sign language users spent a longer time watching the LS screen than the scene screen, independently of the split screen format, the screen size or the SLI and the side of display. These results on attention distribution among the different splits screens on the TV are consistent with Wehrmeyer's findings (2014) with news broadcasts. The repeated measures analysis showed that the different formats, size and position conditions do not have any effect on the ET measures. Likewise, no interactions were found for any of the ET measures. We hypothesise that this consistency among the different split screen variables and conditions might be related to the nature of the content and also the task in our experiment, which was one of the controlled variables in our clip design. In all the documentary video clips, scene content and language content were relevant to task completion and designed to be balanced among the different conditions.

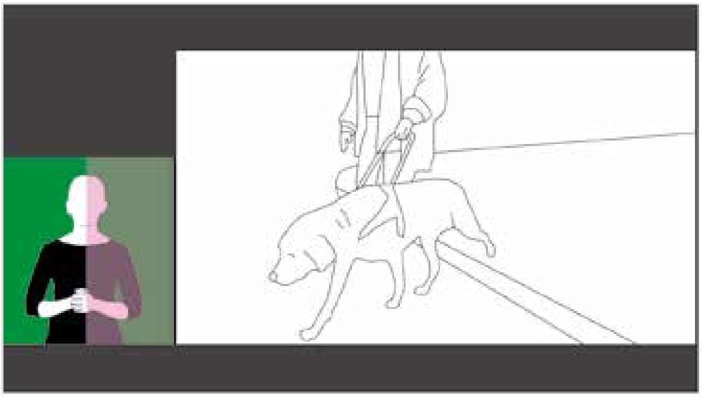

Figure 5.7. Proximal contralateral side (shaded in pink) in format 4

With regard to the visual exploration of ipsilateral (H1) and contralateral (H2) sides of the SLI area, the results show a difference between attention distribution in the two position conditions, as predicted. However, our directional hypothesis is not confirmed: the number and duration of fixations and visits is not higher for H1 SLI area in any position conditions. Although the number of visits for H1 and H2 areas is the same, there is an interaction between right/left positions and dominance side in the number of visits (see Figure 5.6). Namely, the visit count is higher on the ipsilateral side (H1) of the SLI area in the right positions, whereas it is higher on the contralateral side (H2) of the SLI area for the left positions.

Therefore, our results suggest that deaf participants tend to focus their attention on the side of the SLI screen that is more proximal to the scene screen, regardless of the hand dominance. The shaded area in Figure 5.7 illustrates the proximal part of the SLI screen in format 4 which is the part receiving most focussed attention, in left positions this side corresponds to the contralateral side of the interpreter. We hypothesise that by focussing their attention on the proximal part of the SLI screen to the scene screen, participants can include more information content within their peripheral visual field. The heat maps below in Figures 5.8 - 5.11 illustrate the different foci of attention for the right/left conditions in the four split screen formats.

Figure 5.8. Format 1 gaze pattern heat map for all participants in clip 3

Figure 5.9. Format 2 gaze pattern heat map for all participants in clip 3

Figure 5.10. Format 3 gaze pattern heat map for all participants in clip 3

Figure 5.11. Format 4 gaze pattern heat map for all participants in clip 3

Regarding the recall test results, our findings show that the responses to the language recall tests are significantly more accurate than those of the scene recall tests when the SLI appears in small formats, formats 1 and 2. However, when the SLI screen size is medium, in formats 3 and 4, the differences in scores between language and scene recall are not significant. We assume that this contrast is associated with the size of the SLI screen. Although the focus of attention is not evenly distributed between the two split screens, according to ET metrics, the bigger size of the SLI screen probably allows for visual attention to absorb the scene details, using the peripheral, visual perception mentioned above.

Concerning the interaction between the recall scores and the four format combinations, the results indicate that format is not significantly related to language recall performance. However, there are differences regarding scene recall scores, which are the highest in format 4, the format combining the medium sized SLI screen in the left position, and the lowest in format 1, combing a small sized SLI in the right position. Specifically, the data analysis indicates differences between format 4 and both of the other formats, including the SLI screen on the right position. The results show a significant difference between format 4 and format 1, and a trend of significance between format 4 and format 3.

These recall results suggest that the format including an SLI medium screen on the left is a good split screen configuration that facilitates information recall from the scene screen. It is also the format with more balanced mean scores between the language and scene recall tests. This finding suggests that right visual field enhancement, or left-hemisphere bias (Bavelier et al., 2001), could also have an effect on complex visual information processing, such as watching interpreted TV content on a split screen configuration. However, this finding might also be showing effects of a bias in participant sample. As our participants are all Catalan sign language users they might be showing a learning effect, as the medium-size left-position SLI screen is the format used in the daily news of the Catalan public broadcaster. Even though this finding is internally valid for our research, more research is needed to grant the external validity of the results.

5.4 Final remarks

This experimental reception study has shown how deaf sign language users explore a sign-interpreted documentary on TV using a split screen configuration. Although mostly exploratory in nature, the findings suggest that the format used to deploy the service impacts the accessibility of information contents, both textual and non-textual. The differences found in accuracy recall of the documentary content have been associated with format conditions, size and on-screen positioning.

Our findings suggest that including a SLI of medium size (1/4 of the TV screen width) in a left position can contribute to better content access for deaf sign language users. The results indicate that this screen configuration encompasses the optimal formal parameters, enhancing screen legibility and balancing comprehension to both language and scene content. Broadcasters deploying SLI services should consider that the formal parameters choices do not only affect aesthetics but have an impact on content accessibility.

As the application of eye tracking methods in SLI access services is still fairly unexplored, future studies should endeavor to research other formal parameters that may affect sign language processing, such as the use of Chroma key or background colour, which may also impact on perception and usability of the service. These factors might be crucial to improve media experience not only for all members of the sign language communities, but especially for those with a combined sensory loss such as deafblind sign language users or the elderly.

More research is needed not only in order to study the formal parameters, but also for different national sign languages, age groups, TV genres, signing models and newer devices, in order to improve the quality of this access service with a view to offering real personalisation options. We believe that to guarantee equal rights in information accessibility and participation in society for sign language communities, it is of the utmost importance to strive for quantity and quality in media access services in sign language.

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Chapter 6

Summary

6. Summaries

6.1 Summary in English

Sign language interpreting (SLI) is the third major media accessibility service along with audio description and subtitling. Although SLI first appeared on TV nearly seventy years ago, the field of media accessibility on SLI still lacks critical investigation on tested techniques to produce guidelines that can constitute best practice for both broadcasters and stakeholders. This PhD thesis has the purpose of partially filling this knowledge gap by studying the formal parameters that affect legibility and readability of the sign language on the screen. It is framed within two complementary conceptual models regarding deaf sign language users' rights: (1) the inclusive model of accessibility and (2) the dual category status, where deaf signers are regarded as both persons with a disability and as members of a minority language group, namely a Sign Language Community.

This dissertation is exploratory in nature and has two aims: (1) to identify the SLI on-screen parameters and their relevance to content accessibility and SLI service usability and (2) to explore the reception and processing of different split screen composites including sign-interpreted content —combining two variables— by deaf sign language service users in a documentary film. Within a mixed methods research approach, an instrument-development variant of an exploratory sequential design was implemented in order to meet the research aims. The research consisted of three steps: (1) an initial qualitative phase; (2) an intermediate instrument development phase and (3) a final prioritised quantitative phase.

First, the qualitative phase was designed to collect open-ended information from two stakeholder groups: one including semi-structured interviews with professional sign language interpreters working on TV, the other including focus groups with deaf sign language participants that were TV access service users. The results suggest that the speed rate and size of the interpreter on the screen were the most important formal parameters affecting legibility while position may be related to screen readability. These findings provided informed choices to develop the next research phases. The intermediate phase aimed to develop a data collection tool that could implement an accessible and reliable questionnaire to assess information recall in sign language. The final quantitative phase aimed to gather close-ended information on both users' behaviour and performance. It included two experimental studies, the first using eye-tracking techniques to analyse deaf signers visual attention allocation patterns on sign-interpreted TV and the second using recall tests to analyse content accessibility. From the quantitative reception tests, it can be concluded that size in combination with on-screen position are two important factors to consider when producing AV works including signing in a TV split screen design.

The results show that the most balanced information content recall scores are obtained using a mid-sized interpreter's window screen in a left position displaying the scene screen on the right. From this finding, it can be concluded that this split screen composite format encompasses the optimal combination of features for the size and position parameters to access broadcast documentary contents.

Although watching audiovisual contents with signing services is a complex task requiring divided attention, the results from the user tests show that implementing the optimal parameters can have a positive impact on the SLI service legibility and readability and, ultimately, on service usability and content accessibility. This novel methodology combining users' opinions and measuring their psychological responses in a controlled reception test will hopefully constitute a first step towards conducting future research in the field of SLI in media accessibility and audiovisual translation studies.

6.2 Summary in Catalan

La interpretació en llengua de signes (ILS) és un dels principals serveis d'accessibilitat als mitjans audiovisuals, juntament amb l'àudiodescripció i la subtitulació. Tot i la seva rellevància, la recerca en el camp de l'accessibilitat als mitjans pel que fa als serveis en llengua de signes (LS) és incipient. Actualment, les organitzacions de radiotelevisió que ofereixen aquest servei no compten encara amb guies de bones pràctiques basades en resultats empírics. Aquesta tesi doctoral té com a finalitat cobrir parcialment aquest buit de coneixement a partir de l'estudi dels paràmetres formals que afecten la llegibilitat de la ILS i la lectura dels diferents elements visuals de la composició de la pantalla televisiva. El marc conceptual d'aquesta recerca conjumina dos models complementaris sobre els drets dels usuaris de la LS: (1) el model inclusiu d'accessibilitat i (2) el doble estatus social d'aquest grup, com a persones amb una discapacitat sensorial i com a membres d'una comunitat lingüística minoritària.

Aquesta tesi té dos objectius: d'una banda, (1) identificar els paràmetres formals d'inserció de la ILS i els seus efectes en l'accessibilitat als contingut televisats. De l'altra, (2) estudiar la recepció i el processament d'un documental interpretat a la LS emprant diferents dissenys. La investigació implementa mètodes mixtos seguint un disseny exploratori seqüencial que integra tres etapes: (1) un estudi inicial qualitatiu, (2) una etapa intermèdia de desenvolupament de l'instrument de mesura psicomètrica i (3) una etapa final amb l'estudi preeminent de naturalesa quantitativa.

La primera fase es va dissenyar amb l'objectiu de recollir dades qualitatives de dos dels principals grups d'interès del servei d'ILS a la TV: (1) les intèrprets professionals i (2) els sords signants com a principals usuaris dels serveis d'accessibilitat. Els resultats d'aquesta primera fase de recerca suggereixen que la velocitat i la mida de la intèrpret a la pantalla són els paràmetres formals més importants pel que fa a la llegibilitat, mentre que la posició pot ser un dels paràmetres que condicionen la lectura dels diferents elements visuals de la pantalla. Aquests resultats varen constituir la base per al desenvolupament de les fases posteriors de recerca. L'etapa intermèdia tenia com a objectiu desenvolupar

una eina de recollida de dades que pogués implementar un qüestionari accessible en LS i que constituís un instrument vàlid i fiable per avaluar el record visual d'informació en LS. L'etapa quantitativa final va incloure dos estudis experimentals: (1) la captura dels moviments oculars per estudiar els patrons de distribució de l'atenció visual dels signants sords a la pantalla de TV amb ILS incrustada i (2) les proves de record mitjançant qüestionaris de memòria per mesurar l'accessibilitat del contingut. A partir d'aquestes proves quantitatives de recepció, es pot concloure que, a l'hora de produir continguts audiovisuals accessibles que inclouen una finestra per a la ILS en un format televisiu de pantalla dividida, la mida en combinació amb la posició a la pantalla són factors importants a tenir en compte. Els resultats mostren que el format de pantalla òptim per a l'accessibilitat als contingut audiovisuals s'obtémitjançant la combinació d'una finestra de mida mitjana per a la ILS a l'esquerra de la pantalla.

Tot i que la visualització de continguts televisius en LS és una tasca complexa que requereix atenció dividida, els resultats d'aquesta tesi mostren que implementar els paràmetres òptims pot tenir un impacte positiu en la llegibilitat i la lectura dels continguts i, en definitiva, sobre la usabilitat i l'accessibilitat global. Aquesta tesi constitueix un primer pas cap a la realització de futurs tests de recepció de la LS dins del camp de l'accessibilitat als mitjans i la traducció audiovisual.

6.3 Summary in Spanish

La interpretación en lengua de signos (ILS) es uno de los principales servicios de accesibilidad a los medios audiovisuales, junto con la subtitulación y la audiodescripción. Pese a su relevancia, la investigación de los servicios en lengua de signos (LS) en el campo de la accesibilidad a los medios es incipiente. Actualmente, las radiotelevisiones que ofrecen este servicio no cuentan aún con guías de buenas prácticas basadas en resultados empíricos. Esta tesis doctoral tiene como finalidad cubrir parcialmente este vacío de conocimiento a partir del estudio de los parámetros formales que afectan a la legibilidad de la ILS y la lectura de los diferentes elementos visuales en pantalla televisiva. El marco conceptual de esta investigación combina dos modelos complementarios sobre los derechos de los sordos signantes: (1) el modelo inclusivo de accesibilidad y (2) el doble estatus social de este grupo, como personas con una discapacidad sensorial y como miembros de una comunidad lingüística minoritaria.

Esta tesis tiene dos objetivos: por un lado, (1) identificar los parámetros formales de inserción de la ILS y sus efectos en la accesibilidad a contenidos televisados; por otro, (2) estudiar la recepción y el procesamiento de un documental con inserción de la ILS empleando diferentes diseños de pantalla. La investigación implementa métodos mixtos siguiendo un diseño exploratorio secuencial que integra tres fases: (1) un estudio inicial cualitativo, (2) una fase intermedia de desarrollo del instrumento de medida y (3) la ulterior fase principal cuantitativa con el estudio de recepción.

La fase cualitativa fue diseñada para recoger datos exploratorios de los principales grupos de interés del servicio de ILS en la TV: (1) las intérpretes profesionales y (2) los sordos usuarios de la LS, como principales usuarios del servicio de accesibilidad. Los resultados sugieren que los parámetros formales más importantes en cuanto a legibilidad son la velocidad y el tamaño de la intérprete, mientras que la posición puede ser uno de los parámetros que condicionan la lectura de los diferentes elementos visuales de la pantalla. Estos resultados constituyeron la base para el desarrollo de las fases posteriores de investigación. La fase intermedia tenía como objetivo desarrollar una herramienta de recogida de datos que pudiera implementar un cuestionario accesible en LS y que constituyera un instrumento válido y fiable para evaluar el recuerdo visual de información en LS. La fase cuantitativa final incluyó dos estudios experimentales (1) la captación de los movimientos oculares para estudiar los patrones de exploración y distribución de la atención visual en la pantalla de TV con ILS y (2) las pruebas de memoria mediante cuestionarios de recuerdo visual y lingüístico del contenido. A partir de estas pruebas cuantitativas de recepción, se puede concluir que a la hora de producir contenidos audiovisuales accesibles que incluyen una ventana para la ILS en un formato televisivo de pantalla dividida, el tamaño en combinación con la posición en la pantalla son dos factores importantes a tener en cuenta. Los resultados muestran que el formato de pantalla óptimo para la accesibilidad se obtienen mediante la combinación de una ventana para la ILS de tamaño medio (1/4 del ancho de pantalla) a la izquierda de la pantalla.

Aunque la visualización de contenidos televisivos en LS es una tarea compleja que requiere atención dividida, los resultados de esta tesis muestran que implementar los parámetros óptimos tiene un impacto positivo en la legibilidad y la lectura de los contenidos y, en definitiva, sobre la usabilidad y la accesibilidad. Esta tesis constituye un primer paso hacia la realización de futuros tests de recepción de la LS dentro del campo de la accesibilidad a los medios y la traducción audiovisual.

Chapter 7

Conclusions

7. Conclusions

In this final chapter, I summarise the findings of my research and discuss how the obtained results answer my research questions. In the first section, I review the overall research objectives and aims that have guided this PhD thesis (section 7.1). Next, I revisit the findings from the qualitative (§ 7.1.1) and the quantitative (§ 7.1.2) research phases and evaluate the research results (§ 7.1.3). In section 7.2, I address the different contributions of this PhD research to academia, broadcasters and stakeholders. The following section includes my reflections and puts forward the limitations of this thesis (section 7.3). Finally, I include some recommendations and future directions that can be drawn from the previous sections (section 7.4).

7.1 Revisiting Research Aims and Objectives: Evaluation of Results

Signing services in the media, including both sign-presented and sign-interpreted accessibility services, constitute “the third most valuable access service for society as a whole” (ITU, 2014a: 22). However, when compared to the two major access services in AV media (i.e., subtitling and audio description) it is clear that signing services are under-developed both in terms of quantity and quality. The lack of standardisation in technology, the scarce availability of research-based guidelines for the optimal production, and the insufficient social awareness concerning Sign Language Communities are the main reasons behind the gap between the three mature AV media accessibility services (ITU, 2014a). My PhD research intends to partially fill this knowledge gap.

The PhD thesis is framed within two complementary conceptual models regarding accessibility and deafness. On the one hand, I assumed the model ascribing a dual category status to deaf sign language users. In the dual category model, deaf signers are regarded as both persons with a disability and as members of a Sign Language Community. On the other hand, this research is framed in an inclusive model of accessibility as a human right. In this paradigm, access rights and language rights are inextricable to human rights

(Berghs et al., 2016; Ewart & Snowden, 2012; Greco, 2017; Murray, 2015; Storch, 2007). This article-based dissertation focused on studying the formal parameters used to make up the visual appearance of the SLI on TV screen in the design and production of sign-interpreted AV content. The conducted studies explored the formal parameters and features that affected the legibility of the on-screen SLI and readability of the TV screen with the intent of improving both content accessibility and service usability. In particular, the goal of this thesis was to answer the following research questions:

- Question 1: What formal parameters affect the usability of SLI access services on AV broadcast contents?

- Question 2: Which on-screen design features of the SLI parameters facilitate screen legibility and provide deaf sign language users with better access to AV content?

In order to answer both research questions, one aim for each of the questions was put forward:

- Question 1 Aim 1 - To identify the SLI on-screen parameters and their relevance to content accessibility and SLI service usability.

- Question 2 Aim 2 - To explore the reception and processing of different split screen composites including sign-interpreted content —combining two variables— by deaf sign language service users in a documentary film.

After the completion of the literature review, I realised that little guidance existed regarding best practices to implement SLI services on television (CNLSE, 2017; ITC, 2010; ITU, 2014b; 2014c; NDA, 2014; Ofcom, 2017 [2015]; Pyfers, 2000). Although it was generally recognised that broadcasters should strive to monitor the quality of the service by getting feedback from users and stakeholders, most guidelines did not appear to be based on evidence from user tests. Additionally, some overtly recognised that the guidelines provided were not based on tested techniques, but rather to parallel issues for other content access services so that they were rather tentative and speculative (e.g., ITU, 2014; NDA, 2014; Ofcom, 2015; WC3, 2016). The scarcity of previous research implementing empirical methods to study the formal parameters of SLI on TV determined the choice of the methodology and design of this present research (cf. DTV4ALL, 2008; Gil Sabroso & Utray, 2016; Kyle, 2007; Steiner, 1998; Wehrmeyer, 2014; Xiao & Li, 2013).

Based on the exploratory nature of the PhD research questions, and considering the above-mentioned state of the art, I adopted a mixed methodology. Within this framework, an instrument-development variant of the exploratory sequential design was selected (Creswell & Plano Clark, 2007 [2011]). The research consisted of a first qualitative phase designed to collect information, with the purpose of fulfilling the first aim, followed by a second quantitative phase, designed to measure the obtained qualitative exploratory findings.

The selected methods included different types of service user tests. The rationale behind this choice was, on the one hand, to follow the recommendations from the ITU technical report on production guidelines for sign language service on AV content accessibility. This recommendation urged on running tests with deaf signers as the best way to get informed feedback and to assess the quality of SLI access services (ITU, 2014c). On the other hand, the sign language user tests were designed to parallel the pilot tests for subtitling and audio description within the HBB4ALL project (HBB4ALL, 2017).

7.1.1 Revisiting the qualitative research phase.

The first exploratory qualitative phase was designed to address the first research question aim, centred on the analysis of the SLI access service parameters that affect content accessibility, through two specific objectives.

- Objective 1 - to collect user preferences in relation to SLI on-screen presentations in order to establish which SLI on-screen parameters are more relevant to content accessibility.

- Objective 2 - to select two SLI formal parameters that might have an impact on content accessibility to be investigated in the quantitative phase.

In order to meet the specific objectives, two qualitative data collection methods were designed to gather open-ended information from two stakeholder groups: one including semi-structured interviews with professional sign language interpreters working on TV, the other including focus groups with deaf sign language participants that were TV access service users.

Regarding the first objective, the results from the focus groups suggested that not all the formal parameters studied have a relevant impact on the legibility of the broadcast sign language, assuming that standard television requirements (i.e. light, resolution and synchronisation between AV content and signing) are met. For instance, the interpreter's gender or whether s/he was in a sitting or standing position were considered irrelevant. However, deaf signers reported other formal parameters to have an important impact on legibility of the sign language contents. According to our findings, the relevant SLI on-screen formal parameters affecting content accessibility were: the overall on-screen size (i.e. shot size and interpreter's window size), colour contrast (i.e. skin, clothes and background colours) and avoiding the overlaying of superimposed visuals (i.e. wipe style of the picture-in-picture window, overlapping captions, the channel digital on-screen graphic or other on-screen visuals). Additionally, even though there was no agreement in the preference for right/left positions, participants reported that the position might have an impact on readability of the different visual elements on the screen.

Specifically, the data from both qualitative collection methods in this PhD research suggested that the size of the interpreter on screen was the most important formal parameter. This result was consistent with previous literature (Steiner, 1998; Wehrmeyer, 2014; Xiao & Li, 2013). Existing guidelines recommended that the signer should be no smaller than one sixth of the screen in a standard television, that is one third of the screen width (ITC, 2010; ITU, 2014: 5; Ofcom, 2015). At the same time, most users participating in the focus groups suggested that one third of the screen width using a mid-long shot would be optimal for news broadcasts but agreed that for other TV genres, like films, TV series or documentaries, they would prefer a smaller interpreter.

Finally, SLI service users reported that size did not only impact the service usability and content accessibility, but also the social status of the sign language and the reputation of the broadcasters within the Sign Language Community. The participants considered that broadcasters implementing miniaturised interpreters did so as a strategy to comply with accessibility policies regarding signing quotas without providing actual access to the service users.

Regarding the second objective, the findings of the first qualitative research phase aimed to provide informed choices to build on the design of the research instrument and the second quantitative phase tests. The two parameters that were selected as independent variables were size and position on the horizontal axis. All other parameter features were designed to be the controlled variables: interpreter characteristics, mid-long filming shot, colour combination, position in the vertical axis and side by side split screen design including two framed windows overlaid on a background.

The rationale behind the operationalisation of the independent variables to be measured in the experimental tests was specific to each of the formal parameters. Firstly, size was selected because it was the feature widely agreed to be most important. The two conditions to be tested were: one fourth and one fifth of the screen as two sizes between the reported acceptable features. The choice of these two size conditions were partially determined by the results and users feedback from a pre-pilot test carried out within the project for the news channel Spanish TV broadcaster, Canal RTVE 24h (Soler-Vilageliu, Bosch-Baliarda & Orero, 2015).

Conversely, position was selected because our participants' feedback did not coincide with previous literature consistently reporting a preferred right on-screen position (cf. Gil Sabroso & Utray, 2016, for Spanish Sign Language (LSE) users; HBB4ALL, 2017, for German Sign Language (DGS) users; Kyle et al., 2005 and Ofcom, 2015, for British

Sign Language (BSL) users; Van der Graaf & Van der Ham, 2003 for Dutch Sign Language (NGT) users). The two selected conditions to be tested were right and left positions. This choice was also influenced by the literature review on attention allocation patterns, such as enhanced peripheral visual and hemisphere bias reported in other reception tasks with deaf sign language users (Agrafiotis, Canagarajah, Bull, & Dye, 2003; Bavelier et al., 2001; Dye et al., 2009; Parasnis & Samar, 1985; Siple, 1978).

7.1.2 Revisiting the quantitative research phase.

The second exploratory quantitative phase was designed to address the second research aim on the reception and processing of different split screen formats implementing SLI access service. The second aim was broken down into two specific objectives.

- Objective 3 - to measure the deaf signing users' behavioural patterns of screen exploration using eye-tracking technology to assess whether attention allocation changes depending on the variables in the four different screen compositions.

- Objective 4 - to measure the deaf signing users' processing of content to evaluate accessibility to the documentary contents using linguistic comprehension and recall questionnaire scores for both language and scene information in the four different screen compositions.

In order to meet the above objectives, two quantitative data collection methods were designed to collect close-ended information from a sample of the deaf sign language service users. One instrument gathered information on behaviour, specifically attention allocation and eye movement measures, the other was centred on user performance and measured comprehension and recall scores using a cross-modal bilingual questionnaire particularly designed and developed to carry out the experimental reception user tests. The experimental reception test design for the SLI size and position on screen parameters paralleled the tests developed for the subtitling pilots in the HBB4ALL project (HBB4ALL, 2017; Oliver Moreno, 2017).

Regarding the third objective, the results from the eye-tracking measures showed significant differences regarding attention allocation resources between the two parts of the split screen. Overall, deaf sign language users spent longer time watching the SLI screen than the content screen, regardless of the format varying in size and position of the interpreter window. These results were consistent with Wehrmeyer's findings (2014) with news broadcasts for South African Sign Language users. These findings might indicate that, independently of the TV programme content, deaf sign language users focus their visual attention on the signer and access the scene content with their peripheral vision.

Regarding the fourth objective, and in the light of the eye-tracking measures, one could imagine that the scores for the language recall task would be much higher than those for the scene recall. Contrarily, the user performance results were only significantly better for the language recall test when the interpreter was included using the small size, 1/5 screen width. Concerning visual recall scores, differences were not statistically significant considering position alone. However, the interaction of size and position did produce statistically significant results. With respect to the four possible screen composites combining sizes and positions, the results showed that the format 4 (f4) —combining mid-sized SLI screen in the left position— produced better visual recall scores when compared to both formats including the SLI screen in the right position (formats 1, f1, and format 3, f3).

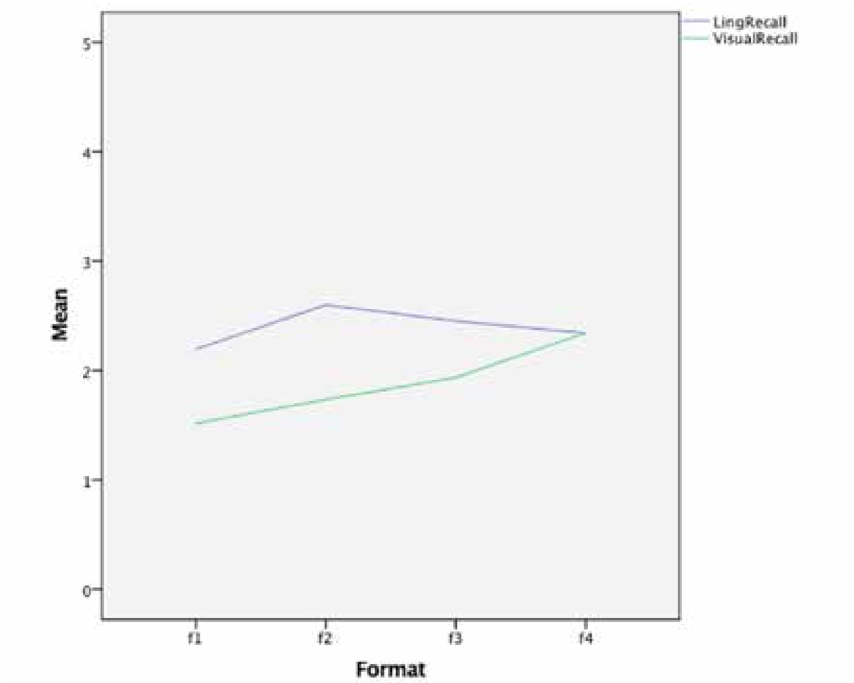

Figure 7.1. Mean scores obtained for the scene recall and language recall according to the different screen formats.

The above overall recall results, as illustrated in Figure 7.1, showed that split screen format 4, produced the most balanced information recall mean scores.

7.1.3 Final remarks: evaluating the results.

The goal of this PhD thesis was to explore what formal parameters affect the usability of the sign language interpreting access services on TV contents and whether certain parameters improve screen legibility and provide better access to AV contents. Based on both the quantitative and qualitative analysis it can be concluded that on-screen formal parameters play an important role in the legibility of the sign language and readability of the visual elements on the screen and, therefore, impacting content accessibility and the quality of the TV access service. The qualitative studies show that users experience several formal on-screen parameters to be more relevant to grant accessibility while using the SLI access service on TV. The findings suggest that the paramount parameter is size, whereas maintaining colour contrast and avoiding overlaying play a central role.

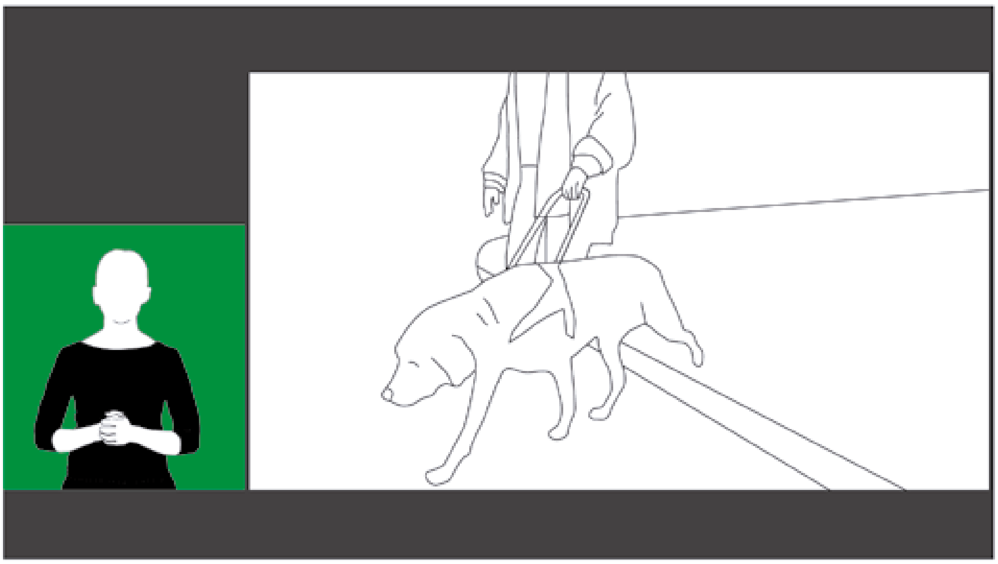

Figure 7.2. Illustration of the optimal size and position combination (f4) for information reception

From the quantitative reception tests, it can be concluded that size in combination with on-screen position are two important factors to consider when producing AV works including signing in a TV split screen design. The results showing that a mid-sized interpreter's window screen in a left position displaying the scene screen on the right produce the most balanced information content recall scores. From this finding, it can be concluded that this split screen composite format encompasses the optimal combination of features for the size and position parameters to access broadcast documentary contents (see Figure 7.2, reproduced from article 3). Although watching AV contents with signing services is a complex task requiring divided attention regardless of the split screen composition, the results from the user tests in this PhD research show that implementing the optimal parameters can have a positive impact on the SLI service legibility and readability and, ultimately, on service usability and content accessibility.

7.2 Contributions to knowledge

Due to the exploratory nature of this PhD thesis, most of the contributions building upon previous research can be characterised as first-time or ground-breaking in the pursuit of 'filling' the research gap and expanding the current academic knowledge in the field of sign language interpretation on the media and AV media accessibility on signing services. On balance, the value of the present PhD research is related to both academic and social outcomes. On the one hand, my research constitutes (to the best of my knowledge) a first reception study of sign-interpreted TV content implementing experimental tests in lab conditions regarding the formal parameters of the SLI presentation and layout. It aims to constitute a relevant contribution to the academic field of MA within the field of AVT. Moreover, it wants to raise awareness on the lack of research on topic of SLI and signing services, as a central area along with subtitling and audio description. As other studies within AVT, the tested techniques contribute to put forward best practice in future commercial uses and to provide guidance to broadcasters deploying the services, ultimately bringing research forward towards future standardisation of the TV signing access services (Matamala & Orero, 2018).

From the quantitative research phase, at least two design features make this research on comprehension and production of sign language interpretation on television unique. On the one hand, regarding the stimuli content, this is the first reception study to use a documentary film, rather than news broadcasts. On the other hand, and regarding the stimuli design, my research constitutes the first reception study conducting a test in which the on-screen formal parameters are studied as independent variables in a controlled experimental setting, in order to measure the behavioural and performative responses with deaf sign language TV consumers.

All previous reception tests for sign-interpreted TV programmes were designed using real footage from specific broadcasters. Using real stimuli proved to be very valuable to provide broadcasters with feedback from the audience. However, this option also came with some drawbacks. Firstly, most of the studies were based on news broadcast contents, because traditionally this has been the most common (if not the only) TV genre available with sign interpretation in many countries (Allsop & Kyle, 2008; Grbić, 2002; Gutermuth, 2011; Kurz & Mikulasek, 2004; Stone, 2007; Werhmeyer, 2014). Werhmeyer's eye-tracking study showed that deaf signers do not attend the scene content where the hearing speaker is placed. Thus, the results were not easily generalised to other TV programmes were access to scene content is as important as language content. Secondly, assessing real TV screen compositions makes it very difficult to control extraneous variables or even to identify the formal parameters that are independent variables and conditions being studied. Consequently, it would be difficult, if not impossible, to relate the results to one set of formal parameters (cf. Gil Sabroso & Utray, 2016; Grbić, 2002; Gutermuth, 2011; Kurz & Mikulasek, 2004; Steiner, 1998; Werhmeyer, 2014). This is one of the reasons why previous guidelines could be considered somewhat speculative, because they were not based on tested results (NDA, 2014).

Hence, the exploratory findings reported in this PhD thesis regarding the optimal on-screen size and position for the SLI screen constitute a first contribution towards TV guidelines based on tested experimental data. Furthermore, the obtained results on size and position conditions contradict previous existing guidelines. Regarding size, recommended guidelines suggested to use a one sixth of the picture, while the tested technique has shown that one fourth of the screen width is optimal for watching a documentary film. Regarding position, existing guidelines suggested to place the SLI window on the right side of the screen, while our experimental results suggest that placing the SLI on the left of the screen produces better access to both language and scene content.

The tests on the quantitative research phase of my thesis constitute a new contribution to the experimental studies using eye-tracking techniques to analyse deaf signers visual attention allocation patterns on sign-interpreted TV contents along with the pioneering studies from Guttermuth (2011) for German Sign Language (DGS) and Wehrmeyer (2014) for South African Sign Language (SASL). Although the findings are exploratory, they are consistent with previous research both reporting left hemisphere bias, or enhanced information processing in the right visual field, and enhanced peripheral vision (Agrafiotis, Canagarajah, Bull, & Dye, 2003; Bavelier et al., 2001; Dye et al., 2009; Parasnis & Samar, 1985; Siple, 1978; *inter alia*). Finding that the optimal screen configuration includes the scene screen on the right visual field may suggest that left-hemisphere bias in deaf signers could also have an effect on complex visual information processing tasks, such as watching interpreted TV content on a split screen configuration.

Moreover, the instrument design included within this research produced two complementary outcomes. This research phase aimed to develop a data collection tool that could implement an accessible and reliable questionnaire to assess information recall in sign language. In this direction, one contribution concerns the literature review regarding the use of video technologies in questionnaire designs. The second article includes an exhaustive literature review on deaf-friendly questionnaire design, conjoining for the first time models from standardised sign language assessment test implementations with large-scale surveying questionnaires.

The second contribution concerns the new design and development of a state-of-the-art computerised multi-clip video sign language questionnaire to implement the interviewer-administered data collection method for the quantitative tests. Moreover, it is the first time that a fully accessible cross-modal bilingual questionnaire has been used in a reception study of TV contents. The web-based questionnaire engineered by the UPM team, introduced an auto-play option designed to reduce the time burden and making it possible to skim through the question and responses. This innovative design may have future application in both sign language research and education to implement questionnaire-based tasks such as testing or surveying.

I would like to think that the most important contribution of this PhD thesis would be to improve the social awareness and status of LSC by both contributing to the existing research on sign languages in Catalonia and by contributing to facilitate knowledge transfer among the university as a research organisation, the Catalan Sign Language Community members as stakeholder groups and the Catalan broadcasters as the industry agents. This research based in Catalonia also constitutes the first user tests that provide the Catalan broadcasters feedback from their local audience. The HBB4ALL project, including a university-stakeholders-industry partnership, has provided the best possible environment for this desired knowledge transfer to happen fulfilling the envisaged social outcomes of this present research. Additionally, it has given me the opportunity to collaborate and participate with deaf community organisations at local, national and international levels (Appendix 5).

7.3 Reflections and Limitations

Developing my PhD thesis within the TransMedia Catalonia research group, in the framework of two interdisciplinary European projects such as HBB4ALL and EASYTV, has given me a unique opportunity to grow as a researcher and learn from both junior and senior researchers from different interconnected fields of knowledge such as translation studies, media accessibility studies, psychology and communication technology. The collaboration with the *Universidad Politécnica de Madrid* (UPM) research team on the technical development of the computerised web-based interface for the cross-modal bilingual questionnaire has been an indispensable part of the instrument design phase of this PhD research. Under the scope of the EASYTV project, the original interface designed to implement the interviewer-administered questionnaires used in the quantitative phase of this PhD is currently being further developed to produce an accessible online self-administered survey tool. Additionally, the international partnership with several European public broadcasters, either as part of the project consortium or as observers, has provided me first-hand insight to current implementations and immediate future advances of signing services across Europe.

However, some limitations should be noted. Firstly, time constraints related to both the deadlines of the HBB4ALL project and the time-consuming instrument development phase influenced the scope of the quantitative phase. Originally, two different reception tests were envisaged for the quantitative phase that would have included the study of four different formal on-screen parameters in two different TV genres, the documentary and film. Because there were no previous valid instruments available or computer-based questionnaires that could easily include sign language, the instrument development phase was far more complex than originally foreseen as they entangled the collaboration between different project partners and needed to be executed sequentially. Altogether it took nearly fourteen months to complete all the necessary steps towards creating a valid questionnaire that could include a sign language as the language of administration. The different steps included: (1) the translation and adaptation process of the signed version of the original film; (2) the filming, editing and production of the stimuli and questionnaire video clips; and (3) the design and development of the web interface for the computerised video sign language questionnaire.

Both the qualitative, the instrument development and quantitative phases of my research have been conducted with a deaf-friendly research perspective in mind. Being myself a non-deaf member of the Catalan Sign Language Community, I am aware that cultural and language match is crucial when conducting research with individuals who are deaf signers. Collaboration with different agents within the community such as sign language interpreter professional groups, local and national deaf associations, deaf research facilitators and deaf research assistants has been present in every designed phase to guarantee not only ethical standards but also to make sure that the ongoing research was meaningful to the stakeholder groups.

This research envisioned the findings to have a local impact on the Catalan Sign Language Community but also to have a more global impact producing results that could be adopted and scaled up across Europe. Three social desired outcomes shaped the design of the research (1) to make a relevant research for the Catalan Sign Language Community, (2) to contribute to knowledge transfer between researchers, broadcasters and stakeholders and, ultimately, (3) to advocate for the rights of sign language community members to access information in their language. Engaging in several academic and non-academic activities for and within the deaf organisations and working in a project with both the state and the national public broadcasters (RTVE and CCMA, respectively) has helped me put forward these expected outcomes within limits, although more actions need to be made to fulfil them.

My PhD research and my role as a research facilitator for the HBB4ALL pilot test with deaf sign language users has shaped and developed my role as a researcher in the Catalan Sign Language Community and, hopefully, has helped me blend some deaf perspectives into my PhD research and overcome the bias of being a non-deaf researcher. At a more personal level, getting to know different Sign Language Community groups in Catalonia and having the opportunity to share my research with them has been a very rewarding learning experience. It has brought the opportunity to grasp the diversity within the groups regarding the access needs of each individual according to her/his personal background.

However, this variability within and among the Sign Language Communities could not be tested in this present research. Hence, the third limitation concerns sample biases: as the primary limitation to the generalisation of the quantitative results. On the one hand, the reported enhanced performance when the scene content is displayed on the right visual field might be influenced by a learning effect. The national public broadcaster in Catalonia produces sign-interpreted news in the news channel 3/24 including a SLI screen on a left position. In order to grant the external validity of the results, more research with different Sign Language Community groups with different TV consumption habits should be conducted.

On the other hand, the expected variation is not only among different sign language communities but also within the Catalan Sign Language Community members who constituted the target population of this PhD. Although Catalan Sign Language Community members are far from being an homogenous group, the sample size of the quantitative reception study was insufficient for statistical measurements based on demographic variables, such as age, gender or language background. This inherent variability could be addressed in future research.

7.4 Recommendations and Future Directions

Based on the above conclusions, from the size and position parameters of the SLI sub-screen for TV contents, it is clear that there is need to pursue testing techniques on signing access services in order to establish research-based guidelines that can constitute best practice for broadcasters. Future research on signing services need to determine the effects on reception of not only the formal parameters (size, postition, shot, colour contrast, etc.) but also their possible interactions.

The emergent application of eye tracking to explore attention allocation and TV screen legibility to SLI access services is still fairly unexplored, but has proved to be a source of valuable behavioural information. Future studies should endeavour to research other formal parameters that may affect sign language processing and visual perception. Studying the parameters affecting colour contrast —such as colour combination or the use of Chroma key without a framed window for the interpreter— might be especially important for the service users with a combined sensory loss, namely deafblind sign language users and the elderly.

As this is the first PhD to study two formal parameters as controlled variables, it seems fair to acknowledge that to achieve research-based comprehensive guidelines for sign-interpreted TV more work is needed to test different on-screen parameters, but also for different TV genres, devices or signing models. However, in order to expand and consolidate this new line of research within the media accessibility studies, it is equally important (if not even more so) to advance on the methods and instruments to test the actual content accessibility. Future efforts should strive to create standardised comprehension and information recall test using appropriate questionnaire designs.

Findings from reception tests of SLI access services on TV may not only provide best practices for implementations with current HbbTV 2.0 technologies, but can produce guidelines for future specifications on real personalisation options addressed to guarantee full accessibility for all Sign Language Community members. Academia, stakeholders and media agents need to strive for more awareness, more quantity and more quality of signing access services in the media. Equal human rights and full participation in society for sign language communities —without regard to language repertoire, hearing status, visual status or communication skills—, will only be achieved when inclusive access services can equally guarantee to all access to information and equal language rights.

Chapter 8

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Appendices

Appendix 1.1 Questions for the semi-structured interviews professional sign language interpreters

Entrevista ILS TV – Nom i Cognoms de l'ILS

Informació personal i professional	
Nom	
Cognoms	
Sexe	
Data de naixement	
Lloc de naixement	
Llengua 1	
Llengua 2	
Llengua 3	
Llengua 4	
Altres llengües	
Formació ILS (INCANOP, CFGS, ...) i any	
Any d'inici de l'activitat professional ILS	
En actiu	
Anys treballats ILS TV	
Captura d'imatge ILS TV	

Informació sobre els serveis de ILS TV	
Canal/s TV i anys	
Programes TV	
Franja horària d'emissió	
Durada del programa	
Condicions de treball i preparació del servei (documentació, temps, nombre d'ils, torns, ...)	

Aspectes tècnics dels serveis de ILS TV en què s'ha treballat	
Roba (color, estil,...)	
Mida ILS a pantalla (50%, 30%, <25%, ...)	
Pla (primer, mig, americà, ¾, ...)	
Lloc (dret/esquerra; superior/centre/inferior)	
Interacció amb altres elements (mosca, rotulació, ... davant/darrera)	

Smart Sign Language on Hbb4all – Marta Bosch i Baliarda

Entrevista ILS TV – Nom i Cognoms de l'ILS

Inserció a la pantalla (dividida/incrustada; amb/sense finestra)	
Positura (dret/assegut)	
Característiques físiques (pentinat, ...)	
Artefactes (arrecades, ulleres, bracelets, ...)	
Altres	

Feedback usuaris sobre els aspectes tècnics dels serveis de ILS TV	
Roba (color, estil,...)	
Mida ILS a pantalla (50%, 30%, <25%, ...)	
Pla (primer, mig, americà, ¾, ...)	
Lloc (dret/esquerra; superior/centre/inferior)	
Interacció amb altres elements (mosca, rotulació, ... davant/darrera)	
Inserció a la pantalla (dividida/incrustada; amb/sense finestra)	
Positura (dret/assegut)	
Característiques físiques (sexe, pentinat, ...)	
Artefactes (arrecades, ulleres, bracelets, ...)	
Altres	

Preguntes obertes:

- Quines característiques creus que són fonamentals per la qualitat de la interpretació?

- Quines característques formals creus que no tenen influència necessàriament en la interpretació?

- En estudis anteriors els usuaris manifestaven que els ILS de la TV han de ser "intèrprets agradables a la vista", amb "autoritat"... què en penses?

- Alguns usuaris creuen que fora bo que el Deaf-T/ILS (intèrpret sord) anés prenent més presència a la TV... què en penses?

Appendix 1.2 Outline design of the focus group with deaf sign language TV consumers

Guió Focus Group – Usuaris sords signants (focus group: _ _ / _ _ / _ _ _ _)

Guió Focus Group

Les característiques d'inserció de l'ILS TV en pantalla

(1)	*Presentació*	Hbb4all – projecte europeu accessibilitat a la televisió connectada: senyal de radiodifusió + IP - Possibilitat de configurar les característiques del subtítols / ILS - Estudi limitat a la interpretació/traducció de programes (no presentador d'LS tipus "en otras palabras") - Moltes característiques: ○ ILS home, dona / roba / pentinat / accessoris ○ Color de fons ○ Mida ○ Posició a la pantalla ○ Velocitat ○ ... - Important: no ens centrarem en el contingut sino en la forma
(2)	*Clips ILS TV*	Per mostrar diverses de les característiques que es volen discutir
(3)	*Característiques que les ILS TV han rebut com a feedback d'usuaris*	- Mida - Contrast color roba / color fons - Velocitat - No al mateix nivell que els subtítols / mosca (per evitar tapar)
(4)	*Altres característiques*	- Pantalla partida / subpantalla - Amb/sense finestra - Posició: dreta/esquerra ; superior/central/inferior - Pla: curt / mig / mig-llarg (americà) / llarg - Sexe: home/ dona - Positura: dret / assegut - Característiques físiques: "agradables a la vista" / ulls / mans … - Altres
(5)	*Clips / fotos ILS TV*	Per si cal il·lustrar alguna característica que no s'hagi discutit
(6)	*Pregunta oberta (1)*	- Quines característiques formals creus que són bàsiques o irrenunciables i afecten l'accessibilitat en LS
(7)	*Pregunta oberta (2)*	- Quines característiques creus que no tenen rellevància o influència. Per tant no afecten a l'accessibilitat en LS
(8)	*Activitat*	- Dibuix configuració en pantalla ideal - Dibuix configuració en pantalla fatal

(8) *Activitat*
- Dibuix configuració en pantalla ideal
- Dibuix configuració en pantalla fatal

Appendix 1.3 Image release form for the qualitative study

UAB
Universitat Autònoma
de Barcelona

DOCUMENT DE CESSIÓ DE DRETS D'IMATGE I D'EXPLOTACIÓ D'ENREGISTRAMENT DE VÍDEO I FOTOGRAFIA

JO, ___________________________________, amb DNI/passaport núm. _______________, que intervindré en el grup de discussió sobre la inserció de la llengua de signes interpretada a TV organitzada per Marta Bosch i Baliarda, amb DNI 46.687.394-Q de la Universitat Autònoma de Barcelona, AUTORITZO aquesta universitat a enregistrar la meva intervenció d'acord amb les condicions següents:

1. La Universitat Autònoma de Barcelona pot enregistrar la imatge, la veu (si s'escau) i el discurs en llengua de signes del sotasignat/de la sotasignada durant la meva intervenció, així com copiar-les en un altre suport, amb finalitats de conservació, recerca i tractament de les dades o difusió dins l'àmbit acadèmic.

2. La Universitat Autònoma de Barcelona pot difondre, publicar o comunicar l'enregistrament, de manera íntegra o parcial, amb finalitats de recerca i suport o il·lustració de la docència.

3. El sotasignat/la sotasignada autoritza la difusió de l'enregistrament mitjançant una llicència Creative Commons o una altra de similar.

4. El sotasignat/la sotasignada cedeix indefinidament els drets d'explotació, reproducció, comunicació pública i distribució dels materials que puguin derivar-se d'aquests a la Universitat Autònoma de Barcelona i al SGR TransMedia Catalonia per a permetre els accessos a través de la xarxa o qualsevol mitjà que cregui adient dins l'àmbit acadèmic.

5. La universitat es compromet a vetllar per la seguretat de les dades enregistrades i a aplicar-los les mesures de seguretat establertes al Reial Decret 1720/2007 de desenvolupament de la Llei Orgànica 15/1999 de protecció de dades de caràcter personal.

Barcelona, _________________________

Signatura

En compliment del que estableixen la Llei orgànica 15/1999, de 13 de desembre, sobre protecció de dades de caràcter personal, i el Reial decret que aprova el Reglament de desenvolupament de la Llei orgànica de protecció de dades de caràcter personal, us informem que les dades personals enregistrades durant la vostra intervenció es tractaran i s'incorporaran als fitxers de la UAB amb l'objectiu de gestionar i difondre correctament les activitats formatives dutes a terme amb la vostra col·laboració. Tanmateix, us informem que podeu exercir els drets d'accés, rectificació, cancel·lació i oposició davant de Marta Bosch i Baliarda, amb adreça electrónica marta.boschbaliarda@gmail.com.

Appendix 1.4 Informed consent form for the qualitative study

Universitat Autònoma de Barcelona

HOJA DE INFORMACIÓN SOBRE EL PILOTO
Hbb4ALL WP6 - ILS en TV

El objetivo principal de este estudio es la mejora de la calidad de los interpretación de la lengua de signos para personas sordas y con diversidad auditiva en los medios de comunicación. En concreto, el estudio pretende obtener datos sobre la experiencia y preferencias de los participantes en cuanto a los distintos parámetros y características formales del ILS en la pantalla con el contenido visual.

Su participación en el experimento consistirá en lo siguiente: participará en un grupo de discusión sobre qué características de la inserción del ILS le parecen más importantes para la recepción de los contenidos de TV. Tendrá que ver diferentes imágenes de distintos formatos de inserción del ILS en TV y visualizar algunos fragmentos. Deberá discutir diferentes parámetros y características, sus preferencias y experiencia del como usuario.

Su participación es totalmente voluntaria y se puede retirar del estudio en cualquier momento sin tenerlo que justificar de ninguna manera y sin que esto le repercuta de ninguna manera.

Sus datos serán totalmente anónimos ya que sus datos del ámbito personal se almacenaran mediante un código de identificación NO vinculado a su nombre y apellidos.

NO recibirá compensación económica por su participación en este estudio, el cual se usará SIN ánimo de lucro.

Las investigadoras que llevarán a cabo el experimento son Marta Bosch Baliarda (que participará en la pruebas) y la Dra. Olga Soler Vilageliu i la Dra. Pilar Orero Clavero (que dirigen la investigación). Marta Bosch Baliarda es la responsable y puede contactar con ella mediante el correo electrónico marta.boschbaliarda@gmail.com o mediante Skype: martaboschbaliarda.

Si quiere continuar informado de las evoluciones de la investigación, solo tiene que pedírselo a la investigadora responsable en el correo electrónico anterior.

¡MUCHAS GRACIAS por su participación!

(Nota: en la siguiente hoja está el consentimiento informado, que se debe firmar para poder formar parte en el estudio)

UAB Universitat Autònoma de Barcelona

CONSENTIMIENTO INFORMADO

Título del experimento: Hbb4all - WP6 Piloto: Parámetros y características del ILS en pantalla

Yo, (NOMBRE Y APELLIDOS) ....

- He leído la hoja informativa que me han dado y también el consentimiento informado.
- He recibido suficiente información sobre el estudio y la he entendido.
- He podido hacer preguntas sobre el estudio.

- Entiendo que mi participación es voluntaria.
- Entiendo que mi participación NO es remunerada.
- Entiendo que mi información será confidencial.
- Entiendo que me puedo retirar del estudio cuando quiera y sin tener que dar explicaciones y sin que me repercuta negativamente.

Doy mi conformidad libremente para poder participar en el estudio.

Fecha: ....

Firma de la investigadora
Marta Bosch i Baliarda

Firma del participante

(Nota: en la hoja anterior se puede leer la información sobre el estudio)

Appendix 1.5 Demographic questionnaire for the focus group participants

Fitxa participants – Usuaris sords signants (focus group: _ _ / _ _ /_ _ _ _) *Codi d'usuari:*

Informació personal i professional

(1) Nom Cognoms (2) Correu electrònic	
(3) Sexe	◯dona ◯home
(4) Data de naixement (5) Lloc de naixement	_ _ / _ _ / _ _ _ _ (dd/mm/aaaa)
(6) Llengua 1 (7) Llengua 2 (8) Llengua 3 (9) Llengua 4	◯ LSC /◯català /◯castellà /◯Altres: ◯ LSC /◯català /◯castellà /◯Altres: ◯ LSC /◯català /◯castellà /◯Altres: ◯ LSC /◯català /◯castellà /◯Altres:

(10) *LSC*		(11) *català*		(12) *castellà*	
Amb la parella	1 2 3 4 5	lectura labial	1 2 3 4 5	lectura labial	1 2 3 4 5
Amb la família	1 2 3 4 5	lectura escrit	1 2 3 4 5	lectura escrit	1 2 3 4 5
Amb els amics	1 2 3 4 5	escriptura	1 2 3 4 5	escriptura	1 2 3 4 5
A la feina	1 2 3 4 5	parla	1 2 3 4 5	parla	1 2 3 4 5

1: mai / 2: rarament / 3: ocasionalment
4: habitualment / 5: sempre

1: FATAL / 2: DIFICULTAT / 3: REGULAR / 4: BÉ / 5: PERFECTE

(15) Altres llengües	◯sí /◯no Quina/es?
(16) Edat de detecció de a sordesa	◯naixement ◯abans dels 3 anys ◯abans dels 7 anys ◯abans dels 16 anys ◯després dels 16 anys ◯Altres:
(17) Etiologia de la sordesa	◯congènita ◯malaltia ◯Altres:
(18) Antecedents familiars de sordesa	◯sí /◯no ◯pare /◯mare /◯avi-a /◯germa-ns /◯fill-s /◯espòs ◯Altres:
(19) Tipus de sordesa	◯sord pur ◯sord mig ◯ensordit amb restes ◯Altres:
(20) Formació acadèmica	
(21) Escola / (22) INS / (23) universitat	Escola: Institut: Univeristat:
(24) Professió	
(25) En actiu	◯sí /◯no jubilat / aturat / excedència laboral
(26) Associacionisme	◯sí /◯no Quina/es?

Smart Sign Language on HbbTV - Marta Bosch i Baliarda

Fitxa participants – Usuaris sords signants (focus group: _ _ / _ _ / _ _ _ _) *Codi d'usuari:*

	Informació sobre el consum de TV i els serveis d'accessibilitat (subtítols i LS)	
	(27) Quantes hores al dia mires la TV?	◯ no miro la TV ◯ miro la TV esporàdicament però no diària ◯ de 0 a 30 minuts ◯ de 30 minuts a 1 hora ◯ de 1 hora a 3 hores al dia ◯ de 3 a 6 hores al dia ◯ més de 6 hores al dia ◯ Altres:
	(28) Quins programes de TV t'agraden més?	◯ informatius ◯ documentals / educatius ◯ sèries ◯ pel·lícules ◯ magazines ◯ concursos ◯ reality shows ◯ retransmissions esportives ◯ Altres:
	(29) Quins programes de TV mires amb LS/ILS?	
	(30) Quins programes mires amb subtítols?	
	(31) Quins programes mires amb LS i subtítols simultàniament?	
	(32) T'agrada que hi hagi subtítols i LS simultàniament?	◯ sí ◯ no Comentaris:
	(33) Mires programes sense adaptació (ni subtítols, ni LS)? En aquests casos:	Quin/s? Fas aprofitament de la labiolectura? ◯ sí ◯ no Segueixes la informació només amb les imatges? ◯ sí ◯ no
	(33) Quin tipus de programa t'agradaria que fos accessible en LS?	◯ informatius ◯ documentals / educatius ◯ sèries ◯ pel·lícules ◯ magazines ◯ concursos ◯ reality shows ◯ retransmissions esportives ◯ Altres:
	(34) Com prefereixes consumir TV?	◯ només LS ◯ només subtítols ◯ amb LS i subtítols ◯ Altres:
	(35) Ahir vas veure algun programa de TV accessible en LS?	◯ sí ◯ no Quin/s?
	(36) Altres comentaris sobre LS/ILS a TV	

Smart Sign Language on HbbTV - Marta Bosch i Baliarda

Appendix 2.1 Image release form for the quantitative study

UAB
Universitat Autònoma
de Barcelona

DOCUMENT DE CESSIÓ DE DRETS D'IMATGE I D'EXPLOTACIÓ D'ENREGISTRAMENT DE VÍDEO, MOVIMENT OCULAR I FOTOGRAFIA

JO, ________________________________, amb DNI/passaport núm. ______________, que participo en les proves sobre la inserció de la llengua de signes interpretada a TV organitzada per Marta Bosch i Baliarda, amb DNI 46.687.394-Q de la Universitat Autònoma de Barcelona, AUTORITZO aquesta universitat a enregistrar la meva intervenció d'acord amb les condicions següents:

1. La Universitat Autònoma de Barcelona pot enregistrar la imatge, el moviment ocular, la veu (si s'escau) i el discurs en llengua de signes del sotasignant durant la meva intervenció, així com copiar-les en un altre suport, amb finalitats de conservació, recerca i tractament de les dades o difusió dins l'àmbit acadèmic.

2. La Universitat Autònoma de Barcelona pot difondre, publicar o comunicar l'enregistrament, de manera íntegra o parcial, amb finalitats de recerca i suport o il·lustració de la docència.

3. El sotasignant autoritza la difusió de l'enregistrament mitjançant una llicència Creative Commons o una altra de similar.

4. El sotasignant cedeix indefinidament els drets d'explotació, reproducció, comunicació pública i distribució dels materials que puguin derivar-se d'aquests a la Universitat Autònoma de Barcelona i al SGR TransMedia Catalonia per a permetre els accessos a través de la xarxa o qualsevol mitjà que cregui adient dins l'àmbit acadèmic.

5. La universitat es compromet a vetllar per la seguretat de les dades enregistrades i a aplicar-los les mesures de seguretat establertes al Reial Decret 1720/2007 de desenvolupament de la Llei Orgànica 15/1999 de protecció de dades de caràcter personal.

Signatura

Barcelona, ______________________

En compliment del que estableixen la Llei orgànica 15/1999, de 13 de desembre, sobre protecció de dades de caràcter personal, i el Reial decret que aprova el Reglament de desenvolupament de la Llei orgànica de protecció de dades de caràcter personal, us informem que les dades personals enregistrades durant la vostra intervenció es tractaran i s'incorporaran als fitxers de la UAB amb l'objectiu de gestionar i difondre correctament les activitats formatives dutes a terme amb la vostra col·laboració. Tanmateix, us informem que podeu exercir els drets d'accés, rectificació, cancel·lació i oposició davant de Marta Bosch i Baliarda, amb adreça electrónica marta.boschbaliarda@gmail.com.

Universitat Autònoma de Barcelona

DOCUMENTO DE CESIÓN DE DERECHOS DE IMAGEN Y DE EXPLOTACIÓN De GRABACIÓN DE VÍDEO, MOVIMIENTO OCULAR Y FOTOGRAFÍA

YO, ________________________________, con DNI/pasaporte núm. ______________, que participo en las pruebas sobre la inserción de la lengua de signos interpretada en la TV organizada por Marta Bosch y Baliarda, con DNI 46.687.394-Q de la Universitat Autònoma de Barcelona, AUTORIZO esta universidad a grabar mi intervención como PARTICIPANTE de acuerdo con las condiciones siguientes:

1. La Universitat Autònoma de Barcelona puede grabar la imagen, el movimiento ocular, la voz (si se tercia) y el discurso en lengua de signos del PARTICIPANTE durante mi intervención, así como copiarlas en otro apoyo, con finalidades de conservación, investigación y tratamiento de los datos o difusión dentro del ámbito académico.

2. La Universitat Autònoma de Barcelona puede difundir, publicar o comunicar la grabación, de manera íntegra o parcial, con finalidades de investigación y apoyo o ilustración de la docencia.

3. El PARTICIPATE autoriza la difusión de la grabación mediante una licencia Creative Commons u otra de similar.

4. El PARTICIPANTE cede indefinidamente los derechos de explotación, reproducción, comunicación pública y distribución de los materiales que puedan derivarse de estos en la Universitat Autònoma de Barcelona y al SGR TransMedia Catalonia para permitir los accesos a través de la red o cualquier medio que crea adecuado dentro del ámbito académico.

5. La universidad se compromete a velar por la seguridad de los datos grabados y a aplicarlos las medidas de seguridad establecidas al Real decreto 1720/2007 de desarrollo de la Ley Orgánica 15/1999 de protección de datos de carácter personal.

FIRMA

Barcelona, ________________________

En cumplimiento del que establecen la Ley orgánica 15/1999, de 13 de diciembre, sobre protección de datos de carácter personal, y el Real decreto que aprueba el Reglamento de desarrollo de la Ley orgánica de protección de datos de carácter personal, os informamos que los datos personales grabados durante vuestra intervención se tratarán y se incorporarán a los ficheros de la UAB con el objetivo de gestionar y difundir correctamente las actividades formativas llevadas a cabo con vuestra colaboración. Aun así, os informamos que podéis ejercer los derechos de acceso, rectificación, cancelación y oposición ante Marta Bosch y Baliarda, con correo electrónico marta.boschbaliarda@gmail.com.

Appendix 2.2 Informed consent for the quantitative study

UAB
Universitat Autònoma de Barcelona

HOJA DE INFORMACIÓN SOBRE EL PILOTO
Hbb4ALL WP6 - LS JtD

El objetivo principal de este estudio es la mejora de la calidad de los interpretación de la lengua de signos para personas sordas y con diversidad auditiva en los medios de comunicación. En concreto, el estudio pretende obtener datos sobre la experiencia y preferencias de los participantes en cuanto al tamaño y posición de la ventana del ILS y la pantalla con el contenido visual.

Su participación en el experimento consistirá en lo siguiente: tendrá que ver 4 fragmentos del documental sobre audiodescripción para personas ciegas "Joining the Dots". Cada fragmento dura aproximadamente 3 minutos. Después de cada visionado tendrà que rellenar un cuestionario sobre memoria visual, memoria del contenido signado y sus preferencias y experiencia del visionado.

Su participación es totalmente voluntaria y se puede retirar del estudio en cualquier momento sin tenerlo que justificar de ninguna manera y sin que esto le repercuta de ninguna manera.

Sus datos serán totalmente anónimos ya que en la hoja en la que se tiene que responder preguntas sobre el ámbito personal, habrá un código de identificación NO vinculado a su nombre y apellidos.

NO recibirá compensación económica por su participación en este estudio, el cual se usará SIN ánimo de lucro.

Las investigadoras que llevarán a cabo el experimento son Marta Bosch Baliarda (que participará en la pruebas) y la Dra. Olga Soler Vilageliu i la Dra. Pilar Orero Clavero (que dirigen la investigación). Marta Bosch Baliarda es la responsable y puede contactar con ella mediante el correo electrónico marta.boschbaliarda@gmail.com o mediante Skype: martaboschbaliarda.

Si quiere continuar informado de las evoluciones de la investigación, solo tiene que pedírselo a la investigadora responsable en el correo electrónico anterior.

¡MUCHAS GRACIAS por su participación!

(Nota: en la siguiente hoja está el consentimiento informado, que se debe firmar para poder formar parte en el estudio)

CONSENTIMIENTO INFORMADO

Título del experimento: Hbb4all - WP6 Piloto: tamaño y posición de la ventana del ILS en pantalla

Yo, (NOMBRE Y APELLIDOS) ………………………………………………………………………………

- He leído la hoja informativa que me han dado y también el consentimiento informado.
- He recibido suficiente información sobre el estudio y la he entendido.
- He podido hacer preguntas sobre el estudio.

- Entiendo que mi participación es voluntaria.
- Entiendo que mi participación NO es remunerada.
- Entiendo que mi información será confidencial.
- Entiendo que me puedo retirar del estudio cuando quiera y sin tener que dar explicaciones y sin que me repercuta negativamente.

Doy mi conformidad libremente para poder participar en el estudio.

Fecha: ………………………………………………………………………………

Firma de la investigadora		Firma del participante
Marta Bosch i Baliarda

(Nota: en la hoja anterior se puede leer la información sobre el estudio)

Appendix 2.3 Sample question design items of the cross-modal questionnaire

Appendix 2.3 Sample question design items of the cross-modal questionnaire

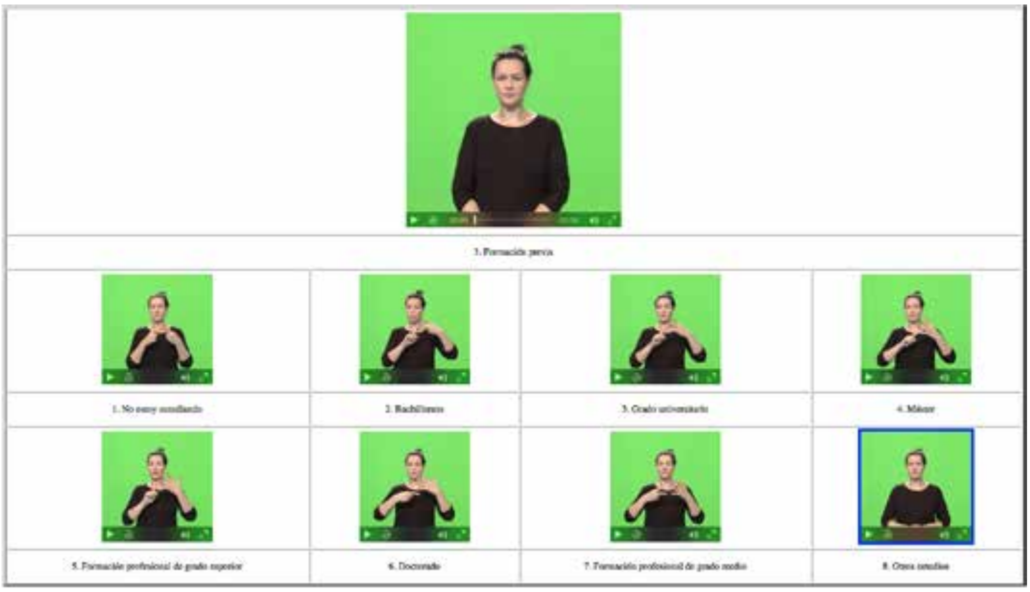
Question item sample 1: scale frequency, 4 responses, single choice, answered item

Question item sample 2: scale number, 11 responses, single choice, answered item

Question item sample 3: 2 responses, single choice, unanswered

Question item sample 4: 3 responses, single choice, answered item

Question item sample 5: 6 responses, single choice, unanswered



Question item sample 6: 8 responses, single choice, answered item

Appendix 2.4 Full written questionnaire for the quantitative study

Cuestionarios para el estudio de recepción

Cuestionario de control demográfico de variables

Q1 Fecha de nacimiento
1a Mes
1b Dia
1c Año

Q2 Sexo
2a Hombre
2b Mujer

Q3 Educación en curso
3a No estoy estudiando
3b Bachillerato
3c Grado universitario
3d Máster
3e Formación profesional de grado medio
3f Doctorado
3g Formación profesional de grado superior
3h Otros estudios

Q4 Estudios (psicología, traducción, …)

Q5 ¿A qué edad se detectó tu sordera?
5a nacimiento
5b antes de los 3 años
5c antes de los 7 años
5d antes de los 16 años
5e después de los 16 años
5f Otros

Q6 Valora del 0 al 10 tu nivel de comprensión escrito en castellano
6a 0 - no comprendo nada
6b 10 - puedo entenderlo todo

Q7 Valora del 0 al 10 tu nivel de comprensión escrito en catalán
7a 0 - no comprendo nada
7b 10 - puedo entenderlo todo

Q8 Valora del 0 al 10 tu nivel de comprensión en LSC, lengua de signos catalana
8a 0 - no comprendo nada
8b 10 - puedo entenderlo todo

Q9 Valora del 0 al 10 tu nivel de comprensión en LSE, lengua de signos española
9a 0 - no comprendo nada
9b 10 - puedo entenderlo todo

Q10 ¿Consumes habitualmente material subtitulado?
10a Nunca
10b Esporádicamente
10c A veces
10d Siempre

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Q11 ¿Consumes habitualmente material original en lengua de signos?
11a Nunca
11b Esporádicamente
11c A veces
11d Siempre

Q12 ¿Consumes habitualmente material interpretado en lengua de signos?
12a Nunca
12b Esporádicamente
12c A veces
12d Siempre

Q13 ¿Has consumido algún material (app, web, diccionarios, TV, …) interpretado en lengua de signos por un signante virtual?
13a No, nunca
13b Sí, esporádicamente
13c Sí, habitualmente

Q14 ¿Cómo prefieres consumir los productos de TV?
14a Sólo en LS
14b Sólo con subtítulos
14c Con subtítulos y LS
14d Otros

Q15 ¿Qué tipo de programas de TV miras con subtítulos?
15a Informativos
15b Documentales / educativos
15c Series
15d Películas
15e Magazines
15f Concursos
15g Reality shows
15h Retransmisiones deportivas
15i Otros

Q16 ¿Qué tipo de programas de TV miras con interpretación en LS?
16a Informativos
16b Documentales / educativos
16c Series
16d Películas
16e Magazines
16f Concursos
16g Reality shows
16h Retransmisiones deportivas
16i Otros

Q17 ¿Qué tipo de programas de TV te gustaría que fueran accesibles con interpretación en LS?
17a Informativos
17b Documentales / educativos
17c Series
17d Películas
17e Magazines
17f Concursos
17g Reality shows
17h Retransmisiones deportivas
17i Otros

Cuestionario de recuerdo para el documental Joining the dots

Preguntas de recuerdo verbal clip 1

Q18 ¿Qué ve Trevor en la actualidad? ¿Con qué compara su visión?
18a Un túnel oscuro
18b Un cubo de nieve
18c Un cuenco de cereales
18d No lo sé

Q19 ¿Cuántos años tiene Trevor en la actualidad?
19a 60
19b 70
19c 65
19d No lo sé

Q20 ¿Por qué Trevor se quedó ciego?
20a Tuvo un derrame en en ojo
20b Tuvo un accidente
20c De cataratas
20d No lo sé

Q21 ¿Cómo se llama el hospital al que fue Trevor?
21a Charing Cross
21b Kings's Cross
21c Holy Cross
21d No lo sé

Q22 ¿De qué estaba asustada Mags?
22a De que Trevor cayera en una depressión
22b De que Trevor se suicidara
22c De que Trevor tuviera un accidente a causa de la ceguera
22d No lo sé

Preguntas de recuerdo visual clip 1

Q23 ¿Cómo es la camisa del entrevistador?
23a Lisa y de color negro
23b De rayas verticales en colores rosados
23c De rayas verticales y horizontales en tonos azules
23d No lo recuerdo

Q24 ¿De que color es el jersey de Trevor (el entrevistado) cuando están en el tren?
24a Azul
24b Lila
24c Verde
24d No lo recuerdo

Q25 Cuando Trevor y Pablo (el entrevistador) andan por la calle…
25a Trevor utiliza un bastón blanco con una bola
25b Trevor no utiliza bastón porque Pablo lo guía
25c Trevor utiliza un bastón blanco y rojo
25d No lo recuerdo

3

Q26 ¿Lleva un anillo Trevor?
26a Sí
26b Solía llevar (se puede ver la marca)
26c No
26d No lo recuerdo

Q27 ¿Cómo lleva el pelo el entrevistador?
27a Rubio y corto
27b Moreno, rizado y un poco largo
27c Moreno y liso
27d No lo recuerdo

Preguntas de recuerdo verbal clip 2

Q28 ¿Cuánto tiempo tardaron en llegar al teatro?
28a 30 minutos
28b 20 minutos
28c 10 minutos
28d No lo sé

Q29 ¿Cómo se llama la mujer que ayudó a Trevor?
29a Joan Greening
29b J.K. Rowling
29c Jane Greene
29d No lo sé

Q30 La mujer dice que Trevor…
30a Le hacía rechinar los dientes
30b Era un pesado
30c Era difícil de tratar
30d No lo sé

Q31 ¿Cuándo aprendió Trevor a usar un ordenador?
31a Después de quedarse ciego
31b Antes de quedarse ciego
31c No sabe cómo usar un ordenador
31d No lo sé

Q32 En la conferencia Trevor...
32a Dijo que deberían audiodescribirse más programas
32b Dijo que todavía hay que mejorar la audiodescripción
32c Agradeció a todo el mundo por haber encendido una vela para él con la audiodescripción
32d No lo sé

Preguntas de recuerdo visual clip 2

Q32 ¿Como es la puerta de entrada del teatro?
32a Es una puerta de cristal giratoria
32b Es una puerta de cristal automática
32c Es una puerta de cristal que se abre para fuera
32d No lo recuerdo

Q33 ¿Cómo es el papel de pared cuando están entrevistando a Joan a solas?
33a Con decoración floral
33b Rosa pálido y liso
33c Todo blanco y liso

33d No lo recuerdo

Q34 ¿Cómo es el collar de Joan?
34a De color plata con motivos naturales
34b Una cadena de oro larga
34c Un collar plata simple
34d No lo recuerdo

Q35¿Que hay encima de la mesa cuando Trevor y Joan están sentados?
35a Varias copas de cristal y un salero
35b Dos copas de cristal y una botella de agua
35c Un jarrón de cristal, cubiertos y servilletas
35d No lo recuerdo
Q36 ¿De que color es el sweater de Trevor cuando está con Joan sentado en el restaurante?
36a Azul claro
36b Lila
36c Gris
36d No lo recuerdo

Preguntas de recuerdo verbal clip 3

Q37 La audiodescripción para el cine …
37a Es un resumen
37b Es grabada
37c Hay que hacerla en directo
37d No lo sé

Q38 ¿Con qué compara Trevor la audiodescripción para ciegos?
38a Con un libro para niños lleno de puntos que se unen
38b Con los subtítulos para sordos
38c No lo compara con nada
38d No lo sé

Q39 Cuando la mujer sale, toca a Trevor…
39a En la cabeza
39b En la mano
39c En la espalda
39d No lo sé

Q40 ¿Cómo tenía el pelo Trevor cuando se quedó ciego?
40a Tenía el pelo rubio
40b Tenía canas
40c Tenía el pelo negro
40d No lo sé

Q41 Trevor explica que los ciegos se crean una imagen mental de las personas …
41a Mediante el tacto se sus rasgos faciales
41b Gracias a la voz que oyen
41c Gracias a los recuerdos visuales que tenían como videntes
41d No lo sé

Preguntas de recuerdo visual clip 3

Q42 ¿Que hay encima de la mesa cuando Trevor nos habla de su vida?
42a Un plato pequeño y una planta
42b Un cenicero, una taza de te y una planta

42c Dominó, una taza de té y un plato con frutos secos y nueces
42d No lo recuerdo

Q43 ¿De que color es el jersey de Trevor cuando lo entrevistan en casa?
43a Azul claro
43b Lila
43c Gris
43d No lo recuerdo

Q44 ¿Que colores llevan los actores en el teatro?
44a Todos van de negro
44b Todos van en tonos ocres
44c Todos van en tonos marrones excepto una actriz de verde
44d No lo recuerdo

Q45 ¿Qué tipo de chaqueta lleva Trevor?
45a Una chaqueta de lana negra
45b Una cazadora de piel negra
45c Una cazadora tejana negra
45d No lo recuerdo

Q46 ¿Qué lleva Joan en el hombro?
46a Una mochila
46b Un capazo
46c Un bolso
46d No lo recuerdo

Preguntas de recuerdo verbal clip 4

Q47 ¿Qué hace Trevor en el jardín cuando viene gente?
47a Beber una cerveza y leer el periódico
47b Beber un refresco y jugar al dominó
47c Beber un vino y charlar
47d No lo sé

Q48 ¿Qué está escrito en el letrero del jardín?
48a Aquí viven una anciana encantadora y un viejo gruñón
48b Aquí viven un caballero encantador y una vieja gruñona
48c Aquí viven una anciana encantadora y un viejo cascarrabias
48d No lo sé

Q49 ¿Quién le dijo a Trevor lo del cartel?
49a Un amigo
49b El cartero
49c El lechero
49d No lo sé

Q50 ¿Cuándo se enteró Trevor de lo del cartel?
50a A los dos años
50b Al año
50c A los tres años
50d No lo sé

Q51 ¿Cuánto tiempo lleva Trevor ciego?
51a 5 años
51b 10 años

51c 15 años
51d No lo sé

Preguntas de recuerdo visual para el clip 4

Q52 ¿Que tiene Trevor colgado en la pared del jardín?
52a Algunas plantas
52b Algunos platos de cerámica
52c Algunas figuras de cerámica
52d No lo recuerdo

Q53 ¿Que animales representan las figuras que tiene Trevor en el lago?
53a Un gato, una tortuga y una rana
53b Un perro, un caracol y un conejo
53c Un conejo, una tortuga y un ratón
53d No lo recuerdo

Q54 ¿Cómo es la camiseta que lleva Mag (la mujer de Trevor)?
54a Un top blanco
54b Un top blanco con lunares negros
54c Un top con rayas blancas y negras
54d No lo recuerdo

Q55 ¿De que color son las sillas del jardín?
55a Negras
55b Rojas
55c Amarillas
55d No lo recuerdo

Q56 ¿Que camisa lleva el entrevistador?
56a Una camiseta blanca con rayas verticales y horizontales de color rojo
56b Una camiseta blanca con rayas verticales y horizontales de color marrón
56c Una camiseta roja con rayas verticales y horizontales de color blanco
56d No lo recuerdo

Cuestionario de valoración de la experiencia

Valoración de la experiencia

Q57 ¿En qué dispositivo has visto este clip?
57a Teléfono
57b Tableta
57c Pantalla TV
57d Ordenador

Q58 ¿Qué porcentaje de la interpretación en lengua de signos crees que NO te ha dado tiempo a ver?
58a Valora de 0 (0%) - 10 (100%)

Q59 ¿Cómo te ha parecido la visualización de la interpretación en lengua de signos?
59a Valora de 1 (muy difícil) -10 (muy fácil)

Q60¿Crees que has perdido partes esenciales de la acción por atender a la interpretación en lengua de signos?
60a Sí
60b No

Q61 ¿Cómo valorarías tu experiencia viendo una película con este tipo de interpretación en lengua de signos en pantalla?
61a Valora de 1 (placentera/cómoda) - 10 (no placentera/incómoda)

Q62 ¿Qué te parece el tamaño de la ventana del intérprete de lengua de signos?
62a Muy pequeño
62b Pequeño
62c Normal
62d Grande
62e Muy grande

Q63 ¿Cómo valoras el tamaño de la ventana del intérprete de lengua de signos?
63a Adecuado
63b Inadecuado

Q64 ¿Qué opinas sobre el tamaño relativo de las dos ventanas?
64a Adecuada
64b Hubiera preferido una ILS más grande y la película más pequeña
64c Hubiera preferido una ILS más pequeña y la película más grande

Q65 ¿Qué opinas sobre la posición relativa de la ILS en la pantalla en esta película?
65a Adecuada
65b Hubiera preferido la ILS al otro lado de la pantalla

Q66 ¿Cómo valoras el color del fondo de la ILS?
66a adecuado
66b demasiado oscuro, preferiría más claro
66c demasiado claro, preferiría más oscuro

Q67 ¿Cómo te ha parecido la calidad de la inserción de la interpretación en lengua de signos en la pantalla?
67a He perdido mucho tiempo atendiendo la intérprete de lengua de signos y no he apreciado adecuadamente el resto del contenido visual en pantalla
67b He perdido un poco de tiempo atendiendo la intérprete de lengua de signos y no apreciado todos los detalles del resto del contenido visual en pantalla
67c He visto cómodamente la intérprete de lengua de signos y me ha dado tiempo de apreciar bastante el resto del contenido visual en pantalla
67d He visto cómodamente la intérprete de lengua de signos, que me han ayudado a apreciar el resto del contenido visual en pantalla

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Appendix 3.1 Article 1 - Towards recommendations for TV sign language interpretation

Towards recommendations for TV sign language interpretation[1]

Marta Bosch-Baliarda, Pilar Orero, Olga Soler-Vilageliu
Universitat Autònoma de Barcelona, Spain

Sign language interpreting (SLI) on TV is still in need of basic research to support video production guidelines, a complex matter given the variety of sign language styles and screen layouts adopted by international broadcasters. The current paper aims to draft recommendations regarding the formal parameters for displaying SLI on TV. First, it offers an overview of current SLI access services. Second, it proposes a set of variables to be further studied. Third, it reports on feedback gathered from stakeholders. The article concludes with a list of recommendations that may be applied by broadcasters offering SLI access services.

Key words: sign language interpreting, accessibility, deaf TV service users, media interpreting, audiovisual translation

1. Introduction

Sign language interpreting (SLI) on TV is one of the three major TV accessibility services, along with subtitling and audio description (e.g. European Parliament 2010a; European Parliament 2010b; European Parliament 2015; International Telecommunication Union [ITU] 2014a; Looms 2009). SLI access services need to improve both in terms of quantity and quality. On the one hand, affordability of the services should go beyond the amount of current broadcasting time (e.g. European Broadcasting Union [EBU] 2016; European Regulators Group for Audiovisual Media Accessibility [ERGA] 2016; Office of Communications [Ofcom] 2017; Haualand & Allen 2009). On the other hand, the quality of the SLI service may depend on various factors such as the language and interpreting skills of the interpreter, or the technical requirements impacting legibility of the signed content. "Television programmes […] may add layers of complexity by placing sign or text over the existing visual message. This creates interesting issues which are currently unresolved as to how to convey information with mixtures of signing, visual action, speech and text" (Kyle, Reilly, Allsop, Clark & Dury 2005: 57). Hence, the importance of studying which formal parameters and layouts affect on-screen sign language legibility and overall screen readability. Both legibility and readability may impact on service usability and, ultimately the service user experience.

Previous studies, mainly from the past EU funded project DTV4ALL, indicated that users prefer an inversion of the content priority where SLI has (visual) priority over the broadcast content as can be seen in Figure 1 (e.g. DTV4ALL 2008; Guttermuth 2011; Kyle,2007; Wehrmeyer 2014).

Figure 1 *SLI in the Danish broadcaster DR (reproduced from DTV4ALL 2008)*

While former research indicates that the screen layout shown in Figure 1 is the preferred format, these findings have not translated into standardised guidelines (e.g. Independent Television Commission [ITC] 2010; Esteban-Saiz 2017; National Disability Authority [NDA] 2014).

The overarching aim of the present paper is to identify the best SL on-screen presentation mode on TV. In order to identify which formal features could be recommended to include SLI on the screen, we have conducted a qualitative analysis of current SLI practice. First, we analysed the screen layouts adopted by 42 international broadcasters (section 2), to identify the variety of formal features that may occur. Second, we gathered feedback from stakeholders in Catalonia —SLI interpreters and deaf signing TV consumers— in order to evaluate the formal features identified in the previous phase and shortlist what features enhance user experience and usability (section 3). The hypothesis is that the preferred screen composite layout identified in previous research (see Figure 1), is influenced by the TV genre most widely available to deaf signing TV consumers, namely news broadcasts. Language information in news broadcasting is more relevant than visual information, especially when the regular newsreader is on the screen. This could explain why the interpreted sign language content is given a more prominent position than the broadcast content. Based on the findings from sections 2 and 3, section 4 offers a series of recommendations for the inclusion of SLI on TV broadcasts. Finally, discussion and conclusions are presented (section 5).

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2. Data collection from broadcasters across 42 countries

The first stage of the research was to understand which formal features could impact the reception of SLI on TV. With this aim, screen layouts were collected from different international broadcasters, offering an overview of the formal features applied by broadcasters within and outside of the EU. The first data were collected from the online platform Sign Language Television for the Deaf.[2] This platform includes different accessible TV programmes from broadcasters in 42 countries. From this website 100 screen shots were retrieved with the aim to classify the many features and formats used when presenting sign-interpreted programmes on TV (Redón 2014). These data were analysed further, taking into account some of the common variable formal parameters and features previously described in the literature (e.g. Gil-Sabroso & Utray 2016; Kyle, Reilly, Allsop, Clark & Dury 2005; Van der Graaf & Van der Ham 2003). The selected parameters were: SL on-screen presentation mode (Table 1), shot size (Table 2), interpreter's clothing colour (Table 3), interpreter's on-screen size (Table 4),[3] interpreter's location on the screen (Table 5). Tables 1–5 present the different categories analysed for each parameter.

Picture-in-picture box	49%
Split screen	27%
Chroma key (silhouette)	24%

Table 1 *SL on-screen presentation modes*

Long shot (LS)	30%
Medium long shot (MLS)	7%
Mid shot (MS)	49%
Medium close-up (MCU)	14%

Table 2 *Shot size*

Plain light-colour	14%
Plain dark-colour	62%
Patterned	24%

Table 3 *Interpreter's clothing colour*

Small	24%
Medium	44%
Large	32%

Table 4 *Interpreter's on-screen size*

	Bottom	Centre	Top
Right	40%	21%	3%
Left	17%	19%	0%

Table 5 *Interpreter's location on the screen*

The collected data analysis shows a great deal of variation among different broadcasters. It also shows an incongruity between the screen layouts adopted by broadcasters, and the user preferred option as shown in Figure 1. From the data collected in Redón (2014) the stereotyped format of SLI is a female interpreter, wearing plain dark-colour clothes, filmed in a mid-shot and shown in a medium-sized frame placed in the bottom right-hand corner of the screen. Figure 2 illustrates this common format.

Figure 2 *Common format of SLI on TV derived from the data analysed*

The typical layout (Figure 2) versus the one preferred by viewers (Figure 1) differ largely. The most common layout features a medium sized picture-in-picture frame, showing a medium-sized mid-shot of the interpreter, either side-by-side or overlaying on the news content. This contrasts with the one preferred by viewers: a prominent interpreter in a foreground position inserted in a layer in front of the broadcast news content, with mid-long shot, occupying a third of the screen width (e.g. DTV4ALL 2008; Kyle 2007; Wehrmeyer 2014). These differences affect the prominence of the interpreter in both the relative size and the on-screen presentation mode.

Variation in screen layout is not only found among broadcasters from different countries within and outside the EU (EBU 2016) but also sometimes within the same broadcaster. A second data collection process was designed in order to discuss the observed variation and understand which of the described formal parameters and features are perceived to affect legibility of the SLI on the screen the most. Information was gathered from two groups directly involved in sign language production and reception on TV: sign language interpreting professionals who currently work or have worked on TV and signing deaf people. For each group a different qualitative data collection method was designed and developed.

3. Collecting data from service providers: TV sign language interpreters

Sign language communities are a minority group. They include not only signing deaf people but also their families and the professionals who take an active role in their cultural and linguistic daily life (e.g. De Meulder, Krausneker, Turner & Conama 2018; Harris, Holmes, & Mertens 2009). Before SLI studies became part of mainstream education programmes, sign language interpreters were normally signing hearing children of deaf parents. Even today some professionals are CODAs (Children of Deaf Adults) or their relatives (Bontempo 2015). In Catalonia (7.5 million citizens) there are some 25,000 Catalan Sign Language (*Llengua de Signes Catalana*, LSC) users, out of which 6,000 are deaf or deafblind (Cabeza & Porteiro 2010).

3.1. Professional interpreters' interviews: Method

We interviewed TV sign language interpreters to collect qualitative data. Sign language interpreters can both provide professional first-hand information and report specific feedback from their Deaf consumers. This method was chosen to allow interaction with professionals on the pre-selected format features.

3.1.1. Participants

Currently there are ten professional TV sign language interpreters in Catalonia working for both local and national broadcasters. These ten professionals were contacted through the Association of Sign Language Interpreters and Guide-Interpreters of Catalonia (*Associació d'Intèrprets de Llengua de Signes i Guies-Intèrpret de Catalunya*, ACILS),[4] and the Catalan Federation of Deaf People (*Federació de Persones Sordes de Catalunya*, FESOCA).[5]All potential participants were contacted either by phone or email.

Finally, a total of 12 professionals (9 female and 3 male) agreed to participate in the research, including nine active professionals and three professionals no longer working for TV. The median age of the participants was 38 (ages raging from 30 to 46). All participants were certified interpreters. Six participants who received their qualifications after 2000 had a level 5 diploma in sign language interpreting and guide-interpreting. The other six participants had other qualifications and accreditations (four of them were CODAs). All the interpreters had at least 3 years of work experience on TV. On average, interpreters had 4 years of prior professional experience in different settings, other than TV.

3.1.2. Materials

During the interview a personal computer was used to take notes and display a selection of screenshots collected from the online platform Sign Language Television for the Deaf. The semi-structured interviews were designed in five sections: 1) personal and professional information, 2) professional experience with TV interpreting, 3) formal aspects of on-screen presentation (including screen-shots when available), 4) feedback from Deaf consumers regarding the formal aspects of SL on-screen presentation, and 5) open questions about other professional and formal aspects not asked in previous sections. Sections 1 to 4 consisted of a series of pre-determined, open-response questions that all interviewees answered in the same order.

3.1.3. Procedure

Prior to the interviews, a written questionnaire including the demographic information and outline of the pre-determined sections of the interview was sent to all participants. Respondents were asked to send screen-shots of their professional work in TV interpreting, if available. The preferred method of carrying out the interviews was face to face. Interviews were held in both public and private locations according to the interviewees' preferences to facilitate participation. Due to geographic distance and personal availability, one interview was conducted via video call and two via phone call. Due to time constraints one phone call participant did not finish all five sections. They were completed a few days later and sent via email. The interviews lasted from one to up to three hours. No participant was excluded.

All interviews started with sections 1 to 4. In section 3, if the professionals could not provide a screen-shot demonstrating their own on-screen presentation mode, they were asked to describe it, paying special attention to all the formal features. After the interview participants browsed the different screenshots collected from the online platform Sign Language Television for the Deaf. This was aimed to elicit further comments on formal features of SLI insertion. After the interview, the notes were sent via email to each participant to check their content. This in-depth qualitative research was carried out over a period of two months.

3.2. Professional interpreters' interviews: Results

Interview results show that both professional interpreters and deaf TV consumers agree that the most important formal aspect of SL on-screen presentation is size —provided that other more basic technical requirements are met (e.g. lighting technique). The perception of the interpreter's on-screen size mainly depends on two formal features: the size of the picture-in-picture box and the shot size. Although some broadcasters have an online feedback service, it is rarely used by consumers to make suggestions or complaints. According to the public Catalan Corporation of Audiovisual Media (*Corporació catalana de mitjans audiovisuals*, CCMA) Accessibility and Audience Feedback Services, only 6 people asked about the sign language service between 2015 and 2018 and none made reference to formal requirements (CCMA, personal communication, April 2, 2019). According to the information obtained in the interviews, deaf TV consumers provide their feedback more frequently by direct contact with the TV sign language interpreters via personal and informal ways. When discussing user feedback, interpreters mention that deaf consumers mostly complain about the interpreter's box being too small. Whenever the box is enlarged, user feedback is always positive. Interpreters also note that shot size also influences the overall size perception. Feedback from the consumers points to a medium long shot as the preferred format. That is just a bit shorter than a knee shot, with some space above the head to allow signs in that region to be clearly seen.

However, interpreters working on TV sometimes need to adapt. When the picture-in-picture box is too small interpreters ask the cameramen for a shorter shot for greater hand visibility. Even though a mid-shot imposes restrictions on the signing space, it is always preferable to a longer shot because the latter makes hand size look even smaller. During the interviews, interpreters mentioned that they always tackle these technical issues during their TV assignments, while broadcasters are generally unaware of them.

Background colour was the second most frequently mentioned formal feature of SL on-screen presentation, and the feedback varies greatly. The reported colours ranged from plain white to grey, orange, all shades of blue and black, or even dotted or patterned backgrounds. This formal variation is due to personal aesthetic choices as to which colours match or contrast with the general on-screen setup of a given TV programme. SL on-screen legibility partly depends on the contrast between the background and the colour of the interpreter's skin and clothing. The right colour combination may contribute to the attractiveness and the visibility of the language presentation (World Wide Web Consortium [W3C] 2016). The interpreters also reported that service users mention that an unsuitable colour of the background not only affects legibility but may also result in eye fatigue. As for the colour of clothing, SL interpreters in Catalonia tend to wear plain dark clothes, and in formal assignments black is always preferred over alternatives. All interpreters currently working on TV said they wear black clothes and mentioned that users tend to accept this as part of their uniform. Most users complaining about colour contrast would rather change the background colour than the clothing colour.

The last formal feature is speed. This feature was not in our original list, but was brought up by professionals in their interviews as one of the most powerful factors in successful communication. Most TV interpreters work on news programmes and speech rate tends to be higher than normal speech rate. According to Serrat-Manén (2011) CCMA news interpreted into sign language show a rate of 2.8 words per second, which is very fast compared to signing news produced by deaf people at Gallaudet University in Washington DC (between 1.4 and 1.8 words per second). Professionals found it difficult to convey every single word. Common interpreting strategies to compensate for a high-speed rate are to paraphrase, compress or omit some information such as transitions between news or greetings (see Isal 2015 for an analysis of sports news reports broadcast by the CCMA). Also reported by interpreters are reading difficulties when finger-spelling names, especially for uncommon longer names in foreign languages. An interesting solution reported was to buffer TV reception to allow for personalised speed. It is worth mentioning that apart from a few exceptions all TV interpreters have worked in news broadcasting, and only three in other TV genres. One has also worked on a children's show at CCMA and the two Catalan professionals working for the Spanish commercial TV channel *La Sexta* have also interpreted some films.

Both interpreters at *La Sexta* also mentioned negative feedback from deaf users about the interaction between subtitles and the interpreter's box. In *La Sexta* subtitling, interpreting, and the digital on-screen graphics share the same bottom-of-the-screen area. From time to time these different layers of information overlap. Consumers suggested that the interpreter's box and subtitles should be displayed in different parts of the screen.

There was general agreement that the most frequent end-user feedback is on language features and content rather than on formal aspects. Interpreters are commonly contacted about the use of regional dialectal signs or neologisms, as well as regarding the general linguistic skills and performance of the interpreter (either to praise them or to suggest improvements).

4. Collecting data from service users: signing deaf TV consumers

According to the European Broadcasting Union (EBU) report on accessibility services, public European broadcasters deliver sign language on 4% of programmes on average (e.g. EBU 2016; ERGA 2016). Although sign languages are under-represented in mainstream media, deaf signers are expert users of TV accessibility services and have an opinion. To determine key formal features and their hierarchy, it is important to gather their views. To this aim a focus group study was designed as the primary qualitative data collection method.

4.1. Focus group with deaf users: Method

In order to raise interest in the topic within the Catalan Sign Language community, we contacted the National Federation of Deaf People of Catalonia (FESOCA). Contacts were also made by participating in the 5th Catalan Sign Language Seminar (Barcelona 2014), which is a social and scientific event organised especially for LSC teachers and other members of the Sign Language community in Catalonia. In this event we were invited to give a 40-minute presentation about the HBB4ALL project. Regarding the sign language pilot study, we presented the data included in section 2. After the presentation, many deaf people showed interest and were willing to share their opinions with us. We also recorded a recruitment video message in LSC asking for collaboration in a focus group to discuss the formal aspects of on-screen sign language presentation. FESOCA sent the video message to all the local associations, the majority of signing deaf people associations in Catalonia. The local associations then forwarded the information to their members.

4.1.1. Participants

The recruitment video message had 184 views and a total of 13 users contacted to participate. A total of 8 participants (7 female and 1 male) took part across 2 sessions. The participant median age was 43. The first session grouped older deaf people (with a participant median age of 63, ages ranging 50-72) whereas the second gathered younger users (with a participant median age of 23, ages ranging 22-38). This distribution was accidental, as users chose either session voluntarily.

All participants were deaf people from the Barcelona region. They all had either or both attended a deaf education center and were active members of a local deaf association. All were profoundly deaf, either congenitally deaf or deaf before the age of 3. They all reported LSC as their first language. Three of the participants were born to signing deaf families and 5 were born to hearing families, one of which reported the occasional use of sign language within the family.

In regard to TV and choice of access services, they all reported having viewed both subtitled and interpreted TV content when available. All but one of the participants mentioned they like to use both access services. Three participants reported to have watched interpreted content within 24 hours prior to the focus group session.

4.1.2. Materials

The focus group sessions were conducted in a meeting room in Casa del Mar, a public venue close to a deaf high school in Barcelona used to host Catalan Sign Language community events. The room was equipped with an overhead projector, a screen and a desktop computer. During the focus group sessions screenshots and video clips were displayed showing different screen formats and on-screen presentation setups.

The participants were placed at two different tables arranged in a V shape facing the screen and the interviewer. Three cameras were used to record each session. Apart from the researcher two other people were present: a research assistant and cameraperson, both fluent signers. Three written forms were administered: an informed consent form, an image release form, and a questionnaire. To fill in the relevant forms and complete the last task of the session there were pens, paper, coloured pencils, and crayons. The questionnaire had two parts: the first part was designed to collect demographic information including hearing status, language use and social participation in the Sign Language community. The second part of the questionnaire gathered information about the habits of the participants as TV and access service consumers.

4.1.3. Procedure

LSC was the language of communication throughout the focus group discussion. At the beginning of the session the participants were welcomed and informed about the procedure and expected duration of the session. The three written information and consent forms were handed out. Both the researcher and the sign language research assistant helped to translate and answered questions about the content of the forms when needed. The aim of the focus group sessions was to discuss all the formal features of on-screen interpreting previously described in the initial data collection phase (see section 2) and those discussed in the interviews with the SLI professionals (see section 3). The results from the interviews were the starting point for the group discussion.

After collecting the completed forms, the group discussion began. From the beginning of the sessions it was stressed that the goal of the focus group study was to discuss the formal features affecting sign-interpreted broadcasts, as opposed to the interpreting and language skills of the SLI professionals.

Both focus group sessions followed a structured outline and made use of the same input materials. The session was organised in seven sections designed to provoke discussion on two topics: the formal features of SLI presentation on broadcast news, and different TV programme genres.

To focus the discussion, previous research within the HBB4ALL project was presented. The features of SL on-screen presentation researched as part of the first data collection process were summarised. Then four video clips (approximately ten seconds each) were shown to illustrate different on-screen presentation setups used by the Catalan or Spanish broadcasters. The third section introduced the results from the interpreter interviews. The following sections aimed to introduce other formal features not previously discussed and not analysed with the previous data collection methods. To wrap up this first part of the session, ten screen shots showing a wide variety of formal characteristics of SL on-screen presentation were selected and displayed. They illustrated several setups of the formal features under discussion and elicited new feature discussion. The participants were encouraged to come up with other formal features, not previously described. The final section was oriented towards rating the formal features from the most to the least important for accessibility. To close the session the participants were asked to draw two TV screens on DIN-A4 white paper and depict the best and the worst screen layouts.

After each session we took notes to summarise the main issues discussed. The videos recorded during the sessions were edited to show all participants simultaneously using picture-in-picture. The relevant parts of the videos were transcribed using glosses for further analysis.

4.2. Focus group with deaf users: Results

The results from the focus group sessions with end-users are consistent with the feedback reported by the interpreters. All participants considered the interpreter's on-screen size to be the most important factor influencing accessibility. Most agreed that approximately a third of a vertically split screen and the use of MS/MLS would be the most suitable setup in this regard. Participants also agreed that different types of TV genres should use different SL presentation modes, utilising different formal features. They acknowledged that the only type of TV programme that they could access regularly in LSC was news broadcasts, and they would need more experience and time to find the best setup for other TV genres. Regarding size, for example, most mentioned that for films or TV series they would prefer a smaller interpreter. They also mentioned the possibility of adjusting clothes and colours according to the target audience and content. Some suggested that for interviews, or some reality shows, more than one interpreter could be used in different parts of the screen to match speaker location.

Deaf users also considered colour contrast to be one of the most important features. However, they did consider the possibility of interpreters wearing colours other than black, as a way to prevent eye-fatigue and provide colour contrast. The participants also mentioned the need to be consistent in the future if colours and the interpreter dress code matched the type of programs and their targeted audience. The suggested colours for the interpreter clothing showed a wide range of preferences including: light, dark, bright, and the classic black. They all seemed to prefer plain colours with no patterns. There was no consensus regarding the background colour beyond the expectation that it should contrast with clothing and skin colour. This was suggested as a means of highlighting linguistic details and preventing eye-fatigue. Regarding the colour contrast and the on-screen presentation mode, most participants considered that embedding the interpreter in a framed picture-in-picture box, rather than using chroma key technology, was a better way to guarantee contrast. Some participants mentioned that the contrast between the interpreter's box and the screen should also be considered.

Deaf consumers also discussed the overlaying (or even overlapping) of subtitling and the digital on-screen graphic with the interpreter's box on the screen. They all agreed overlapping should be avoided. Given that subtitles are displayed at the bottom of the screen most participants agreed that the sign language interpreter's box should be placed midway along the vertical axis. However, while there was no consensus regarding the right/left location, the participants agreed that the position parameter affected the overall screen readability. Interestingly, some said it was more comfortable to start by viewing the sign language on the right and then continue reading the subtitles whereas others argued the opposite.

When asked about the speed of delivery, most did not feel it was a feature that could be altered and would not elaborate further on this. They seemed to accept that news is delivered at a rapid pace of speech and that it is the interpreter's job to keep up with it, regardless of the challenges posed. They did point out that having the option to slow down the speed would make the content accessible for more people.

All the other features such as: gender, age, appearance or position, were considered irrelevant to accessibility. However, both groups agreed that certain aesthetics are important to appear on TV and always stressed the importance of interpreting skills, and cultural background. Further results and comments that arose during the focus group sessions are included in the next section as recommendations.

5. Recommendations for sign language on-screen presentation on TV

In addition to the commonly agreed criteria mentioned in sections 3.2 and 4.2, in both sets of interviews additional criteria were proposed. The provisional recommendations for SLI broadcast we suggest in this section combine our findings from the qualitative studies with previous guidelines for including a sign language in the video stream or in other multimedia content access services (for guidelines on TV see Centro de Normalización de la Lengua de Signos Española [CNLSE] 2017; ITC 2010; ITU 2014b; NDA 2014; Ofcom,2015, 2017; for web-accessibility metrics see W3C 2016; for signing video books see Pyfers 2000; for video interpreting see Ryan & Skinner 2015; and for hardware and software see Oliver, Martín & Utray 2009). Finally, the recommendations on size and position of the interpreter on the screen are partially supported by the results from experimental tests using eye-tracking and recall measures (Bosch-Baliarda, Soler-Vilageliu & Orero, 2020).

5.1. Signer Filming

Lighting is crucial for sign language articulators to be clearly seen with no shadows or dark parts on or around the signer. It is especially important to control the signing space, the shot size and the eye-line. The signing space is the area in front of the signer, and is used to articulate all the signs. This is very important because sign language is a three-dimensional language using different active articulators: in the head, torso and arms including face, lips, tongue and eyes, shoulders and arms, hands and fingers (Pyfers 2000). All these body articulators should be in shot at all times. Another important issue is that the signing space may vary from language to language, signer to signer, or even within different registers.

When filming the signer:

a. Check the lighting
b. When framing the shot: check the size of the signing space with the signer
c. Use a medium long shot to film the signer
d. When framing the signer: leave some room above the signer's head and on both sides
e. Use an eye-level camera angle with the signers' head at the level of the focus
f. Use a frontal or a semi-profile shot
g. Maintain the shot

Additionally:

h. Avoid shadows on or around the signer
i. Avoid long shots or close-ups
j. Avoid cut-offs
k. Avoid using different shot sizes
l. Avoid high and low camera angles

5.2. Interaction with the visuals and screen layout

On-screen sign language implies the presentation of a visual language through the visual medium. One of the key concepts to bear in mind is split or divided attention. Deaf signers need to attend to both the signed input and the visual medium broadcasting visual content. Not only promoting positive interaction with on-screen visual information, but also avoiding negative interaction is fundamental to screen readability. The signer creates a positive interaction when the signed discourse is related to the visual information on screen. This is performed by pointing to the visuals or incorporating the visual properties of the objects on the screen into the signed discourse. On the other hand, negative interaction is created whenever blockages or obstructions occur. On some occasions, visual information blocks the signer, such as: digital on-screen graphics, on screen text or subtitles. A fundamental requirement is to avoid obstructing the interpreter's facial expressions or hand-shapes. On other occasions, it is the signer who blocks, completely or partially, other on-screen visual information.

When designing the screen layout:

a. Facilitate positive interaction between the signer and the on-screen visual information

b. Provide the interpreter with all additional visual information prior to the interpreting/translation service (i.e. clips, graphics, tables)

c. Let the signer know where the visual information will appear on the screen prior to the interpreting/translation service (i.e. presenters, interviewers/interviewees, clips, graphics, tables)

d. Allow time to attend to all the visual information on the screen

Additionally:

e. Avoid any visual, on-screen information blocking the signer

f. Avoid the signer blocking any of the visual information on the screen

g. Avoid overlapping of the interpreter's box, when using picture-in-picture or chroma key technology

5.3. Colour combination

Colour contrast and combination are important to grant accessibility of sign language on screen. Three different aspects can impact colour interactions: background colour, the colour of the signer's clothes, and the signer skin colour. The colour combination can affect perception, legibility, and thus accessibility. Negative colour interactions can produce eye fatigue. Colour contrast and combinations have an even greater impact on accessibility for deaf-blind users. Deaf-blind people who typically use sign language services are congenitally deaf people who have acquired blindness later on in life; often they are not completely blind but have low vision, different eye conditions or are partially sighted.

Regarding colours:

a. Provide the signer with clothes that contrast with their skin colour

b. Provide the signer with one-colour plain clothes with no patterns

c. Use a plain, patternless background for the signer that contrasts with the signers skin

d. Use a dark blue plain background to grant accessibility to the deaf-blind users

Additionally:

e. Avoid multi-coloured or patterned clothes
f. Avoid multi-coloured or patterned background
g. Avoid dark spots or shadows on or around the signer

5.4. Shape and size of the sign language on screen

Deaf signers normally mention the size of the signer as the most important feature affecting legibility. It is important for older and deaf-blind users. The size and shape of the signer also reflect and affect the language status on broadcast media. The recommended minimum size established in earlier guidelines for picture-in-picture interpreters was at least one-sixth of the picture area, roughly 1/3 of the screen width, based mostly on news broadcast (e.g. ITC 2010; Ofcom 2015). However, this might not be optimal for other TV genres (Bosch-Baliarda, Soler-Vilageliu & Orero, 2020).

Regarding size and shape:
a. Present a "human-sized" signer
b. Use a rectangular-shaped signer's box, when using picture-in-picture technology
c. Provide a box at least 1/4 of the width of the screen
Additionally:
d. Avoid miniaturised signers
e. Avoid using circular or egg-shaped boxes when using picture-in-picture technology

5.5. Position of the sign language interpreter on screen

The on-screen position of the interpreter is determined in terms of left and right along the horizontal axis, and top, central, and bottom along the vertical axis. The most common location is bottom-right. However, it seems there could be cultural differences or learning effects regarding side preferences. Whereas British (Ofcom 2015), Spanish (Gil-Sabroso & Utray 2016) and German deaf viewers (HBB4ALL 2017) prefer the signer to be placed screen-right, Catalan deaf viewers did not show a clear preference when it comes to the horizontal location of the interpreter. Similarly, Van der Graaf & Van der Ham (2003) showed that Dutch deaf viewers preferred the screen-right position (coinciding with the common broadcast format) but considered the screen-left area appropriate too. Results from the experimental reception tests indicate that left position might enhance overall readability (Bosch-Baliarda, Soler-Vilageliu & Orero, 2020).

On the vertical axis, central positions seem to facilitate reading the different visuals on the screen and to allow positive interaction with the subtitles. Position choice made by broadcasters is dictated by design criteria rather than accessibility criteria.

News broadcasting is the genre commonly chosen by broadcasters for signing services. The screen layout for news broadcasting includes the visual information, the hearing newsreader and the sign language newsreader or interpreter. Eye-tracking studies have shown deaf people do not pay attention to the hearing newsreader (e.g. Gutermuth 2011; Wehrmeyer 2013; 2014), but rather concentrate on the signer and sometimes attend to the main visual information on the screen.

Regarding the screen position:
a. Use a central position along the vertical axis of the screen to present the sign language

b. Contact your national association of the deaf to know if they have any preference in regard to the positioning of the interpreter along the horizontal axis (screen-right or screen-left area).
c. Choose preferably the screen-left position and use it throughout your broadcast programs
d. Place the visuals between the signer and the news presenter
Additionally:
e. Avoid top and bottom positions
f. Avoid using different positions for different programs
g. Avoid placing the newsreader between the visual information and the signer

5.6. Recruitment of sign language professionals

It is important that broadcasters hire qualified and experienced interpreters, who have worked in a variety of interpreting settings, and have been exposed to different sign language users, so they can adjust to a wide range of registers, according to the programs and target audiences. Moreover, media interpreters need to be highly skilled interpreters. They should have native-command of the national sign language of the country and they should also have up-to-date knowledge of neologisms and terminology of current events. They have to be suitably trained for TV interpreting, that is, they should be familiar with using a teleprompter, signing in front of the camera and having no feedback from users. These are some characteristics that novice interpreters might not be equipped with.

Recruiting sign language interpreters (including both deaf and hearing):
a. Contact the national association to learn about the sign language qualifications and training in your country

b. Hire only qualified, accredited or registered interpreters
c. Hire signers with native-command of their national sign language(s)
d. Hire experienced interpreters
e. Hire highly skilled interpreters
f. Offer training for signers and interpreters (media technologies)
g. Always ask for expert advice when casting or recruiting new signers/interpreters

5.7. Preparation time and materials

Service preparation time is crucial to ensure interpreting quality in the visual media. The interpreter should have time to prepare for the task prior to the actual interpretation. During this preparation time, the relevant visual materials should be provided: the script, the step outline and/or the video clips that will be used in the program. Sign language is a visual language and the interpreter should interact positively with the visual media.

Before the sign language interpreting/translation service:
a. Provide all the audio-visual materials (clips, graphics, etc.)
b. Provide the script or step-outline
c. Allow sufficient time for preparation
Additionally:
d. Avoid introducing new visual materials without letting the signer know
e. Avoid hiring the signer only for the time of the assignment

6. Discussion and conclusion

Our findings suggest that both target groups consider the interpreter's size and speed of delivery the two most important formal features determining accessibility. These findings are consistent with previous research on other sign languages. For sign language users size and speed are as important as the linguistic content, and the interpreter's linguistic and interpreting skills (e.g. Steiner 1998; Wehrmeyer 2013; 2014; Xiao & Li 2013 as cited in Wehrmeyer 2014). Findings from the focus group study also suggest that the minimum size of the interpreter or the interpreter's box should be at least one-fourth of the total screen width regardless of the TV genre, which is relatively large for an embedded image. Previous guidelines suggested a minimum size of at least one-sixth of the picture area and were mainly based on news broadcasts (e.g. ITC 2010, Ofcom 2017). However, deaf SLI service users agreed that a larger image of the signer such as those described as the preferred setup in earlier literature would be appropriate for news broadcasts but not for other programme genres (as reported in section 4.2).

Another finding in our study is that miniaturised interpreters not only negatively affect accessibility but also the language's social status. Furthermore, adoption of smaller image sizes might have a negative impact on the TV providers' reputation within the Sign Language Community. Deaf signing TV consumers seem to assume it is a strategy used by broadcasters to comply with accessibility policies without providing actual access. Hence, customisation of the image size seems to be one of the formal parameters to be prioritised in future practice.

Regarding the position of the interpreter or the interpreter's box on the screen, our findings show a greater variation. Previous literature suggests that users preferred a right-hand-side position (e.g. DTV4ALL 2008; Gil-Sabroso & Utray 2016; Kyle 2007; Ofcom 2015; Van der Graaf & Van der Ham 2003; Whermeyer 2014). However, the results from the focus group study show that users either preferred a left position or considered the horizontal location of the interpreter irrelevant to the accessibility of the service. However, experimental tests using eye-tracking and memory measures indicate that significantly better results are achieved with screen layouts featuring the interpreter on the left and at a medium size (Bosch-Baliarda, Soler-Vilageliu & Orero, 2020). 289

In any case, both individual and cultural differences may exist due to a learning effect. Since the Catalan national broadcaster is currently deploying this access service using a left-central on-screen position, Catalan deaf signers may have been influenced by their TV consumption habits. This contrasts with the interpreted content broadcasts in Spanish Sign Language or LSE (also available to Catalan deaf signers): According to Gil-Sabroso & Utray (2016), 90% of the interpreted broadcasts in LSE implement a bottom-right location. Regarding the vertical position, users also commented that they preferred a more central position to avoid negative interaction with the subtitles. Although studying the interaction between subtitling and signing was clearly not our goal, we observed that deaf users exploit both access services in many different ways according to availability, literacy skills, TV genre and personal preferences (e.g. Bernabé & Orero 2019; Gaerts, Cesar & Bulterman 2008; Kurz & Mikulasek 2004).

In a similar unforeseen way, participants in both sets of interviews and focus groups pointed out that broadcasters deploying sign-interpreted content tend not to have sufficient knowledge about the Sign Language Community as a language minority. According to the participants, some broadcasters still think that subtitling can grant full accessibility to all deaf people, regardless of their primary language of communication and thus think that SLI provision is redundant or unnecessary (see Neves 2007 for a discussion on the divide between subtitling and sign language on TV). Additionally, lack of awareness of the peculiarities of the sign language modality sometimes leads to misconceptions and prejudices that can affect sign language representation on the screen. More specifically, interpreters report that broadcasters are not familiar with the professional role of the SLI or the existing technical guidelines regarding on-screen presentation of SLI. This unawareness can impact negatively on the quality of the service and might explain why it is still not widely adopted.

The results of our research are preliminary. This initial probing of the current practice is a first step towards further investigation into the issues of sign language interpreting and its TV presentation. The main limitation of our findings is the number of participants, which is quite low, as with most research in Media Accessibility (Orero et al. 2018). Our tentative recommendations should be further validated by more experimental research methods, like the ones used in studying size and position.

Given the new ways of customising accessibility services on TV (Mas & Orero 2018), there are various areas of research worth pursuing, including viewers' preferences regarding sign language presentation depending on the TV genre, the implementation of formal features or interaction between different accessibility services. We are at an important time since legislation, research and technology are joining forces to guarantee equal access to media. The social and personal inclusion rights should be equal across groups of disabilities, and that includes deaf TV consumers who are Sign Language Community members.

Endnotes

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2 http://signlangtv.org/

3 The following scale is used: small - less than 1/4 of the screen width; medium - between 1/4 and 1/3 of the screen width; large - more than 1/3 of the screen width.

4 http://www.acils.org

5 http://www.fesoca.org

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Authors' address
Marta Bosch-Baliarda, Pilar Orero, Olga Soler-Vilageliu
Edifici MRA 126 - Campus UAB
Universitat Autònoma de Barcelona
08193 Bellaterra
Barcelona, Catalonia
Spain (EU)

Marta.Bosch@uab.cat (institutional) / mboschbaliarda@gmail.com (corresponding)
Pilar.Orero@uab.cat
Olga.Soler@uab.cat

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Appendix 3.2 Article 2 - Toward a sign language-friendly questionnaire design

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Toward a Sign Language-Friendly Questionnaire Design

Marta Bosch-Baliarda*,†, Olga Soler Vilageliu and Pilar Orero

Universitat Autònoma de Barcelona

*Correspondence should be sent to Marta Bosch-Baliarda, Edifici MRA 126—Campus UAB, 08193 Bellaterra, Barcelona, Catalonia (EU)
(e-mail: Marta.Bosch@uab.cat)

Abstract

The United Nations Convention on the Rights of Persons with Disabilities requests “Nothing about us without us.” User-centered methodological research is the way to comply with this convention. Interaction with the deaf community must be in their language; hence sign language questionnaires are one of the tools to gather data. While in the past interacting with an online video questionnaire was out of the question, today it is a reality. This article focuses on the design of an interactive video questionnaire for sign language users. From a historical review of the existing literature on research methods and previous sign language questionnaire, the article examines the design features affected in the process of making accessible questionnaires with sign language videos: format and layout. The article finishes with the solution developed toward mainstreaming sign language questionnaires in order to contribute to a diverse and inclusive society for all citizens.

Questionnaires are a common instrument used for research. A set of questions extracts relevant information given to a sample of respondents to complete (Harkness, 2008). They are used in research over other data collection methods and frequently have standardized answers that provide easy to compile and analyze data. They are relatively cheap to implement, compared to other surveying or assessment instruments, such as interviews or focus groups (Survey Research Center, 2016).

As with any research instrument involving deaf participants, questionnaires need to incorporate a deaf-friendly perspective toward equity for the deaf population in both surveys and testing research. Questionnaires are frequently administered through the official, written languages and rarely present accessibility features, such as using Easy to Read (Bernabé & Orero, 2019). Cultural and linguistic lack of perspective in instrument design has a negative impact on both the appropriateness of the instrument itself as well as the validity of the results (Freeman, 1989). More recently, accessibility through computerized video technologies in questionnaire designs has promoted the possibility of incorporating sign languages. The application of information and communication technologies (ICTs) allows for deaf-friendlier design and also to implement translation protocols toward access to information for all users (Fontaine, 2012; Young & Hunt, 2011; Young & Temple, 2014). Moreover, designs are crucial when creating a fully accessible questionnaire to develop robust instruments to collect data on sign language from sign language users, within the sign language communities (De Meulder, Krausneker, Turner, & Conama, 2018; Harris, Holmes, & Mertens, 2009).

In this article we review the evolution of methods in filmed-based approaches that include sign language to make questionnaires accessible. Specifically, we look into the language accessibility features, design features, and administration modes implemented in previous approaches. We present our own methodological approach to create a sign language-friendly questionnaire design, taking into consideration time-efficient and cost-efficient limitations. The implementation is a computerized video questionnaire fully accessible in sign language that can robustly deploy a small-scale, research-oriented, sign language recall and comprehension test.

†Marta Bosch-Baliarda, http://orcid.org/0000-0002-8778-2820
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Toward a Deaf-Friendly Questionnaire Design

Fully accessible questionnaire designs in sign language are important to guarantee the reliability of the research and the validity of the results. They are also relevant both to protect ethical standards in human subject research within the deaf population and to promote accessibility to comply with the new, inclusive "human right" paradigm (Berghs, Atkin, Graham, Hatton, & Thomas, 2016; Ewart & Snowden, 2012). This is not only to control the bias that may arise from the lack of linguistic and cultural concordance between the researchers and the signing deaf participants (McKee, Schlehofer, & Thew, 2013) but also to promote inclusive research that undertakes and integrates the diversity inherent within the Deaf communities, especially regarding language accessibility: language choice and literacy (Guardino & Cannon, 2016).

Deaf-Friendly Research Methods

The literature for sign language research methods tackles specific knowledge areas in both theoretical and applied sign language linguistics (Meurant, Sinte, Vermeerbergen, & Van Herreweghen, 2013) such as sign language acquisition (Baker, van den Bogaerde, & Woll, 2006), sociolinguistics (Lucas, Mirus, Palmer, Roessler, & Frost, 2013), and sign language assessment (Haug, 2011). Both hearing and deaf researchers have focused on ethical considerations when conducting research within the deaf communities, particularly on communication accessibility, truly informed consent, and anonymity (Baker-Shenk & Kyle, 1990; Benedict & Sass-Lehrer, 2007; Gutman, 2005; Harris et al., 2009; McKee et al., 2013; Pollard, 2002; Singleton, Jones, & Hanumantha, 2012; Singleton, Martin, & Morgan, 2015; Sign Language Linguistics Society, 2016). Accessible communication and informed consent should be a priority for researchers. Additionally, privacy issues may arise from the fact that it is almost impossible to separate the video-recorded sign language data from the participants' identity; hence signed, accessible image release forms should be provided.

Some of these ethical considerations and guidelines on deaf-friendly research have been compiled by Orfanidou, Woll, & Morgan (2015) in their handbook *Research Methods in Sign Language Studies: A Practical Guide*. This text is a landmark on sign language research devoted to data collection methods and new instruments and tools for sign language research in different fields of linguistics, paying special attention to ethical considerations. Unfortunately, deaf-friendly questionnaire design using sign language as a mode of administration is not discussed. More recently, Cawthon & Garberoglio (2017) edited the text *Research in Deaf Education: Context, Challenges, and Considerations*, featuring an array of diverse research methodologies for the Deaf community. This volume includes a chapter on accessible, large-scale survey design in education (Cawthon, 2017). The chapter describes some considerations when developing large-scale surveys in deaf education, for example, how to control the heterogeneous demographics within the Deaf communities or how to enhance the recruitment process. In the section on accessible survey designs, the author argues that dual-language designs not only provide better access but also promote engagement within the deaf community. Although she advocates the use of technology platforms that fully support dual-language/dual-modality surveys is a requirement, technical design features are not further discussed.

A number of authors have included deaf-friendly methodological approaches and good practices in their research to promote cultural and linguistically adequate research methods. This means involving members of the Deaf community in the research process in meaningful ways following emancipatory or transformative paradigm approaches, not only as research participants (Harris et al., 2009; Mertens, 2005, 2010; Munger & Mertens, 2011; Mertens, Sullivan, & Stace, 2011). The participation of deaf native signers and deaf organizations in research teams is subsequently regarded as a key concern. Research teams should include different roles such as deaf researchers, deaf research assistants, deaf research facilitators, deaf interpreters or support communicators, and deaf-signing models (Ladd, 2003; McKee et al., 2013; Pollard, 2002; Singleton et al., 2012, 2015).

On the other hand, developing deaf-friendly research methods involves merging accessibility and communication best practices with different research materials, documents, and the dissemination of research projects and results. The potential of eAccessibility through ICT for social inclusion, and participation of all citizens, is increasingly allowing full integration in everyday life for all (Orero, 2017). The use of video protocols in computer-based technologies is an opportunity to represent the modality-specific visual features of sign languages (Haug, 2011, p. 46). Video technologies have also had an impact on the type of data and data collection methods for research involving sign language users, such as face-to-face video chatting or user-generated video sharing (Lucas et al., 2013, p. 548).

Language Accessibility in Questionnaire Designs

The language and culture of the participants can affect their perception of questions and therefore their answers (Choi & Pak, 2005). Ethnic minority groups have a higher rate of nonresponse (Erens, 2013). This can be related to "language barriers, lack of trust, wariness of government authorities, perception that the research is unimportant or that their contribution is unimportant, reluctance to have their information written down, and a feeling that they have been over-researched" (Erens, 2013, p. 59). Similar factors have been described for signing deaf participants, though their low participation may be partially linked to participant fatigue (Cawthon & Garberoglio, 2017).

In this article we examine traditional monolingual-written text questionnaires using signing participants, because they are widely used in many research fields with sign language users. Hearing researchers may be unaware of the cultural and linguistic characteristics of the deaf community and vice versa. Understanding questions will depend on the respondent's literacy skills that can lead to uncontrolled variation in question misunderstanding bias and participant cognitive burden. Adequate language options and question wording are important toward the validity of the questionnaire design. Questions must be phrased appropriately for the target audience with the information acquired avoiding ambiguity and connotative meaning (Boynton & Greenhalgh, 2004). Even though it is still not common practice, our literature review includes several examples on explicit explanations, or overt discussion, on how data collection instruments and materials are made available to signing deaf participants and the language choices in which data and questions are presented.

Translation procedures in questionnaire design. Most research is still developed in written languages. Translation should be performed according to standards to guarantee the quality of the instrument and to control the effects of translation (Harkness, 2008). The process of preparing, performing, reviewing, and assessing translated questionnaires is thus quite complex and costly (Erens, 2013).

There are different translation procedures and protocols devised to control translation quality and minimize translation bias that may jeopardize research results. One of the early documented translation approaches in sign-translated questionnaires is back translation. Back translation was a recommended standard for translating survey instruments (Erens, 2013; Survey Research Center, 2016). This procedure involves a specialist translating the text into the target language, which is then independently translated back into the source language. The original and back translated source language texts are compared to check if there are any translation issues in the target text. Even today, back translation is one of the most common translation techniques. Some of the reviewed questionnaires for deaf populations included professional sign language interpreters and/or signing deaf research team members carrying out the role of back translators in the development of the target video sign language questionnaires (VSL questionnaire; Brauer, 1993; Cohen & Jones, 1990; Goldstein, Eckhardt, & Joyner, 2004; Lipton, Goldstein, Fahnbulleh, & Gertz, 1996; Rojba, 2016).

Nowadays, best practices and guidelines recommend team translation approaches for survey instrument production. Currently, the common best practice in survey translation is the five-phase iterative team approach model called translation, review, adjudication, pretesting, and documentation (TRAPD; Harkness, 2008). The TRAPD method involves several translators, survey experts, and consultants and is pretested with a small-scale target population group before producing the final translation. The team members involved may take on one or more roles as translators, reviewers, or adjudicators. During the first stage, translators produce initial parallel translations independently. Then an expanded team including the translators and a reviewer go through the draft translations, discuss the versions, and agree on a review translation.

Adjudicators decide if the reviewed version moves to pretesting. Adjudication may take place at the review session, or at a different meeting between the reviewer and the adjudicator. All steps are fully documented. Documentation is a monitoring tool for quality assurance that provides information for further analysis. For example, team members take notes on compromised decisions, unresolved issues, or consultant feedback. The procedures are partially iterative. For example, pretesting may trigger further modifications of the translation before the adjudicator decides on the final version for fielding (Harkness, 2008; Survey Research Center, 2016).

Adaptation in sign language questionnaire design. Sign linguists in the field of sign language tests have addressed methodological issues concerning translation and adaptation procedures to develop reliable and valid assessment instruments (see, e.g., Enns & Herman, 2011; Haug, 2011, 2015; Haug & Mann, 2008; Hermans, Knoors, & Verhoeven, 2010). Within the field, the term adaptation is used to emphasize that the goal is to create a test in the target language that parallels the source test not only in its language contents but also in its functionality. Although the translation process is assumed to be centered in faithfully rendering the source contents into the language of the target test, the adaptation process involves more flexibility in test construction and may introduce further alterations according to the cultural and social needs of the target language users (Haug & Mann, 2008, p. 139).

The goal of adaptation in cross-cultural questionnaire design is to match the needs of the target population, also known as "localization" in translation studies, as is the case in Pollard, Dean, O'Hearn, and Haynes (2009) for health education material for deaf audiences.The modifications "may be made to the content, format, response scale, or visual presentation of any part of the question, questionnaire, or instrument" (Survey Research Center, 2016). Sign language linguists have outlined several phases in the adaptation process of sign language assessment tests to ensure the standardization of the developed tools. These adaptation protocols aim to guarantee the validity and reliability of the test instrument (Enns & Herman, 2011; Haug, 2011; Hauser et al., 2016; Mann, Roy, & Morgan, 2016)

New language approaches in sign language questionnaire designs. More recently, Cawthon (2017) suggests the inclusion of bimodal–bilingual for the development of research materials. The author favors a dual-language development process rather than designing survey items in the written form and the implementation of translation or adaption procedures. "Beginning the development of survey items with an understanding of how they may be represented in different linguistic formats holds promise in making large-scale surveys more accessible by design" (Cawthon, 2017, p.31). Dual-language development of survey items would only include concepts that are equally easy to express in both languages. They would control potential sources of bias and also provide a more accessible design for all participants.

A different innovative language approach to survey item development has recently been designed and implemented by Napier, Lloyd, Skinner, Turner, and Wheatly (2018), targeting multilingual deaf signers using multiple national sign languages from various European countries. Their goal is to implement a large-scale survey to engage a larger number of international participants from a broader range of linguistically diverse signing backgrounds. Because of time and cost restrictions, the authors choose to use International Sign Language for those users who lack literacy or prefer to use a signed language as opposed to a multicultural multilingual approach including many national sign languages. This solution also avoids prioritizing certain national sign languages over others, potentially excluding users of minority sign languages (Napier, et al., 2018, p. 104).

On balance, time and cost constraints will greatly influence the choice of language approach, translation, and adaptation protocols and procedures, as will study specifications such as sample size and standardization (Kappelhof, 2015). Adaptation and translation procedures may be determined according to the nature of the material being implemented and the project characteristics. Lastly, a successful questionnaire translation is expected to keep the content of the questions semantically similar or maintain the same stimulus and measurement options. It should also keep the question format similar between the source and target questionnaires, within the bounds of the target language (Survey Research Center, 2016). For sign languages that differ greatly in modality and have no established written form, much more research is required.

A Review of the Literature on Deaf-Friendly Questionnaires

Computerized sign language implementations for questionnaire research have rapidly changed, thanks to the advances of new technologies especially in the development of video technology and online survey platforms (Lucas et al., 2013, p. 54). When reviewing early research methods in sign language studies linguists often relied on written-only questionnaires for data collection on sign language structure and use. To present sign language stimuli, written forms of the signs or sign structures being analyzed were used in paper format questionnaires (see, e.g., Woodward, 1973, and Woodward & DeSantis, 1977). During the following decade, video protocols were introduced using the different video formats available. Early video implementations involved a written questionnaire with a video-taped sign-translated version that was played alongside (Brauer, 1993). Although this solution would give access to the content, the signed and written versions differed largely in format and layout.

The first attempt of a self-administered sign language questionnaire that did not require literacy was the Interactive Video Questionnaire, developed to question deaf people about drug abuse (Lipton et al., 1996). The questionnaire was implemented using a Laserdisc player on a standard television monitor displaying questions in American Sign Language. In Phase I of the study, the participants had a bar code reader that served to scan the responses and add them on the paper questionnaire answer sheet. In Phase II, touchscreen technology for automatic data capture and storage was used, which proved to be a simple mode of administration. Responses were recorded directly to the hard disk and then downloaded to a cassette tape.

For interviewer-administered tests, Haug (2015, p. 45), in his exploratory study based on an international survey on the usage of ICT for sign language test delivery, listed different test modes of administration including noncomputerized and computerized formats. Noncomputerized formats included, for instance, videotape (VHS and other formats) or DVD either with or without an accompanying booklet. Haug (2015) also listed some computerized modes of administration, for example, web-based tests or sign language tests implemented into existing learning tools such as Moodle.

There are many deaf-friendly designs implementing video protocols in order to give full access to signing participants. The term VSL questionnaire is used to refer to all instrument designs and modes of administration using video protocols that grant accessibility in sign language to a certain extent. This includes both computerized and noncomputerized modes of administration that have used different video protocols and technologies available since the 1980s.

There are three types of computerized survey instruments classified according to their mode of administration:

- Computer-assisted surveys using video clips are called video computer-assisted personal interviews, or video-CAPI. This is when a physically present interviewer administers the questionnaire and enters the answers on a computer or similar device.
- A video computer-assisted self-administered interview, or video-CASI, is when the respondent enters the answers on a computer provided by an interviewer who is physically present.
- Computer-assisted video interviewing, or CAVI, is when the communication between the interviewer and the respondent is established remotely via video chat.

In addition there are other terms that have been used in the literature to refer to video questionnaires specifically designed to include the use of sign languages as the language of interview administration. These video questionnaires are listed here in chronological order: interactive video-questionnaire (Lipton et al., 1996); animated questionnaire for deaf and hard of hearing (DHH) people, or ANIMAQU (Gerich & Lehner, 2006); dual-mode (CATI/CAPI) survey-computer-assisted telephone interview/computer-assisted personal interview (Sloan, Wright, & Barrett, 2012); virtual video survey (Lucas et al., 2013); and dual-language, dual-modality survey (Cawthon & Garberoglio, 2017).

In this article, the term used is VSL questionnaire to refer to the computerized deaf-friendly questionnaire designs implementing full access in sign language using video protocols. When it is necessary to distinguish between the modes of administration we use the short forms VSL-CASI and VSL-CAPI, for convenience.

In the 21st century, sign language assessment tests have been another important source of advances in computer- and web-based video sign language implementations (Enns et al., 2016; Haug, 2011; Haug, Herman, & Woll, 2015; Haug & Mann, 2008; Hauser et al., 2016; Herman, Holmes, & Woll, 1999; Hermans et al., 2010; Lara-Escudero, 2017; Mann et al., 2016). New methodologies have started to adopt VSL questionnaires as a mode of administration, such as sign language comprehension and video quality evaluations on technological devices (Cavender, Ladner, & Riskin, 2006; Tran, 2014; Tran, Kim, Riskin, Ladner, & Jacob, 2011; Tran, Riskin, Ladner, & Wobbrock, 2015) including synthesized sign language played by signing avatars or animations (Huenerfauth & Kacorri, 2015). Other VSL questionnaires are described in some research-led surveys and tests in different fields, such as Deaf education and sign language teaching applications (Hansen et al., 2018; Higgins, Famularo, Bownman, & Hall, 2015; Hussein & Al-Bayati, 2009), cross-modal language user tests (Lucas et al., 2013), cross-cultural social surveys (Fontaine, 2012), sign language teaching surveys (Pyfers, 2017), sign language interpretation (De Wit, 2011; Lang, 2015), or accessibility services and use of technology (Maiorana-Basas & Pagliaro, 2014; Napier et al., 2018), among others. Even though all these researchers acknowledged the use of a computer-based VSL questionnaire, the technical design of the implementations varies greatly, ranging from specially created, interactive applications to the use of existing online survey platforms that play video sign language content alongside it.

Moreover, for self-administered interviews, participants should go back-and-forth between the two versions, which would increase both time burden and cognitive burden, and therefore affect response time and nonresponse rate. Together with participant burden, this mode of administration still required some degree of literacy to match the sign language to the written in order to submit the responses. The written source questionnaire was laid out in a clear manner, containing not only the source language but also the main language of interaction with the test platform. The sign language version contained an additional target language with a less prominent or lower position, thus subordinating sign language to the official written language.

Nowadays, new technologies have allowed sign language interlocutors to interact virtually using their own language (Lucas et al., 2013). Deaf community members have rapidly become extensive users of mobile and computer applications that implement video technologies, such as video telephones, video chats, video calls, video blogs, video messages, or video sharing. At the same time, computerized, web-based instruments containing sign language have started to become more frequent. New technologies not only introduce the possibility of embedding video clips to develop web-based questionnaire application, but also existing online survey platforms (such as MonkeySurvey or Google forms), which introduce the possibility of inserting videos from video-sharing platforms (such as YouTube) and upload user video files in their features. These platforms and applications allow sign language on-screen setups following different technical designs that directly impact accessibility features, language status, and usability.

Accessible technical designs: question format and layout. Most studies including a computer-based VSL questionnaire do not provide detailed descriptions, if any at all, particularly in regard to technical design, delivery format, and usability of the instrument. Some exceptions are Gerich and Lehner (2006), Haug et al. (2015), Lipton et al. (1996), Napier et al. (2018), and Samar, Barnett, Oyzon, Mowl, and Sutter (2012). After conducting a survey among sign language test developers, Haug (2015, p.37) acknowledges that none of the studies that had a computerized format addressed the usage of ICTs for sign language test development. According to the language of on-screen presentation, we distinguish two types of VSL questionnaires: One-clip VSL questionnaires and multiclip VSL questionnaires

One-clip VSL questionnaires. One-clip VSL questionnaires show a written online survey with one video screen embedded, showing a video clip of the sign-translated version (see Figure 1). Video clips contain both questions/stimuli and answers in a single video sequence. Answers can be identified by using numbers, letters, and vertical or horizontal lists. In order to make the video clips and question sequence more usable in the signed version, some authors use one clip per questionnaire item; only one item is shown on screen at a given time (Barnett et al., 2017; Goldstein et al., 2010; Pyfers, 2017; Tran, 2014; cf. Huenerfauth & Kacorri, 2015, simultaneously display four questions and their response items on one screen).

The common layout shows the video at the top of the screen with the text version at the bottom or on the left. Typically, responses have to be submitted using the written format. For closed-ended questions the answer has to be selected from a set of predefined written responses, for example, yes/no or multiple choice. For open-ended questions, frequently, a text box requires the participant to write the answer (see, e.g., Fontaine, 2012; Goldstein et al., 2010; Huenerfauth & Kacorri, 2015; Pyfers, 2017). As with the noncomputerized video-taped questionnaire in Brauer (1993), this is an accessibility option that adds too much strain to the signing participant, as it only translates the linguistic content but not the format of the questionnaire. Additionally, it requires literacy and has limited interaction features with the signed video version. This might affect usability in an attempt to remove written language literacy requirements and enhance accessibility.

Some studies have used color codes and symbols instead of written options to submit responses in multiple choice and Likert scale answers (Gerich & Lehner, 2006; Kipp, Nguyen, Heloir, & Matthes, 2011; Napier et al., 2018; Pardo-Guijarro et al., 2015).

Multiclip VSL questionnaires. The second type of VSL questionnaire format is multiclip VSL questionnaire, which displays a combination of more than one set of videos simultaneously to present both the question and the selected answers in separate video sequences. Multiclip layout designs aim to reproduce standard, computerized written instruments, both in content and in layout to provide better adaptations.

One of the most prominent advantages over other designs is that they are fully accessible in sign language and do not require written language literacy. Multiclip VSL questionnaires can implement monolingual questionnaires in the signed modality. Thus, they can provide improved reliability and validity of the survey or research instrument for sign language users, especially in the case of language assessment tests. Furthermore, multiclip formats are a way of implementing fully translated bilingual questionnaires, where sign languages can be laid out in a prominent on-screen position, removing the hegemonic subordination to the written formats.

Similarly, developing multilingual cross-modal questionnaires allows one to implement visual communication systems toward universal design. They grant access to a greater number and a wider range of potential deaf respondents within the diverse deaf population and their language choices in a number of ways (Graybill et al., 2010; Napier, et al. 2018; Tran, 2014). Multiclip formats present not only advantages but also limitations. Among the former they can reduce burden and nonresponse in questionnaires targeting deaf populations by offering choice of language and mode of questionnaire completion that might suit groups with differing communication skills. They may help to solve the issue of underrepresentation of the signing Deaf community in general population surveys. Finally, they provide better representation of languages in the signed modality and promote equality. Regarding limitations, they commonly display only one item—one question and the set of responses—at a time. Thus, they cannot provide an equivalent format for standardized questionnaires that present a whole set of questions (Dillman & Christian, 2005, as cited in Gerich & Lehner, 2006, p.271). Be that as it may, using computer-assisted VSL questionnaires has the potential to create better questionnaire adaptations and enhances accessibility for sign language users.[1]

Implementing Accessibility and Usability Features in Sign Language-Friendly Questionnaires

Our multiclip video sign language questionnaires were first developed withn the HBB4ALL project funded by the European Commission (CIP-ICT-621014; 2013-2016) as a web-based data collection tool for sign language interpretation pilot tests. The tests aimed to collect data about perception and processing of information of the contents, usability, and user preferences regarding size and position of the sign language interpreter on TV in four different screen configurations. The detailed design and procedures, results, and findings of the experimental pilot tests are further presented in Bosch-Baliarda, Soler-Vilageliu, and Orero (2019). For the purposes of this paper we will first briefly describe the experimental procedure to provide a context to the questionnaire and later focus on the description of the design and development of the tool itself.

Experimental Settings

Participants in the pilot test were 32 deaf users (16 men/16 women) from the metropolitan area of Barcelona in Catalonia (Spain). Their ages ranged from 17 to 76 years (mean, 40 years). They were recruited through the Catalan Federation of the Deaf (Federació de Persones Sordes de Catalunya, FESOCA). All of them use Catalan Sign Language (LSC) to communicate in their everyday lives and have self-identified as being proficient signers.

The experimental task consisted of watching four clips extracted from the documentary "Joining the Dots"

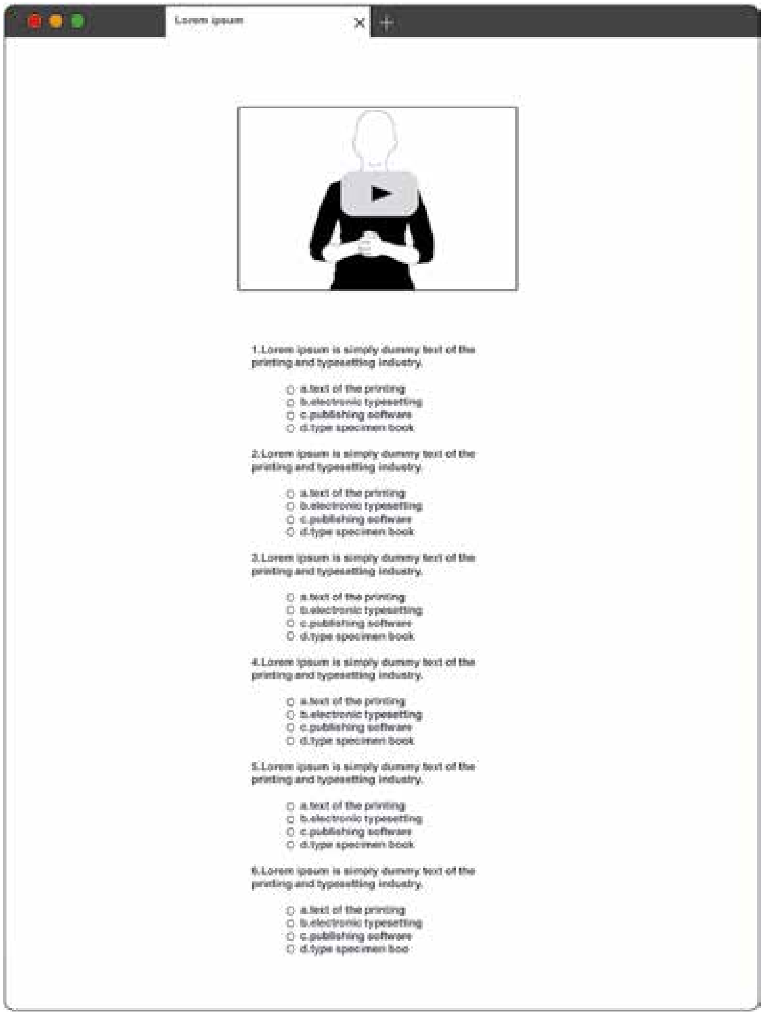

Figure 1 One-clip layout for cross-modal bilingual VSL questionnaire.

(Romero-Fresco, 2012). Each clip was displayed in a different screen configuration and an Eye tracker Tobii 60, controlled by a Toshiba Portable personal computer recording participant's eye movements.

Users were individually tested in different local Deaf association offices. After being welcomed, they had to fill out the consent and image release forms and answer the demographics questionnaire. Following these preliminary steps, the experimental procedure began. Each participant watched one clip and answered three questionnaires immediately after a visual recall test, a language recall test, and a user experience test to tackle usability and user preferences for each screen configuration. We did not include any questions to gather data regarding the usability of questionnaire itself. All tests were administered and recorded on a MacBook Air personal computer. This process was repeated four times, one for every clip.

Questionnaire Design

The design approach to develop the target questionnaires was a mixed mode. The source questionnaires were first created in written Spanish and were later translated into LSC for the target questionnaire. The initial approach in question design involved asking the same questions and translating, or the ASQT approach. The questionnaires developed for captioning user tests were taken as the source question sets. Later some questions were adapted to the visual culture of the Deaf community in Catalonia and others had to be newly created to address specific features of the sign language interpreter on screen presentation (asking different questions, or the ADQ approach; Harkness, 2008; Survey Research Center, 2016).

The translation/adaptation was dealt with in a one-team framework by a small team comprised of three members: one

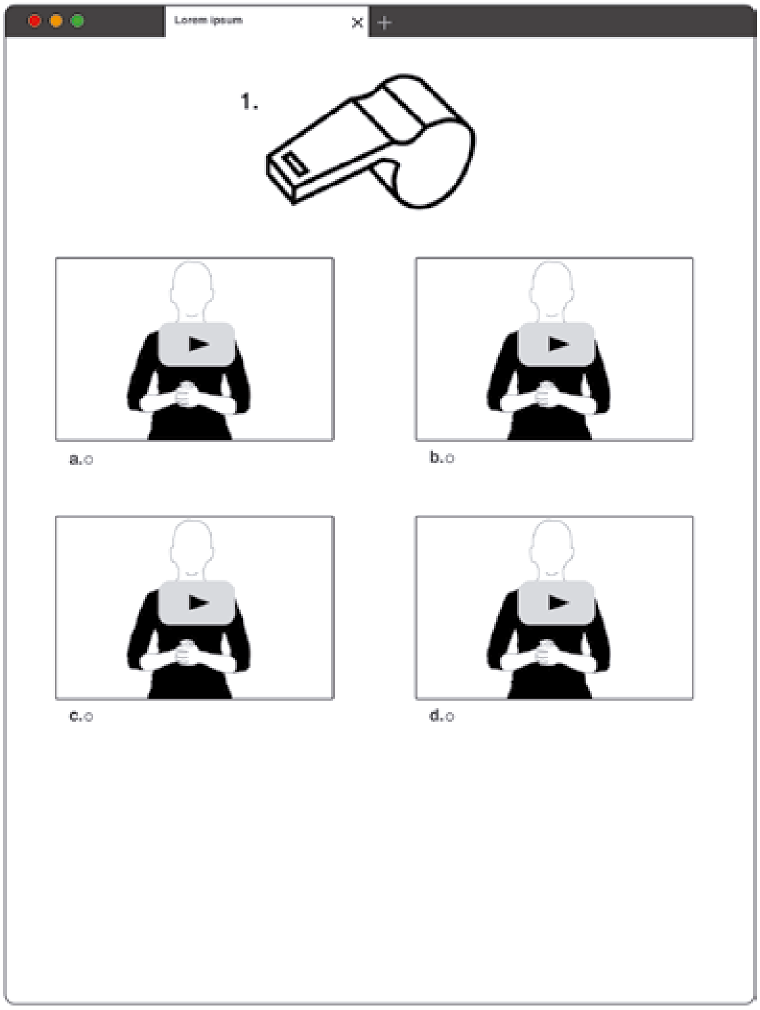

Figure 2 Multiclip layout monolingual VSL questionnaire.

deaf native signer and two hearing nonnative signers. The deaf team member was a highly skilled sign language teacher for sign language interpreters and communication support workers. She has a vast experience as a deaf consultant in research and in creating and adapting educational materials into LSC. The second team member was a certified hearing sign language interpreter with more than 15 years of intensive working experience in many areas and skilled areas, such as TV. The third member of the translation team was the bilingual bimodal researcher assistant, trained in deaf studies, sign language linguistics, and sign language interpretation.

The translation procedures included two translations from the hearing team members reviewed by the deaf consultant. She fine-tuned the translations and also pointed out which questions should be further adapted. The final translation was thus collaborative and agreed on by the three team members. The team translated both the video clips for the stimulus and all the questionnaire items. The signing model for the translated documentary clips was down to the input of the professional hearing interpreter, providing a parallel input to the most frequent use of sign language on TV, whereas the signing model for the questionnaire items was the deaf signer, in order to provide a native input. Special care was taken when creating the linguistic recall questions to use the same lexical items in both the interpreted clips and the questionnaire items, questions and responses. Thus, the linguistic input was controlled in both dialect and phonological variation of the targeted signs. Failing to do so would make the evaluation of the participants' performance impossible to evaluate and would have compromised the validity of the results. Finally, all questionnaire items were video-recorded using a chroma key. A video protocol was the selected format so that the questionnaire input, accuracy, and consistency could be guaranteed throughout the pilot test.

Technical design features implemented in HBB4ALL questionnaires. Even though the test was designed to be conducted with a small sample of 32 participants, the research team wanted to create a technical instrument design that allowed full accessibility of the questionnaire contents in sign language. The researchers wanted, on the one hand, to create a sign language-friendly data collection tool that could include video protocols to enhance validity and reliability of the instrument, especially for the sign language recall test. On the other, they wanted to create a deaf-friendly instrument that would enhance research engagement and usability of research tools by the targeted respondents, deaf sign language users. Additionally, we aimed to design a web-based on-screen layout that would attribute the same social and linguistic status to both language modalities, LSC and the written languages of the territory, namely Spanish and Catalan. This methodology was innovative because it had never been used in the country before nor in the field of accessibility research.

Because no existing online survey platforms allowed multiclip layout customization for the different types of questions (multiple choice, yes–no, etc.), the technical team members developed a multiscreen, computer-assisted data collection program that could implement the desired features. Both local and online versions were tested in the different pilot tests. Even though developing tools that allow implementations of questionnaires fully accessible in sign language was more time- and cost-consuming, it was an effort that was not to be avoided to grant research standards. For a more detailed description of the technical platform implementation, question technical designs, and technical formats see López et al. (2019).

Regarding language on-screen presentation, we wanted the research tool to be fully accessible in both signed and written modalities. The aim was to improve its usability within the diverse deaf signing communities, from skilled deaf signers regardless of their literacy levels to nonnative deaf signers that may rely on the written form or that prefer the written form to access certain questionnaire items, especially in the demographic questions. The platform was designed so that it could include a computerized sign language version of the informed consent and image release forms, so that these crucial aspects of the research tools were also accessible to signers who preferred this modality. Both forms were played or read before conducting the test and answering the questionnaires.

As in most of the previous multiclip VSL questionnaire designs, only one question was displayed on-screen at a time so that no scrolling was necessary. The multiclip question layout was designed to make LSC prominent on the screen (see Figure 3). The video clips for the questions were placed top center of the screen, and the different possible responses were displayed horizontally underneath. Each answer video clip was identified with a thumbnail showing the fingerspelling hand shapes for A, B, C, and D, respectively—or number hand shapes in the Spanish Sign Language test—to make them visually more distinct from the question video clips and to provide consistency throughout the different question designs. The written versions were displayed under each video clip.

To give the same status to both language modalities in the technical design we introduced an innovation for submitting the answers. As mentioned in Implementing Accessibility and Usability Features in Sign Language-Friendly Questionnaires section, most VSL questionnaires require participants to submit their responses using the written items, generally by a single click on the selected response or a bullet in line with the response item. In our questionnaire we wanted sign language to be the language of interaction too, so that both language modalities could play the same central role. To select the desired answers, participants could click on the video clip. Once the answer was selected, a blue frame would appear and the next button would be enabled. See Figure 4.

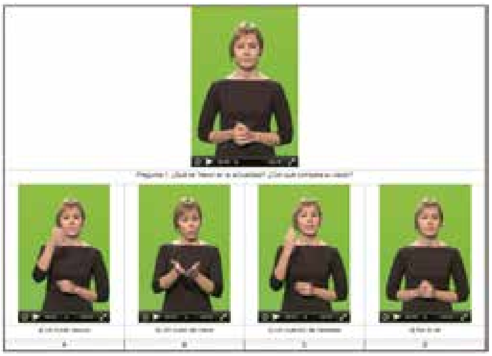

Figure 3 Screenshot of the multiclip layout design from the LSC HBB4ALL cross-modal bilingual questionnaire.

Figure 4 Screenshot of a multiple choice question design with four answers selected for submission in the Spanish Sign Language HBB4ALL cross-modal bilingual questionnaire.

Thus, participants' responses would not rely on their literacy, and they could avoid going back and forth between the written and signed versions of the questionnaire items in order to respond. This innovation was designed not only to improve the language status but also to reduce cognitive burden, response time, and overall time, which was one of our concerns regarding test duration.

A reproduction feature to allow "skimming" and "scanning" the videos was designed. The function was to make the user experience more comparable within the two languages in the fully cross-modal bilingual questionnaire. By swiping on the available answers the video clips were played automatically. Both the question and answer clips could be replayed, paused, forwarded, and rewound by clicking on the symbol buttons in a standardized video player bar.

Other features were introduced to improve the experience of older users, blind or partially sighted signers. For example, the speed rate and size of the video clips could be adjusted according to the user needs in order to improve usability and accessibility. Each video clip item could be played full-screen if selected.

Results

The participants acknowledged that it was the first time they had used a questionnaire fully accessible in sign language and positively valued the language choice offered in the bilingual–bimodal approach. They also valued the use of deaf signers. Although we did not include any formal controlled questions to gather feedback on the strategies used, some were discussed informally at the end of the test. All participants used both language modalities to some extent when completing the questionnaire. Participants with higher literacy skills skipped most of the video items, especially in the demographic and user experience tests, because it was much faster than going through the response items. However, they all watched the sign language version for the recall tests. Strategies regarding the language chosen to access the questionnaire items differed greatly. Some participants first read the written items and used the signed version to double-check comprehension, whereas some used the opposite strategy. For example, some users would watch the video first and then read the responses to "learn" the words for some of the signs they did not know previously. However, the signed version was mostly used for response submission.

The "skimming" feature was used both to previsualize the possible responses and to double-check the response before submitting the final choice. Younger participants exploited this feature more than older subjects, which helped them going much faster through the tests. Additionally, three older participants asked the interviewer to help them submit the responses, because they were not confident enough to interact with the computerized interface.

The other built-in accessibility features were scarcely used. None of the participants used the speed adjustment, and only one used the full-screen video feature in two questionnaire items. The size and color contrast of the filmed items was considered to grant accessibility to the signed content.

The web-based questionnaire design allowed automatically saving the results on the server. However due to server connectivity issues 5 recall test responses and 11 individual response items were not saved automatically.

Discussion of the Current Approach

The present questionnaire design aims to encompass previous findings in the method designs developed for sign language assessment tests and in deaf-friendly surveying instruments. The resulting interface is an appropriate tool that can successfully implement a cross-modal bilingual questionnaire design. It not only is fully accessible in both sign language and in writing, but also provides a similar status of the two language modalities in both their on-screen representation and in their functionality, such as allowing participants to submit their answers through the interactive signed version of the responses. It has shown to be a valid research tool to implement an interviewer-administered sign language recall test that can match the modality representation of the stimuli, the questions, and the response items, and thus enhances the reliability of the results.

However, schedule and budget limitations together with the scope of the study impeded the implementation of more features that have been described for deaf-friendly surveying instruments, such as offering choice from different signing models using a wider range of sign language styles or other accessibility features in the written versions such as including Easy to Read. Similarly, other customization features such as offering background color choice were discussed but could not be implemented in this prototype version. Still, background color is a feature that could both reduce eye fatigue and improve accessibility and readability among signers with different sight status.

As already mentioned, computerized, sign-friendly questionnaires are the most affordable and reliable mode of administration that give access to sign language as a prerequisite to comply with ethical standards and achieve human rights for sign language communities in research. Nevertheless, this mode of administration holds some disadvantages when compared to traditional, written paper-and-pencil questionnaires. Namely, there are at least three major drawbacks: they are more expensive to produce, they are bound to technical malfunctioning, and sometimes there is increased time burden, as they take longer to be conducted.

Regarding the detrimental time factor, Graybill et al. (2010) acknowledge that access to answer choices in a sign language survey is necessarily sequential, unlike what occurs in a written survey. Participants in a written survey have a near-simultaneous access to all response items. They are able to scan and skim answer choices and reread them repeatedly, in any order, before making a final choice, whereas respondents to a VSL questionnaire have to watch and consider each answer in turn before selecting a response or replay any of the answer video clips. These authors admit that the modality differences greatly affect the experience of completing a survey, although VSL questionnaires would be more comparable to the experience of a telephone survey.

When designing our interface, we discussed some features in the questionnaire design to reduce the overall interview time. On the one hand, reducing time burden was one of the arguments for choosing a cross-modal bilingual design for all the questionnaire sets over a monolingual sign language design. This option clearly reduces time burden but introduces new sources of uncontrolled bias among and within participant responses.

Furthermore we wanted to implement some technical innovation that would allow simultaneous access to all the video responses. A first attempt in the design displayed all the signed response items playing simultaneously, nonstop along with the written items. However, this version produced too much noise and was not deployed. In this same direction, we finally implemented the "skimming" function that had to be activated by the respondent. This feature helped manage the sign-based version faster.

Conclusion

This article revised existing literature toward the design of a new sign language questionnaire. From the revision, the first recommendation is that data collection from end users should be performed in their preferred language and language modality. This is the safest way to avoid any polluted resulting data due to misunderstanding, biased replies, and lack of participation. Moreover, dealing with deaf sign language users means combining the language and culture minority paradigm of the sign language communities. Including sign language in all steps of research to grant full accessibility is a requirement to comply with the human rights of this minority group. In the human rights paradigm, authors generally agree that accessibility plays a central role, either as a human right *per se* or as an instrument for the fulfillment of human rights (Greco, 2016).

Therefore, removing communication barriers and granting accessibility to question content in sign language is a prerequisite in order to conduct ethical research with signing deaf individuals. Yet it is not enough to meet research standards. Specifically in questionnaire-based research, such as surveys or tests, it is equally important to develop robust instruments in terms of question design, format, and mode of administration to reduce affliction and participant burden and measure effects due to the language visual modality. Although the production of video sequences is time-consuming and costly (Gerich & Lehner, 2006), this is a prerequisite for result validity and reliability.

We have argued that multiclip VSL questionnaires are currently the best mode of administration for sign-friendly video-CASI. These questionnaires can deliver adapted designs for both signed monolingual and cross-modal bilingual tools. Whereas instruments fully implementing a sign language are necessary when carrying out sign language testing. Further adaptations may be necessary when the questionnaire is designed for surveying a wider range of deaf populations with different communication needs and language preferences. Deaf-friendly research instruments are crucial to any survey research within the social sciences that target a more general population. Deaf-friendly questionnaires should capture the inherent heterogeneity within deaf populations regarding the diversity of communication and literacy skills along with language choice and preference. Failing to do so would entail underrepresentation of deaf people, both due to noncontact (such as in telephone surveying) and a higher rate of nonresponse.

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The literature review led to the finding that most VSL questionnaires happen in very specific field areas, such as health surveys or sign language testing. VSL questionnaires are not mainstreamed across any democratic citizen participation portal or any general topic. Moreover, differences are even greater when we have a look at the sign languages that have been implemented. The vast majority of computerized VSL questionnaires have been developed in American Sign Language, and just a few are sparsely found in other national sign languages: de Wit (2011) for Dutch Sign Language, Fontaine (2012) for Belgium Sign Language, Gerich and Lehner (2006) for Austrian Sign Language, Kipp et al. (2011) in German Sign Language, Pardo-Guijarro et al., 2015 for Spanish Sign Language, Napier et al. (2018) and Pyfers (2017) in International Sign System, or our questionnaires developed in LSC and Spanish Sign Language. An encouraging exception is found in the field of sign language assessment tests, where the collaboration between researchers and a well-documented tradition of procedures in test adaptation have favored the development of tools in multiple sign languages.[2]

Cross-modal VSL questionnaires, displaying both a written language and a signed language, enhance the linguistic and social status of both languages represented, thus raising the status of the minority language. Additionally, they introduce new possibilities for universal design questionnaires that can simultaneously include different forms of communication. Cross-modal bilingual designs can thus provide better language accessibility and language choice and avoid or bridge literacy requirements. In fact, advances and innovations on computerized VSL questionnaires are promising and can benefit not only sign language users and researchers. Offering the possibility to choose and combine one screen several language variants, language modalities or other adapted visual communication systems, is a benefit not only for the diverse deaf population but also for the diverse general population.

However, there is still much need for research, collaboration, and development. Haug (2015) acknowledged that exploring ICT for sign language testing is a barely researched and indeed almost neglected area. This is still applicable to surveying and general questionnaire design in other field areas too. In our pilot questionnaires we implemented skimming advance and other customizations such as size and speed of the video. These are examples of better adaptations aiming to reduce both time and cognitive burden. However, more research is needed to promote new advances related to video processing and usability for video questionnaires. These advances should be widely available through cost-efficient technological platforms that should be developed collaboratively in research teams involving deaf professionals and consultants at all stages. All advances toward mainstreaming sign language-friendly and deaf-friendly questionnaires will thus contribute to a more diverse and inclusive society not only for deaf populations but also for all citizens.

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Conflict of Interest

No conflicts of interest were reported.

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Notes

[1] See Gerich and Lehner (2006) and Haug (2015) for a review of the advantages and disadvantages of video-supported CASI compared to traditional noncomputerized data collection methods in the context of the research in sign languages.
[2] Visit Sign Language Assessment Instruments hosted by Tobias Haug at http://www.signlang-assessment.info for a fully comprehensive resource; see Lara-Escudero (2017) for an updated short list of the languages available.

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Appendix 3.3 Article 3 - Sign language interpreting on TV: a reception study of visual screen exploration in def signing user

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SIGN LANGUAGE INTERPRETING ON TV: A RECEPTION STUDY OF VISUAL SCREEN EXPLORATION IN DEAF SIGNING USERS[1]

Marta Bosch-Baliarda[2]
Marta.Bosc@uab.cat
Universitat Autònoma de Barcelona

Olga Soler-Vilageliu
Olga.Soler@uab.cat
Universitat Autònoma de Barcelona

Pilar Orero
Pilar.Orero@uab.cat
Universitat Autònoma de Barcelona

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2. All authors are TransMedia Catalonia members (2017SGR113, 2017). This research has been conducted in the Department of Translation and Interpretation in the Autonomous University of Barcelona (UAB) within the PhD program in Translation and Intercultural Studies. This research has been partially funded by the H2020 projects ImAc grant no. 761974 and EasyTV grant no. 761999.

However, these studies did not address the specifics of signing individuals watching contents with a split screen. Wehrmeyer's research (2014) pioneers the use of eye tracking metrics. Her study describes the viewing patterns of deaf and hearing users whilst they watch news broadcasts in a split screen showing both sign language, in a right position, and subtitles, in a central bottom position. As a main finding, her data indicates that deaf sign language participants focus their attention primarily on the interpreter and secondly on the imagery footage, but that they do not use subtitles or lip-reading to access the news contents.

1.4. Study overview

The goal of this present research is to contribute towards establishing quality criteria to help advance the deployment of SLI access services on TV in terms of perception and usability. The study explores whether or not there is an on-screen format, regarding size and position of the SLI split screen, that can enhance screen legibility and content comprehension, or one that is preferred or perceived as optimal by the users. To study this particular situation in sign language, users could contribute to bettering the development of sign language services offered by broadcasters.

This experiment is part of the sign language pilot tests developed within the European project Hybrid Broadcast Broadband for All (HBB4ALL) on media accessibility. Our experiment was designed to parallel the pilots with user tests on subtitling within the project (HBB4ALL 2017; Oliver Moreno 2017). In our experiment we wanted to explore whether watching SLI in different, split screen configurations has any effect on information access.

In the experiment the signing users watched four different parts of a documentary film that were edited using four controlled formats of split screen configuration. The different formats varied on two counts regarding size and position of the SLI sub-screen as independent variables: two sub-screen sizes (Small: 1/5 of the screen width; Medium: 1/4 of the screen) and two positions (right/left). See Figures 1 - 4 below.

In addition, we recorded participants' eye movements in order to collect data from deaf signing users' behavioural patterns regarding attention distribution, perception and information processing of stimuli on a split screen displaying two types of information on each screen: (1) The sign language interpreted, textual content on a sub-screen, and (2) the documentary scene with non-verbal content on the main screen. After each clip, participants responded to three sets of questions on visual, verbal memory (language recall), visual, non-verbal memory (scene recall) and user preferences. The scope of this present article focuses on the results from the eye tracking measures and the recall tests only.

With these questionnaires we wanted to test user comprehension and recall of language content and visual information from the clips, and check if screen configuration had any effect on them. Is there any difference regarding visual exploration and attention allocation on the screen in the four different conditions? Do differences in attention allocation affect visual recall results (both language and scene)? Do SLI size and/or position affect how users read the on-screen sign language or comprehension and recall tasks? Are user preferences affected by visual exploration behaviours?

Regarding eye tracking measures, we want to investigate if there are any differences in visual behavioural patterns (number and duration of fixations and visits), and in turn, between the four format conditions (size and positions). We predict that there is a difference in the eye tracking metrics between the two parts of the split screen, SLI and Content screen. As previously found in Wehrmeyer (2014), we predict that deaf users will focus their attention primarily on the interpreter. Thus, the number and duration of fixations and visits will be higher on the SLI screen than on the documentary scene screen. As for the format conditions, we do not expect to find significant differences in eye tracking metrics between the four formats; in this respect our study is exploratory.

Although previous literature shows that attention is focused on the face and meaningful information is accessed from the hands through peripheral vision (Dye et al. 2009), we want to explore whether the visual, attentional patterns within the SLI area differ in the right and left position conditions. Left and right positions do not differ in the relative distance between the scene and the face, as a source of linguistic information. However, when a right-handed interpreter is displayed on the right side of the screen, their dominant hand (the right hand) is more proximal to the scene screen whereas the left hand is more proximal in the left conditions. We hypothesise that this will have an effect on the distribution of visual attention between the dominant and non-dominant sides of the SLI. If the professional interpreter is right-handed, we hypothesise that the number and duration of fixations and visits will be higher on the ipsilateral SLI area, the side of the body including the dominant hand (or H1).

Regarding the information recall measures, we want to explore if the recall tests produce different scores, according to the different conditions. We hypothesise that the size of the stimuli will produce differences. Our study is exploratory on this matter.

As for the on-screen position, we hypothesise that there will be a difference in recall scores between right and left positions. We predict that our participants will obtain higher visual recall scores when the scene screen is located in the right visual field. This would be consistent with the reported enhanced performance during motion visual tasks in the right visual field, left-hemisphere bias (Bavelier et al. 2001).

2. The experimental reception study

2.1. Method

2.1.1. Participants

Participants in this study were 32 deaf sign language users (16 men/16 women) from the metropolitan area of Barcelona. Their ages ranged from 17 to 76 years (mean 40, STDEV 15). All of them reported using Catalan Sign Language (*Llengua de signes catalana, LSC*) to communicate in everyday life. They were recruited through the mailing list and social media of the National Association of the Deaf (*Federació Catalana de Persones Sordes, FESOCA*) via a written and signed video message with the help of deaf research facilitators. Two users were removed from the experiment due to technical malfunctioning.

2.1.2. Material

2.1.2.1. Apparatus

An eye tracker, a Tobii T60 integrated into a 17-inch monitor run by a Toshiba Portable personal computer was used to display the stimuli and record the participants' eye movements while watching the four picture-in-picture sign language video clips. The Tobii T60 screen has a resolution of 1280x1024. It has a sampling rate of 60Hz. The Tobii Pro Studio software for screen-based eye trackers was used to prepare, administer and record the experiment and for calculating eye tracking metrics and statistics. For statistical analysis and data preparation we used SPSS.

In the analysis, two areas were taken into account in the eye tracking (ET) metrics for the full duration of the clips: the area of interest (AOI) was drawn on the full SLI rectangle area and the remainder of the screen was considered scene (Not AOI). The SLI screen AOI was further divided into symmetrical areas on a vertical axis, either side of the interpreter: namely the ipsilateral side of the torso for the dominant side (H1) and the contralateral side of the torso for the non-dominant side (H2).

Additionally, a MacBook Air personal computer was used to administer and record the cross-modal, bilingual questionnaires.

2.1.2.2. Stimuli

Four clips were extracted from the English documentary film "Joining the Dots" by Pablo Romero Fresco (2012). The rationale behind this choice was that all selected clips would have a similar format, the same subject, and the same characters. Each video clip lasted between 2 and 3 minutes (see Table 1). The clips were selected on the basis of meaningful content in the scene. The translation/adaptation of the language content into LSC was carried out by a small team which comprised three members: a deaf native signer and two hearing, non-native, qualified signers. The Spanish subtitles created for the subtitling pilot were used as the source text for the translation/adaptation into LSC to allow full access to all team members (See Oliver Moreno (2017: 55) for a full description of the settings and design parameters for the source subtitles).

The translation procedures included two translations made by the hearing members which were later reviewed by the deaf consultant, who fine-tuned them and indicated which clips should be further adapted. The final edit was approved by all three members. The signing model for the translated documentary clips was a professional hearing interpreter, and a hearing signer, to parallel the most common use signed content on TV. The sign language clips were filmed following professional studio standards by the partner project organisation RTVE (*Corporación de Radio y Televisión Española*, the Spanish public broadcaster). The signed version of the clips was recorded over the voiced version of the subtitles to control the signing pace and later help with synchronisation in post-production.

Clips	**Start and end times**	**Duration**	**Number of words**	**Number of subtitles**	**Words per subtitle**	**Words per second**
clip 1	00:00 - 03:10	03' 08" (188")	297	47	6,31	1,58
clip 2	03:10 - 05:50	02' 40" (160")	328	46	7,13	2,05
clip 3	05:50 - 08:50	03' 00" (180")	289	45	6,42	1,61
clip 4	08:50 - 11:10	02' 20" (140")	227	36	6,31	1,62

Table 1. Stimuli clips design from the documentary "Joining the dots"

The UPM partner team edited the clips and synchronised the sign language interpretation clip with the documentary scene clip. Later they generated the 16 different clip stimuli combining the four split screen configuration formats (see Figures 1 - 4) for the four video clips.

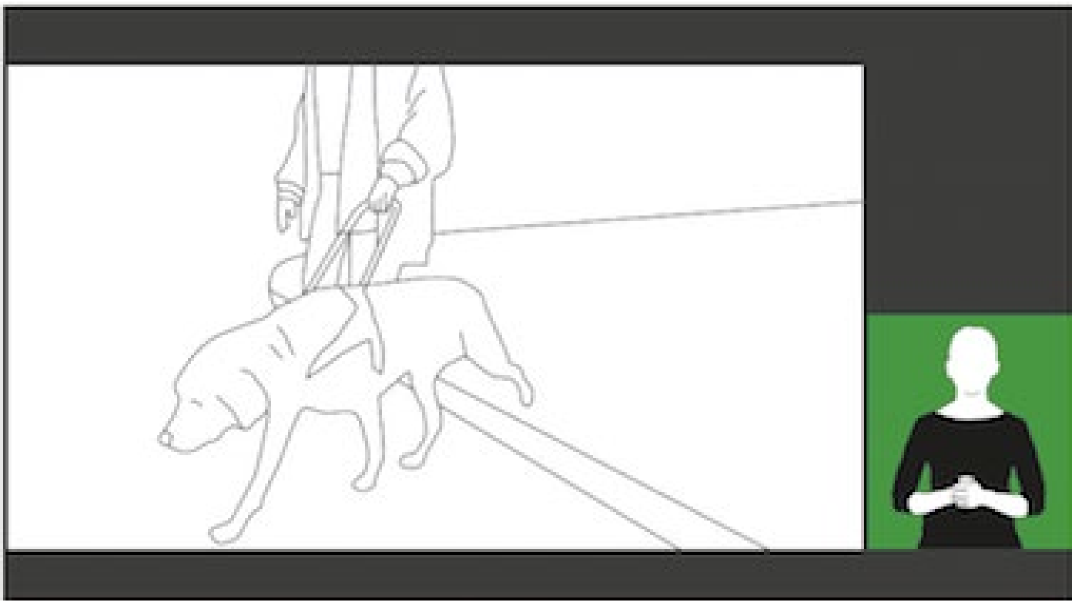

Figure 1. Illustration of the split screen configuration small size (1/5 of width screen) and right position of SLI screen (format 1)

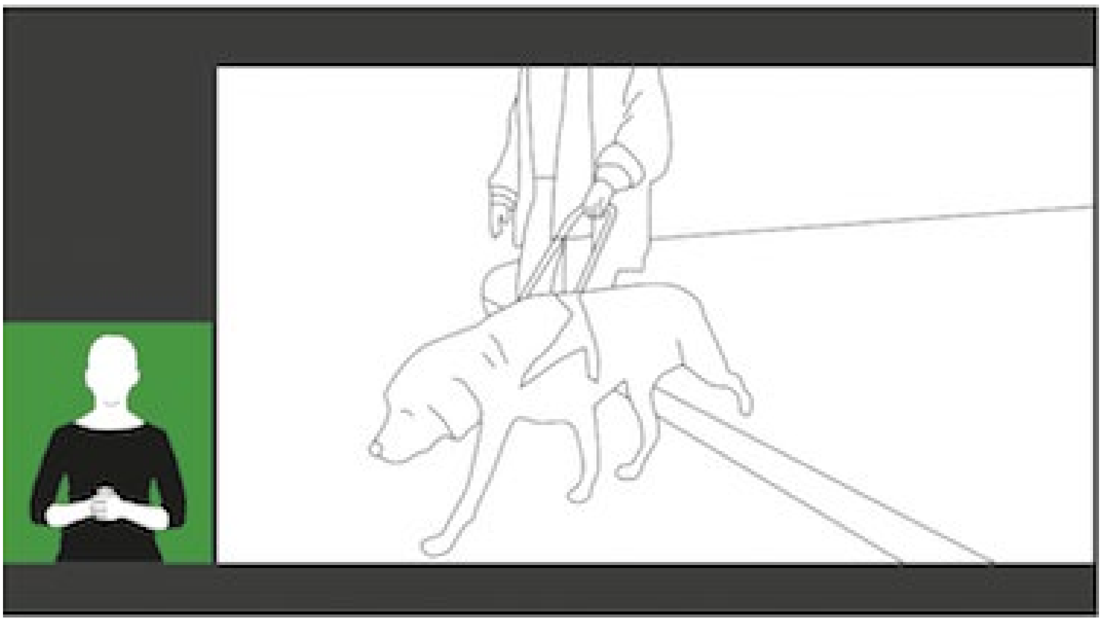

Figure 2. Illustration of the split screen configuration small size (1/5 of width screen) and left position of SLI screen (format 2)

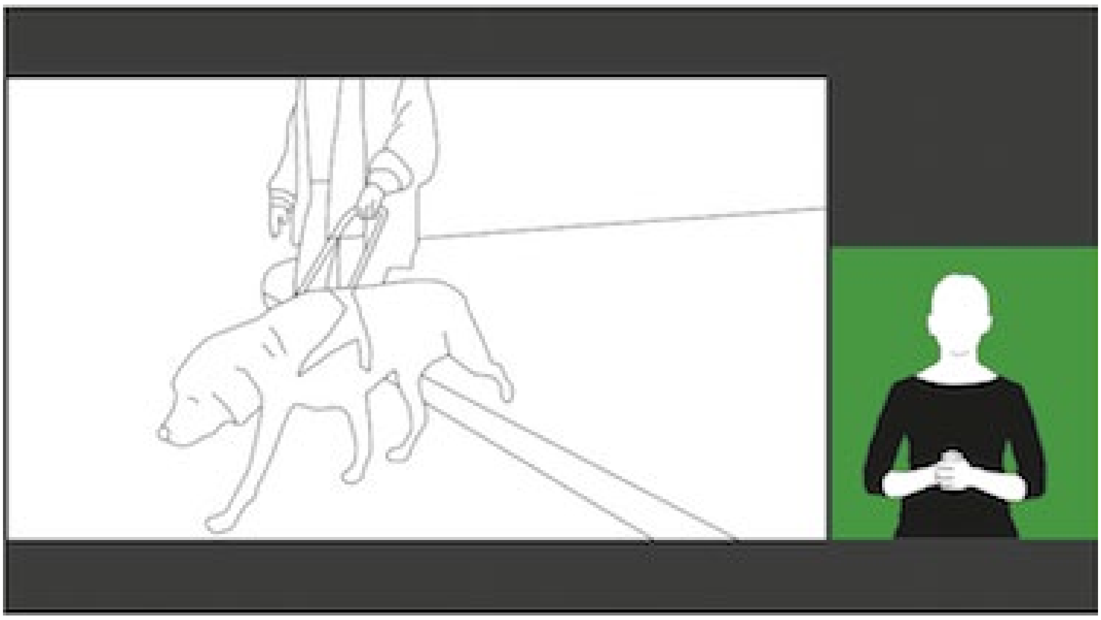

Figure 3. Illustration of the split screen configuration medium size (1/4 of width screen) and right position of SLI screen (format 3)

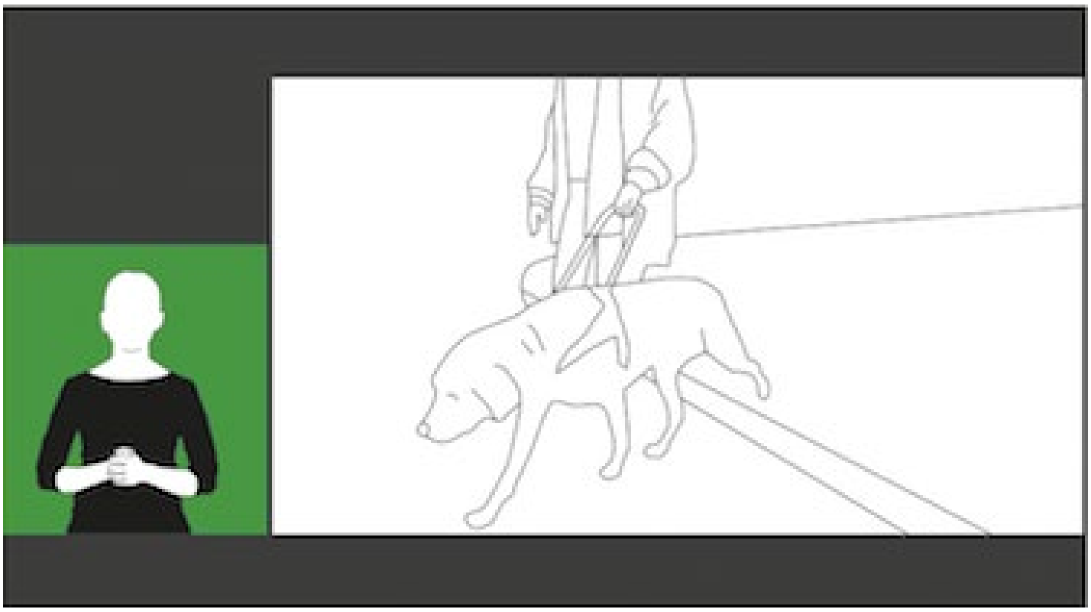

Figure 4. Illustration of the split screen configuration medium size (1/4 of width screen) and left position of SLI screen (format 4)

2.1.2.3. Other

Informed consent forms and image release forms were available in video format in LSC signed by a deaf, native signer to grant accessibility and in writing (Catalan and Spanish versions available) to be signed by the participant.

Four cross-modal, bilingual questionnaires (LSC / written Spanish) were designed to be administered by the interviewer, using an innovative web-based application developed in collaboration with the UPM partner team (see Figure 5). This data collection tool was innovative because it used sign language as the main language for accessing, understanding and evaluating the information. The cross-modal, bilingual questionnaire was designed to avoid subordination of sign language with respect to the written language so that the same social and linguistic statuses were given to both modalities in the experiment materials. Additionally, this design enhanced validity and reliability of the results because it didn't require the participants to sight-translate the questionnaires in situ. It also gave a much more accurate and consistent variety of language use between participants and throughout the experiment, thus making it possible to obtain more reliable results.

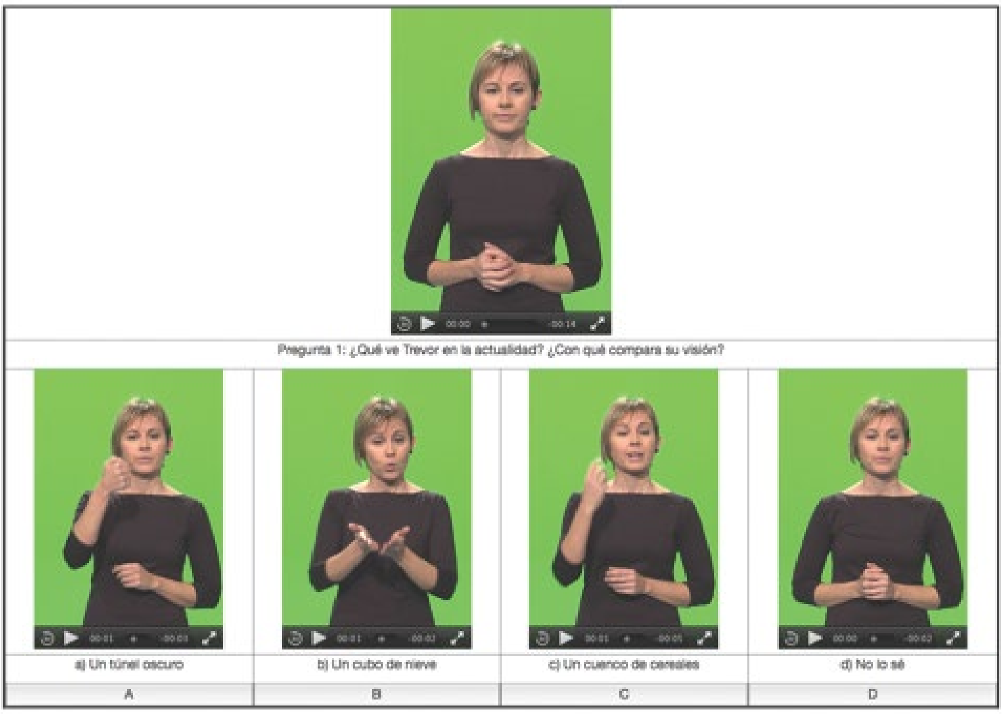

Figure 5. Screenshot of a multiple-choice question from the web-based, cross-modal, bilingual questionnaire.

The four questionnaires included: (1) the demographic data questionnaire, including basic personal information, and data on language skills and TV access service uses; (2) the sign language recall test (visual verbal memory), including five questions on sign language content comprehension and recall for each of the clips; (3) the scene/pictorial recall test (visual non-verbal memory), including five questions on the content recall of the documentary film imagery scene for each of the clips; and (4) user preference test, including questions about the usability and user experience of each of the conditions. The contents of the questionnaires were adapted from the subtitling pilot tests within the project (HBB4ALL 2017; Oliver Moreno 2017). The translation/adaptation approach for the questionnaire items was a mixed approach similar to the one described for the stimuli. However, the signing model for the LSC was the deaf member of the translation team in order to provide a better cultural and language concordance with the target language users. For a more detailed description of the questionnaire design and the translation and adaptation approach of the survey items, see Bosch-Baliarda, Soler-Vilageliu & Orero (2019).

2.1.3. Design

In this intra-subject study, each participant was shown four video clips from a set of sixteen. The four clips were presented in the four conditions. The order of presentation was varied randomly for the different participants, following a latin-square design. After watching each clip, the participant was asked to fill out three questionnaires: two on the clip information contents —one on the clip scene contents for visual non-verbal recall; and another for the sign-interpreted, textual contents for visual verbal recall— and one for users' preferences. The eye movements of the participants were recorded for the duration of the documentary clips in the different conditions.

The tested independent variables and conditions were:

– Screen area: SLI versus Main Screen
– Size of the SLI AOI (small = 1/4 of the total screen width; medium = 1/5 of the total screen width)
– Position of the SLI AOI (right; left)
– SLI screen format combination (format 1: small/right; format 2: small/left; format 3: medium/right; format 4: medium/left)
– Split SLI screen side: H1, H2
– The dependent variables used were:
– ET measures within the SLI AOI (number of fixations, number of visits; mean duration of fixations, mean duration of visits)
– Visual recall measures (score on language recall; score on scene recall)

2.1.4. Procedure

Users were individually tested in different local deaf association offices. In every interview room there was a table and two chairs (one for the interviewer and one for the interviewee). The participants were first welcomed by one of the bilingual researchers. She outlined the test components and objectives. Next, the consent form was signed and the demographics questionnaire completed using the cross-modal, bilingual, web-based questionnaire on a laptop computer. The participants sat in front of the eye-tracker at roughly 60 cm from the screen. After the standard 9-point calibration procedure, participants were asked to watch the clips. After each visualisation they answered both the linguistic and the visual memory questionnaires. The whole procedure carried out on each participant lasted about one hour.

2.2. Results

In order to analyse our data, we mainly used General Linear Models with repeated measures, that allowed us to compare the effect of different screen settings on Eye tracker recorded measures (Fixation Count, Fixation Duration Mean, Visit Count and Visit Duration Mean), on the Linguistic and Visual accuracy of recall (tested with questionnaires).

2.2.1. ET measures

2.2.1.1. Effects of screen format and AOI on ET measures

This analysis explores the effect of Format (format 1: SLI screen size 1/5; right, format 2: SLI screen size 1/5; left, format 3: SLI screen size 1/4; right, and format 4: SLI screen size 1/4; left) and Area: SLI area (AOI) and Scene screen area (Not AOI) on the above-mentioned ET measures. A summary of the data can be found in Table 2. 321

	Fixation Count SLI	**Fixation Count Not AoI**	**Fixation Duration Mean SLI**	**Fixation Duration Mean Not AoI**	**Visit Count SLI**	**Visit Count Not AoI**	**Visit Duration Mean SLI**	**Visit Duration Mean Not AoI**
Format 1 Small/Right	181,3	101,7	,56	,18	28,0	28,4	6,64	1,35
Format 2 Small/Left	184,6	100,0	,43	,18	28,5	28,7	4,53	1,33
Format 3 Medium/ Right	164,1	107,8	,58	,19	27,8	28,0	4,95	4,01
Format 4 Medium/ Left	189,5	91,9	,46	,19	26,8	27,1	5,31	1,12

Table 2: Mean values of ET measures for SLI screen and Scene screen (Not AOI) according to Format.

Abstract

We studied how sign language users responded to a screen composition including a larger screen for the content and a smaller screen for the sign language interpreter. 32 deaf users participated in this experiment, watching four similar clips with four different screen compositions. We registered the pattern of screen exploration with Eye Tracker, and we assessed content recall with two questionnaires. Our results show that sign language users mainly look at the sign language interpreter screen. Participants tend to look more often and for longer time at the SLI side closer to the main screen. Results are interpreted in terms of perceptual strategies developed by Sign Language users.

Keywords: Sign language interpreting; Accessibility for the deaf; Access in HBBTV; Service quality; Eye-tracking.

Resum

Hem estudiat com els usuaris de llengua de signes (LS) exploren una composició de pantalla formada per una pantalla gran per al contingut i una de petita per a l'ILS. 32 usuaris sords han vist quatre clips similars amb quatre composicions de pantalla diferents. Hem registrat l'exploració de pantalla amb Eye Tracker i avaluat el record amb dos qüestionaris. Els resultats mostren que els usuaris miren principalment la pantalla de l'ILS i tendeixen a mirar més sovint i més estona el costat de l'ILS més proper a la pantalla principal. Els resultats s'interpreten en termes d'estratègies perceptives desenvolupades pels usuaris de LS.

Keywords: Interpretació en llengua de signes; Accessibilitat per a sords; Accessibilitat en la televisió connectada; Qualitat dels serveis; Moviments oculars.

1. Towards the accessibility of sign language in media platforms

Sign language interpretation (SLI) made its appearance on TV around 1950 (Ladd 2007) and is thus considered one of three mature TV accessibility services along with subtitling and audio description (European Commission 2010; European Parliament 2010; European Parliament 2015; Looms 2009). There are also some newer, hybrid accessibility services, such as audio subtitling, and easy to read subtitles or audio description, often offered with personalisation options (Bernabé & Orero forthcoming). Some more recent accessibility services to arise include clean audio and the numerous possibilities offered through personalisation options (Mas & Orero 2018). Technology

The repeated measures analysis shows that the different formats do not have any effect on the measures Fixation Count ($F_{(3,81)}$= 342, p= .795; Partial Eta squared= .12); Fixation Duration Mean ($F_{(3,81)}$= 1.485, p= .225; Partial Eta squared= .52); Visit Count ($F_{(3,81)}$= .090, p= .965; Partial Eta squared= .003) nor on Visit Duration Mean ($F_{(3,81)}$= .674, p= .570; Partial Eta squared= .024).

However, there are significant differences for all ET measures in the two areas (SLI screen /Scene screen): Fixation Count ($F_{(1,27)}$ = 23,231; p= .000; Partial Eta Squared= . 462); Fixation Duration Mean ($F_{(1,27)}$ = 39,131; p= .000; Partial Eta Squared= . 592); Visit Count ($F_{(1,27)}$ = 18,875; p= .000; Partial Eta Squared= .411) and Visit Duration Mean ($F_{(1,27)}$ = 11,935; p= .002; Partial Eta Squared= .307). No interactions of Format and Area were found for any of the measures.

2.2.1.2. Effects of size and AOI on ET measures

As our findings did not show an effect on format, we decided to explore the two components of Format separately: Size of the SLI screen (Medium and Small) and Position of the SLI screen (Right or Left with respect to the Scene screen). A summary of this data can be found in Table 3 below. 323

		Fixation Count SLI	Fixation Count Not AoI	Fixation Duration Mean SLI	Fixation Duration Mean Not AoI	Visit Count SLI	Visit Count Not AoI	Visit Duration Mean SLI	Visit Duration Mean Not AoI
Size	Small	182,9	100,9	,49	,18	28,2	28,5	5,60	1,34
	Medium	176,8	99,8	,52	,19	27,3	27,5	5,13	2,56
Position	Right	173,0	104,7	,57	,19	27,9	28,2	5,83	2,63
	Left	187,0	96,0	,44	,18	27,7	27,9	4,91	1,23

Table 3: Mean values of ET measures for SLI screen and Scene screen (Not AoI) according to Size and Position.

The repeated measures analysis did not show any effect of SLI Size on the measures Fixation Count ($F_{(1,29)}$= .141; p= .710;Partial Eta Squared= .005); Fixation Duration Mean ($F_{(1,29)}$= .139; p= .712;Partial Eta Squared= .005); Visit Count ($F_{(1,29)}$= .937; p= .341; Partial Eta Squared= .031) nor on Visit Duration Mean ($F_{(3,81)}$= .347, p= .561; Partial Eta squared= .012).

The impact Area made was significant in all measures: Fixation Count: $F_{(1,29)}$= 21.028; p= .000; Partial Eta Squared= .420; Fixation Duration Mean: $F_{(1,29)}$= 37.999; p= .000; Partial Eta Squared= .567; Visit Count: $F_{(1,29)}$= 12.293; p= .001; Partial Eta Squared= .353; and Visit Duration Mean: $F_{(1,29)}$= 15,833; p= ,000; Partial Eta Squared= ,298. No interactions between Size and Area were found for any of these measures.

2.2.1.3. Effects of position and area of interest on ET measures

The analysis of the effect of Position of the SLI screen regarding the Scene screen did not show any significant differences in ET measures: Fixation Count: $F_{(1,31)}$= .006; p= .931, Partial Eta Squared= .000; Fixation Duration Mean: $F_{(1,31)}$= 3.262; p= .081, Partial Eta Squared= .095; Visit Count: $F_{(1,31)}$= .002; p= .961, Partial Eta Squared= .353; and Visit Duration Mean: $F_{(1,31)}$= 2.266; p= .142; Partial Eta Squared= .068. Area had a clear effect on all measures: Fixation Count: $F_{(1,31)}$= 22.984; p= .000, Partial Eta Squared= .426; Fixation Duration Mean: $F_{(1,31)}$= 37.137; p= .000, Partial Eta Squared= .545; Visit Count: $F_{(1,31)}$= 19.821; p= .000, Partial Eta Squared= .390; and Visit
324 Duration Mean: $F_{(1,31)}$= 14.477; p= .001; Partial Eta Squared= .318. No interactions between Position and Area were found for any of these measures.

2.2.1.4. Dominant hand and Position effects within the SLI screen on ET measures

In order to examine visual attention given to the dominant hand on the visual exploration of the screen, we split the SLI screen into ipsilateral (the dominant hand side) and contralateral (the non-dominant hand) areas and compared the ET measures obtained for both sides in relation to the position of the SLI screen with respect to the Scene screen.

The repeated measures analysis did not show significant differences for Fixation Count according to Position ($F_{(1,30)}$= .174; p= .680; Partial Eta Squared = .006) nor Dominant Hand side ($F_{(1,30)}$= .544; p= .467; Partial Eta Squared= .018). No interaction can be reported either.

Similar results are obtained for Fixation Duration Mean, according to Position ($F_{(1,30)}$= .084; p= .774; Partial Eta Squared= .003) and Dominant

Hand side ($F_{(1,30)}$= ,337; p= ,566; Partial Eta Squared= ,011). No interaction was found either.

However, the analysis of the differences in Visit Count did show the statistical significance of Position ($F_{(1,30)}$= 4.375; p= .45; Partial Eta Squared= .127). No effects were found concerning the Dominant/Non-dominant Hand side ($F_{(1,30)}$= .009; p= .924; Partial Eta Squared= .000), but there was a significant interaction between Position and Hand Side ($F_{(1,30)}$= 4.710; p= .038; Partial Eta Squared= .136). The Dominant hand side received more visits when it was placed at the Right of the Scene screen, while the contrary was found for the Non-dominant hand side. This interaction is depicted in Figure 6.

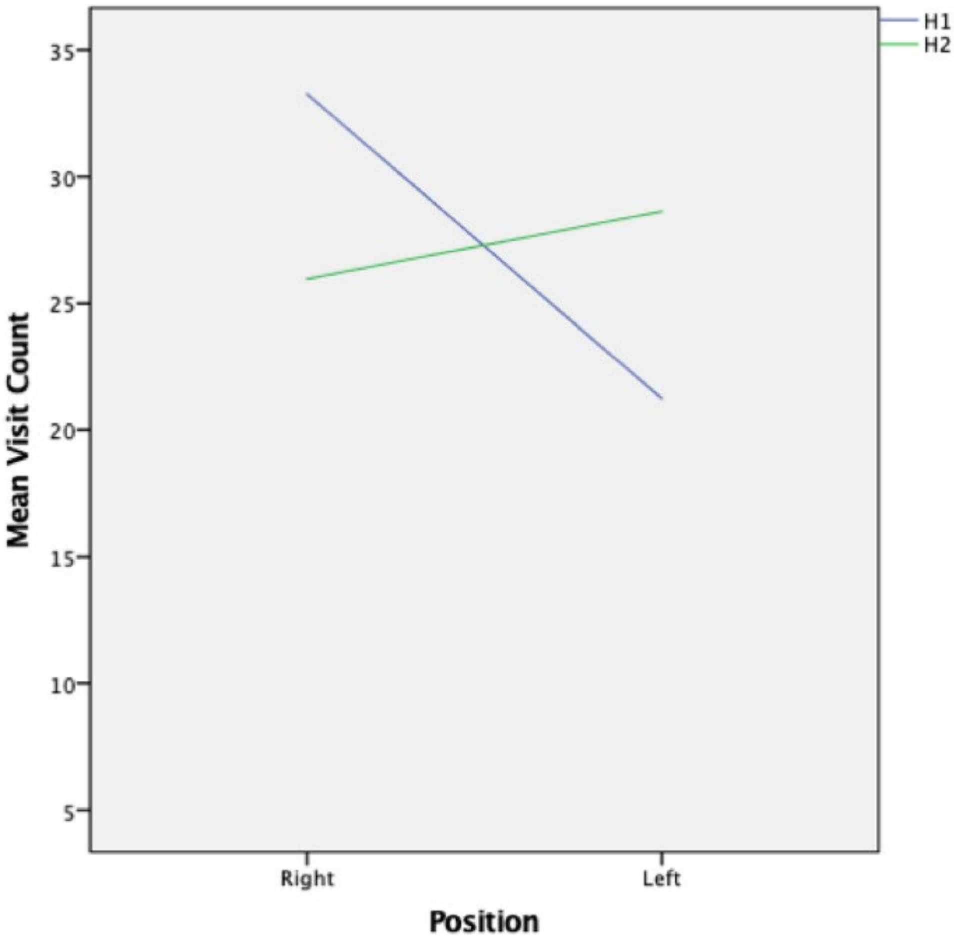

Figure 6. Interaction between position of the SLI and visits received by each hand-side.

No effects were found for the Visit Duration mean measure, nor for Position ($F_{(1,30)}$= 1.345, p= .255; Partial Eta Squared= .043), nor Hand ($F_{(1,30)}$= 1.558; p= .222; Partial Eta Squared= .049.

2.2.2. *Effects of format on language and scene recall results*

A General Linear Model with repeated measures was carried again to test the effects of the screen format on the scores obtained in both recall questionnaires. Values can be seen on Table 4.

We did not find effects of Format on Recall: $F_{(3,84)}$= 1.921; p= .132; Partial Eta Squared= .064, but we did find significant effects of type of recall: $F_{(1, 28)}$= 10,783; p= .003; Partial Eta Squared= .278.

Format	f1: Small/right			f2 small/left			f3 medium/right			f4 medium/left		
	Mean	St Dev	Valid N	Mean	St Dev	Valid N	Mean	St Dev	Valid N	Mean	St Dev	Valid N
Language Recall	2.19	1.45	31	2.60	1.10	30	2.45	1.36	31	2.34	1.15	32
Scene Recall	1.52	1.06	31	1.73	1.28	30	1.94	1.21	31	2.34	1.18	32

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Table 4. Mean scores obtained for the scene recall and language recall according to the different screen formats.

Since scene recall and language recall are different, according to the repeated measures analysis, we carried out planned comparisons between both scores in each format. The results point out that mean scores for the scene recall and the language recall are significantly different for f1($t_{(30)}$= 2.358; p= .025) and for f2 ($t_{(29)}$= 3.432; p= .002), in which language recall is better than scene recall. For the scene recall in format f3 and f4, however, differences are not significant (f3: $t_{(30)}$= 1.609; p= .118; f4: $t_{(31)}$= .000; p= 1).

We also carried planned comparisons within each type of test to compare the results obtained for each format. T-tests show significant differences between Scene recall scores obtained with Format 1 and Format 4 ($t_{(30)}$= 3,233; p= .003) and a trend of significance between Format 3 and Format 4 ($t_{(30)}$= 1.995; p= .055). That is, Format 4 (medium/left) produces significantly better results of the scene recall than Format 1 (small/right) and Format 3 (medium/right). No significant differences were found for Language recall across formats.

3. Discussion

Even though sign language access services on TV target hours have not yet been met, SLI service broadcast hours have been growing over the past few years. The goal of our study, under the scope of the HBB4ALL project, was to provide experiments to support recommendations for broadcasters regarding size and position of the SLI on screen.

In this reception study we researched the user's visual behaviour and information processing of sign-interpreted TV access service while watching video clips in different split screen configurations. We recorded participants' eye movements and scored their performance on memory questionnaires about the language and scene content. Our purpose was to explore if different split screen formats elicited differences in the way information content on screen is processed. Although our experimental reception study is largely exploratory we found some interesting findings that we discuss later.

We also carried planned comparisons within each type of test to compare the results obtained for each format. T-tests show significant differences between Scene recall scores obtained with Format 1 and Format 4 ($t_{(30)}$= 3,233; p= .003) and a trend of significance between Format 3 and Format 4 ($t_{(30)}$= 1.995; p= .055). That is, Format 4 (medium/left) produces significantly better results for the scene recall than Format 1 (small/right) and Format 3 (medium/right).

Turning first to the ET data, regarding screen exploration in the four different formats, we found that sign language users spent a longer time watching the LS screen than the scene screen, independently of the split screen format, the screen size or the SLI and the side of display. These results on attention distribution among the different splits screens on the TV are consistent with Wehrmeyer's findings (2014) with news broadcasts. The repeated measures analysis showed that the different formats, size and position conditions do not have any effect on the ET measures. Likewise, no interactions were found for any of the ET measures. We hypothesise that this consistency among the different split screen variables and conditions might be related to the nature of the content and also the task in our experiment, which was one of the controlled variables in our clip design. In all the documentary video clips, scene content and language content were relevant to task completion and designed to be balanced among the different conditions.

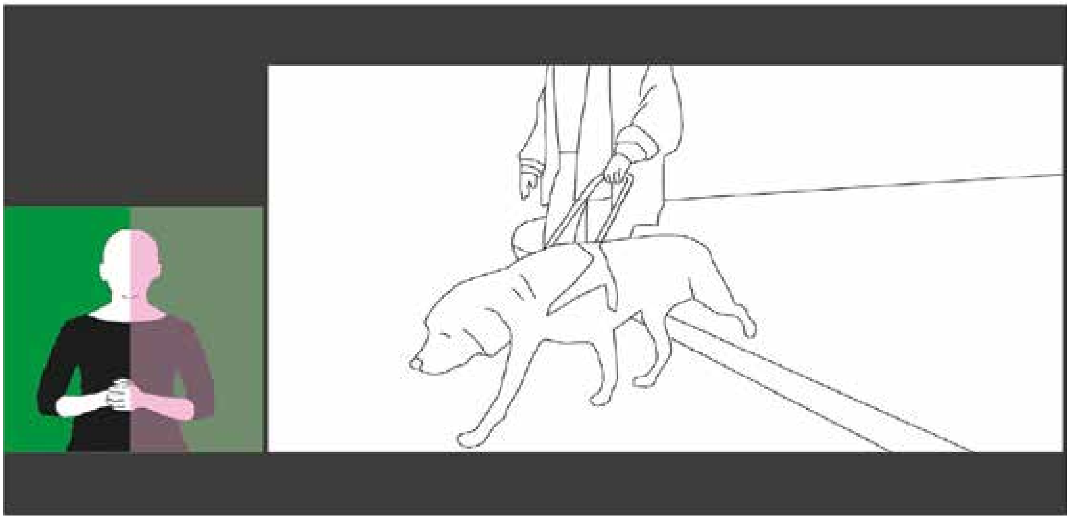

Figure 7. Proximal contralateral side (shaded in pink) in format 4

With regard to the visual exploration of ipsilateral (H1) and contralateral (H2) sides of the SLI area, the results show a difference between attention distribution in the two position conditions, as predicted. However, our directional hypothesis is not confirmed: the number and duration of fixations and visits is not higher for H1 SLI area in any position conditions. Although the number of visits for H1 and H2 areas is the same, there is an interaction between right/left positions and dominance side in the number of visits (see Figure 6). Namely, the visit count is higher on the ipsilateral side (H1) of the SLI area in the right positions, whereas it is higher on the contralateral side (H2) of the SLI area for the left positions. Therefore, our results suggest that deaf participants tend to focus their attention on the side of the SLI screen that is more proximal to the scene screen, regardless of the hand dominance. The shaded area in Figure 7 illustrates the proximal part of the SLI screen in format 4 which is the part receiving most focused attention, in left positions this side corresponds to the contralateral side of the interpreter. We hypothesise that by focusing their attention on the proximal part of the SLI screen to the scene screen, participants can include more information content within their peripheral visual field. The heat maps below in Figures 8 - 11 illustrate the different foci of attention for the right/left conditions in the four split screen formats.

Figure 8. Format 1 gaze pattern heat map for all participants in clip 3

Figure 9. Format 2 gaze pattern heat map for all participants in clip 3

Figure 10. Format 3 gaze pattern heat map for all participants in clip 3

Figure 11. Format 4 gaze pattern heat map for all participants in clip 3

Regarding the recall test results, our findings show that the responses to the language recall tests are significantly more accurate than those of the scene recall tests when the SLI appears in small formats, formats 1 and 2. However, when the SLI screen size is medium, in formats 3 and 4, the differences in scores between language and scene recall are not significant. We assume that this contrast is associated with the size of the SLI screen. Although the focus of attention is not evenly distributed between the two split screens, according to ET metrics, the bigger size of the SLI screen probably allows for visual attention to absorb the scene details, using the peripheral, visual perception mentioned above.

Concerning the interaction between the recall scores and the four format combinations, the results indicate that format is not significantly related to language recall performance. However, there are differences regarding scene recall scores, which are the highest in format 4, the format combining the medium sized SLI screen in the left position, and the lowest in format 1, combing a small sized SLI in the right position. Specifically, the data analysis indicates differences between format 4 and both of the other formats, including the SLI screen on the right position. The results show a significant difference between format 4 and format 1, and a trend of significance between format 4 and format 3.

These recall results suggest that the format including an SLI medium screen on the left is a good split screen configuration that facilitates information recall from the scene screen. It is also the format with more balanced mean scores between the language and scene recall tests. This finding suggests that right visual field enhancement, or left-hemisphere bias (Bavelier et al. 2001), could also have an effect on complex visual information processing, such as watching interpreted TV content on a split screen configuration. However, this finding might also be showing effects of a bias in participant sample. As our participants are all Catalan sign language users they might be showing a learning effect, as the medium-size left-position SLI screen is the format used in the daily news of the Catalan public broadcaster. Even though this finding is internally valid for our research, more research is needed to grant the external validity of the results.

4. Final remarks

This experimental reception study has shown how deaf sign language users explore a sign-interpreted documentary on TV using a split screen configuration. Although mostly exploratory in nature, the findings suggest that the format used to deploy the service impacts the accessibility of information contents, both textual and non-textual. The differences found in accuracy recall of the documentary content have been associated with format conditions, size and on-screen positioning.

Our findings suggest that including a SLI of medium size (1/4 of the TV screen width) in a left position can contribute to better content access for deaf sign language users. The results indicate that this screen configuration encompasses the optimal formal parameters, enhancing screen legibility and balancing comprehension to both language and scene content. Broadcasters deploying SLI services should consider that the formal parameters choices do not only affect aesthetics but have an impact on content accessibility.

As the application of eye tracking methods in SLI access services is still fairly unexplored, future studies should endeavor to research other formal parameters that may affect sign language processing, such as the use of Chroma key or background colour, which may also impact on perception and usability of the service. These factors might be crucial to improve media experience not only for all members of the sign language communities, but especially for those with a combined sensory loss such as deafblind sign language users or the elderly.

More research is needed not only in order to study the formal parameters, but also for different national sign languages, age groups, TV genres, signing models and newer devices, in order to improve the quality of this access service with a view to offering real personalisation options. We believe that to guarantee equal rights in information accessibility and participation in society for sign language communities, it is of the utmost importance to strive for quantity and quality in media access services in sign language.

and end user lobbying are the two forces behind the development and mainstreaming of accessibility services.

The latest technological advances have contributed to an increase in informative, social and cultural content, transmitted through various media platforms. The new TV formats (Digital TV —DTV— and more recently Hybrid-Broadcast-Broadband —HbbTV or Smart TV) are mixed formats that combine TV broadcasting with Internet broadband access. These more recent formats allow the customisation of content and in particular, open up new possibilities to deploy personalised, synchronised access services, which are crucial to grant accessibility to information broadcasting (Martín, Orero, Menéndez & Cisneros 2015). Validating the optimal parameters for any personalised access service implementation is key to ensure best practice in future commercial use and to provide guidance to broadcasters deploying the services. However, as for SLI it is still unclear which formal parameters are to be implemented to fully explore the possibilities of its customization, that grant quality sign language access services and equal rights in media accessibility for sign language users.

The provision of accessible audiovisual media services in Europe is covered by the European Audiovisual Media Services Directive. Article 46 of the directive states that access to audiovisual media forms part of the "right of persons with a disability and of the elderly to participate and be integrated in the social and cultural life of the Union" and specifies that "the means to achieve accessibility should include, but need not be limited to, sign language, subtitling [and] audio-description." Also according to article 7 of the Audio Visual Media Standard Definition (AVMSD), "Member States shall encourage media service providers under their jurisdiction to ensure that their services are gradually made accessible to people with a visual or hearing disability." It is then up to each member state to gradually make appropriate services available, with a view to reaching targets of 100% for subtitling of public-service broadcasting, and 10% for both audio description and sign language.

1.1. Sign language interpreting on television

Stakeholders have devoted many efforts towards attaining information access (Orero et al. 2014). Deaf and hard-of-hearing people are active advocates of

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BIONOTES / BIONOTAS

Marta Bosch Baliarda is a sign language linguist and interpreter specialised in Deaf studies who has worked as a trainer for sign language interpreters, sign language teachers and communication support workers. She is currently a PhD research assistant in the research group TransMedia Catalonia from the Autonomous University of Barcelona and working on sign language accessibility services.

Marta Bosch Baliarda és lingüista i intèrpret de llengua de signes especialitzada en estudis de persones sordes. Ha treballat com a formadora d'intèrprets de llengua de signes, professors de llengua de signes i treballadors de suport a la comunicació. Actualment és assistent d'investigació de doctorat al grup de recerca TransMedia Catalonia de la Universitat Autònoma de Barcelona i treballa en serveis d'accessibilitat en llengua de signes.

Olga Soler Vilageliu is an associate professor at UAB, where she teaches psycholinguistics and cognitive processing to undergraduates in Psychology and Speech Therapy. With a background in language processing, her research has focused on on-line measuring of handwriting in preschool and school children. Within the TransMedia projects she is currently setting up experiments on different accessibility services: quality of perception of Sign Language on TV and emotional involvement of users of Audio description and Audio Subtitling.

Olga Soler Vilageliu és professora associada de la UAB, on imparteix classes de psicolingüística i processament cognitiu a estudiants de grau de Psicologia i Logopèdia. Amb experiència en el processament del llenguatge, la seva recerca s'ha centrat en el mesurament en línia de l'escriptura a mà en nens en edat preescolar i escolar. En el marc dels projectes de TransMedia, actualment està preparant experiments sobre diferents serveis d'accessibilitat: qualitat de percepció de la llengua de signes a la televisió i implicació emocional dels usuaris d'audiodescripció i d'àudio-subtítols.

Pilar Orero is an associated professor at the Faculty of Translation at Universitat Autònoma de Barcelona. She works in the field of Media Accessibility She has edited 12 books and wrote 86 papers in international journals, and more than 40 book chapters. Leader of numerous research projects funded by the

Spanish and Catalan Gov. She leads TransMedia Catalonia Group (2005-2017) and the Audio Description and Audio Subtitling group at UN agency ITU 2011-2013 focus group on Media Accessibility. She is now working for WSIS+10. Co-editor of ISO/IEC JTC 1/SC 35 N on Audio Description.

Pilar Orero és professora associada a la Facultat de Traducció de la Universitat Autònoma de Barcelona. Treballa en l'àmbit de l'accessibilitat als mitjans de comunicació. En els darrers deu anys ha editat 12 llibres i escrit 86 publicacions en revistes internacionals i més de 40 capítols de llibres. Líder de nombrosos projectes d'investigació finançats pel governador espanyol i català. Dirigí TransMedia Catalonia Group (2005-2017) i el grup Audio Description i Audio Subtitling dins el grup de debat sobre l'accessibilitat als mitjans de comunicació de l'ONU ITU 2011-2013. Ara treballa per a WSIS + 10. Coeditor de ISO / IEC JTC 1 / SC 35 N en Descripció d'àudio.

Appendix 4.1 Diseño de experimentos con usuarios para evaluar la recepción de LSE en TV

Diseño de experimentos con usuarios para evaluar la recepción de LSE en TV[106]

Olga Soler Vilageliu, Marta Bosch i Baliarda y Pilar Orero Clavero

TRANSMEDIA CATALONIA

UNIVERSITAT AUTÒNOMA DE BARCELONA

Resumen

Describimos el diseño de los experimentos del proyecto Hbb4all con usuarios de lengua de signos (LS), que tienen como objetivo estudiar la relevancia de algunos parámetros visuales de la interpretación de LS en TV. En un trabajo previo identificamos algunos de estos parámetros: el tamaño relativo de la subpantalla del intérprete respecto a la pantalla principal, el lado de inserción, el modo de inserción (sobreposición o cromakey), el color de fondo del intérprete y la ropa del intérprete. Los estudios posteriores sirven para seleccionar las variables más importantes y proporcionar un estándar de calidad a los operadores.

En las primeras fases del estudio trabajamos con dos tipos de personas implicadas: se entrevistaron individualmente profesionales de la interpretación y se organizó un grupo de discusión con usuarios. Los resultados de estas entrevistas señalaron como variables más relevantes el tamaño de la subpantalla y el lado de inserción.

Para la tercera fase diseñamos los estudios empíricos. Un estudio piloto permitió determinar qué tamaños de la subpantalla evaluaremos y la adecuación de la metodología empleada. La tarea de los usuarios consistió en el visionado de tres clips de noticias y responder a cuestionarios de preferencias y de recuerdo. Para medir el efecto de cada condición, los usuarios respondieron a tests de preferencia y de comprensión. Los resultados indicaron la preferencia de los usuarios por los dos tamaños de pantalla menores. En un experimento futuro, los participantes visionarán cuatro clips de un documental y cuatro de una película de ficción, con cuatro opciones de posición de la subpantalla de interpretación, combinando las posiciones arriba / abajo y derecha / izquierda. Después del visionado, los par-

106 Dicha comunicación puede visualizarse en el siguiente enlace.

ticipantes responderán a cuestionarios signados en vídeo de preferencias y de recuerdo. Además, para evaluar sus estrategias perceptivas para captar la información en pantalla, se registrarán los movimientos oculares durante el visionado.

1. Presentación[107]

El proyecto Hbb4all[108] es un proyecto financiado por la Unión Europea que se coordina desde la Universidad Autónoma de Barcelona. En este proyecto participan distintos socios entre los que se encuentran universidades, productoras de programas de televisión y compañías emisoras de televisión públicas. El proyecto está organizado en distintos paquetes de trabajo, que estudian los servicios de accesibilidad en este formato de televisión. Nosotras formamos parte del equipo de la Universidad Autónoma y estamos integradas en el Paquete de Trabajo 6 o Piloto D. En este piloto las aplicaciones que se están estudiando son dos: el formato de inserción del intérprete de la lengua de signos en pantalla y el servicio de interpretación mediante un avatar basado en la tecnología HbbTV.

Nuestro trabajo consiste fundamentalmente en realizar pruebas con usuarios para determinar cómo se percibe, se procesa y se comprende la lengua de signos en función de las distintas configuraciones de pantalla.

En la Figura 1 podemos observar algunas capturas de pantalla que encontramos en distintas cadenas de televisión en el mundo (Redón, 2013).

107 Agradecimientos: este trabajo se ha llevado a cabo dentro del proyecto Hbb4All, un proyecto cofinanciado por el programa Competitiveness and Innovation Framework program de la Comisión Europea y 12 socios. Las autoras agradecen profundamente a las intépretes de lengua de signos y los usuarios sordos que han participado en el estudio su colaboración amable y desinteresada.

108 http://www.hbb4all.eu/.

Figura 1. Capturas de pantalla con interpretación de signos de cadenas de televisión de distintos países

Fuente: cadenas de televisión de distintos países.

Como se puede ver, no existe ningún tipo de estandarización definido. En diferentes países, en diferentes canales, o incluso en distintos programas de un mismo operador, se utilizan formatos de inserción de la intérprete muy diferentes. La variación se debe a distintas variables y nuestro objetivo es determinar cuáles de estas variables son importantes para que el contenido se comprenda.

2. Estudio de variables

El punto de partida es que prácticamente no existe investigación previa ni resultados sobre cuáles son las configuraciones de pantalla que favorecen que la información en lengua de signos sea comprendida. Nuestro objetivo es obtener unos primeros resultados que indiquen qué tipo de inserción del intérprete de lengua de signos (ILS) permite que la lengua de signos que se emite sea funcional, es decir, que no haya un intérprete solamente para cubrir la cuota de lengua de signos en pantalla, sino que realmente sirva para que el contenido sea accesible.

Lo primero que hicimos para seleccionar las variables a estudiar fue recopilar 100 imágenes diferentes de intérpretes, sobre todo de noticias, que es en el tipo de programas en el que más se encontró interpretación (Redón, 2013). Los datos se obtuvieron mediante el acceso a la plataforma en línea para sordos *signlangtv.org*. Esta plataforma incluye diferentes programas de televisión accesibles desde las emisoras en 42 países, dentro y fuera de la UE. Partiendo de estos datos, se analizaron diferentes características formales para cada tipo de formato de inserción: el género del intérprete (hombre / mujer), tipo de inserción en la pantalla (pantalla secundaria o ventana / media pantalla / croma), plano de grabación (plano largo / plano largo medio / plano medio / plano corto), color de la ropa del intérprete (color claro / color oscuro / estampado o multicolor), el tamaño del intérprete en pantalla (pequeño / medio / grande), ubicación del intérprete en la pantalla (derecha / izquierda, arriba / centro / abajo). Estas múltiples características constituyen las posibles variables a estudiar en la fase experimental de nuestras investigaciones.

Seguidamente mostraremos la variación observada en términos de las características formales de inserción del intérprete de lengua de signos (ILS) en pantalla. Hemos anotado el valor más frecuente según nuestros datos, que no tiene por qué ser la opción que ayuda más a la accesibilidad. Por otro lado, la variación para cada tipo de característica formal se ilustra mediante distintas imágenes correspondientes a las capturas de pantalla.

La primera variable es el sexo de la intérprete (Figuras 2 y 3). En estas imágenes vemos que la intérprete mayoritariamente es una mujer (68 %).

Figura 2. Captura de ILS mujer TV China

Fuente: TV China.

en un 7 % de los casos. Los planos más largos o plano entero (PL) permiten que la lengua de signos sea mucho más natural, incluyendo todo el espacio sígnico. Pero por cuestiones de espacio o estéticos, muchas veces la intérprete sale muy pequeña y se opta por un plano más cerrado, para que las manos en pantalla tengan un mayor tamaño relativo.

Figura 6. Capturas de pantalla con diferentes planos de grabación del ILS en pantalla en distintos países (Kosovo PML, Suiza PL y Portugal PMC)

Fuente: cadenas de televisión de Kosovo, Suiza y Portugal.

En lo que respecta al tamaño del ILS en pantalla (Figura 7), hemos agrupado la variedad de tamaños en tres categorías según el espacio ocupado por el ILS en el eje horizontal de la pantalla. En los tamaños pequeños el ILS ocupa menos de 1/5 de la pantalla, en el medio entre 1/5 y 1/3, y en el tamaño grande entre 1/3 y 1/2. En la mayoría de los casos es un tamaño medio, aunque hay mucha variedad.

Figura 7. Capturas de pantalla con diferentes tamaños de inserción del ILS en pantalla en distintos países (Korea - pequeño, Letonia - medio)

Fuente: cadenas de televisión de Korea y Letonia.

Tal y como mostramos en la Tabla 1, otra característica donde se observa una gran variedad es la ubicación, aunque hay una tendencia a que el intérprete aparezca en la parte inferior a la derecha (40 %).

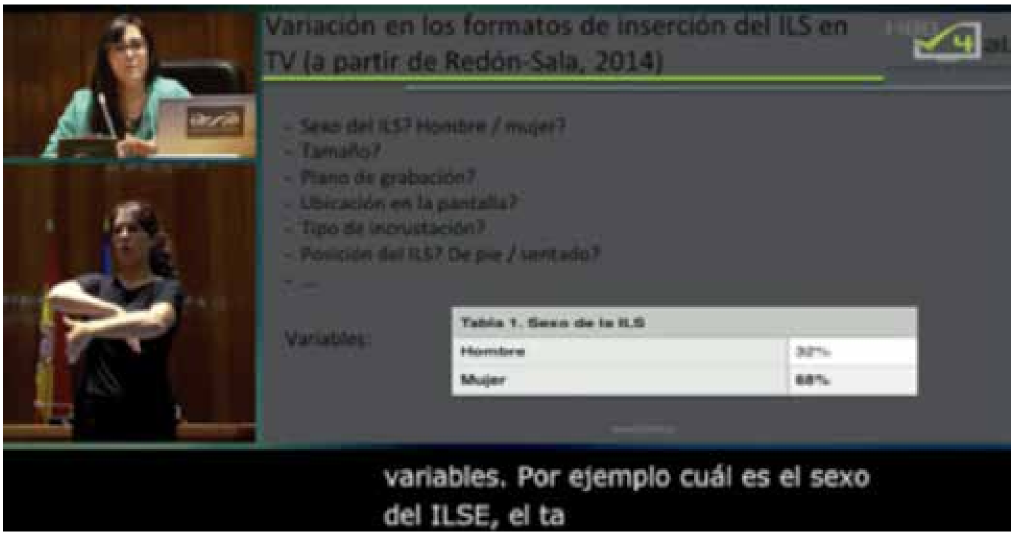
Tabla 1. Resultados porcentuales de las posiciones de aparición del ILS en pantalla

Superior derecha	3 %
Central derecha	21 %
Inferior derecha	40 %
Total de posiciones derecha	64 %
Superior izquierda	0 %
Central izquierda	19 %
Inferior izquierda	17 %
Total de posiciones izquierda	**36 %**

Fuente: cadenas de televisión de Korea y Letonia.

Sin embargo, parece que cuando los usuarios eligen donde va ubicado el ILS la situación es a la izquierda, como en el caso de la emisión por streaming del presente Congreso del Centro de Normalización de la Lengua de Signos Española, CNLSE (Figura 8).

FIGURA 8. CAPTURA DE PANTALLA DE LA EMISIÓN EN STREAMING DEL CONGRESO DEL CNLSE CON LA ILSE UBICADA A LA IZQUIERDA DE LA PANTALLA



Fuente: elaboración propia.

Finalmente, la última variable que describimos es la posición de trabajo del ILS (Figura 9). En el 63 % de los casos la interpretación se hace de pie.

FIGURA 9. CAPTURAS DE PANTALLA DEL ILS EN DIFERENTES POSICIONES DE TRABAJO EN DISTINTOS PAÍSES (LITUANIA - SENTADO, KOSOVO - DE PIE)

Fuente: cadenas de televisión de Lituania y Kosovo.

En estos ejemplos hemos mostrado la gran variedad de posibilidades empleadas por los distintos operadores de televisión. Era necesario decidir qué variables eran las más importantes para empezar con el primer estudio. Para la primera y la segunda fase de nuestro estudio era fundamental para nosotros entrar en con-tacto con la comunidad sorda, miembros de asociaciones, y también las ILS profesionales que han trabajado o trabajan en el ámbito televisivo con los usuarios, para que nos comentaran cuáles de las variables –si el tamaño, el color, el plano, la posición– eran las más importantes para empezar nuestro estudio.

3. Estudio – fases 1 y 2

En la Fase 1, con las ILS del ámbito televisivo, estudiamos cómo se lleva a cabo la interpretación en lengua de signos en las televisiones de nuestro ámbito. Puesto que la comunidad sorda es pequeña, las intérpretes reciben mucho feedback de los usuarios, que les comentan lo que les gusta y lo que no (“te iluminan bien o mal”, “el fondo es oscuro” y otras muchas cuestiones, tanto de forma como lingüísticas, sobre su lengua de signos). Por esta razón, las ILS son una fuente importante de información para nuestro estudio, porque nos permitían recoger información desde el punto de vista profesional y de este feed-back que reciben de los usuarios.

La finalidad de las entrevistas con ILS era orientarnos para ir reduciendo el número de características a introducir en los experimentos. En esta primera fase participaron once intérpretes, ocho en activo y tres en excedencia o retiradas, de distintos canales autonómicos y también locales. Los resultados –resumidos– de esta fase primera indican que, según los profesionales y su experiencia, las variables más importantes son el tamaño en que aparece la interpretación de la lengua de signos, que puede ser una combinación de qué tamaño tiene la inserción de la lengua de signos y también el plano en el que se ha grabado la ILS. También es importante el color de fondo, el contraste del fondo de la ventana con el color de la piel y el color de la ropa, que es una variable que ha sido estudiada anteriormente. Finalmente, la velocidad de locución; citamos como ejemplo el estudio de Jordi Serrat, que ha presentado antes con Guillem Carles, donde se ha visto que la velocidad de locución de las noticias es muy superior a la velocidad de locución en otro tipo de programas, y la mayoría de programas interpretados son las noticias. Hay poca oferta de otro tipo de programas que sean accesibles.

En la segunda fase del estudio, con usuarios sordos, usamos una metodología diferente, que son los grupos de discusión o “focus groups”. El objetivo era presentar los diferentes tipos de inserción para ver cuál es la experiencia del usuario que está visionando los programas. La finalidad de estos grupos de discusión era elegir finalmente las variables que se van a introducir en la tercera fase experimental. En este caso participaron ocho signantes sordos. Por cuestiones técnicas, para poder grabar simultáneamente a los participantes, se organizaron dos sesiones y se dividió el grupo por edades, los signantes mayores de cuarenta años y los menores, porque también hay diferencias en cómo se prefiere la inserción del ILS según la edad.

El procedimiento fue el siguiente: primero, los usuarios visualizaron distintos ejemplos de inserción, en vídeo y en capturas de pantalla; luego, se llevó a cabo una discusión guiada de los diferentes parámetros y variables y, finalmente, los usuarios realizaron una tarea de dibujo en la que dibujaban su pantalla ideal y su pantalla fatal, en la que no había accesibilidad. Así podiamos ver también la distribución que cada uno cree que puede ser la ideal, aunque no la haya visto nunca emitida.

En esta fase los resultados fueron consistentes (no idénticos) a los obtenidos en la Fase 1. El parámetro más importante se valoró que era el tamaño de la ILS en pantalla, también el contraste de colores (ropa, fondo, incluso el contorno de la ventana) y la posición de la subpantalla valorada como preferida en sentido vertical fue la posición central (no en las esquinas superiores e inferiores) y en el sentido horizontal no había una tendencia clara, algunos usuarios preferian la ubicación en la derecha y otros en la izquierda.

Con estos resultados se han preparado los estímulos y las pruebas para la fase experimental del estudio, la Fase 3.

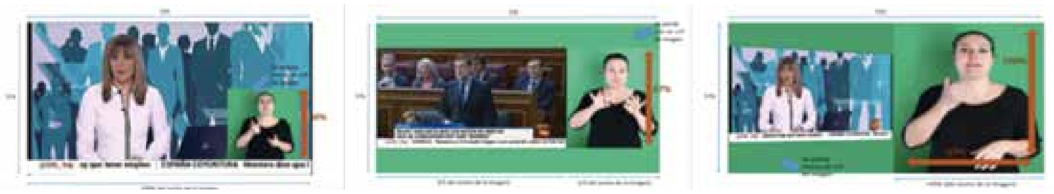
4. Fase 3 (en preparación)

La tercera fase consistirá en determinar con metodología experimental, metodología que se aplica habitualmente en psicología de la percepción, cuáles son los formatos óptimos para la recepción de la interpretación de la lengua de signos. La finalidad de este estudio, y de los que desarrollaremos en un futuro, es proporcionar datos para establecer un estándar de calidad en la emisión de la lengua de signos, que garantice la plena accesibilidad y que se ajuste a las preferencias de los usuarios.

- **Estudio piloto**

  Con el fin de evaluar la metodología del visionado de clips llevamos a cabo un experimento piloto, con la colaboración de RTVE y los compañeros del Grupo de Aplicación de Telecomunicaciones Visuales de la E.T.S.I. de Telecomunicación de la Universidad Politécnica de Madrid. Colaboraron en el experimento 14 participantes sordos de entre 20 y 70 años de edad, de los cuales cinco eran hombres y nueve mujeres. Las tareas que debían llevar a cabo eran visionar tres clips de noticias y responder un cuestionario escrito, que interpretó in situ Marta Bosch Baliarda, nuestra investigadora bilingüe. En la Figura 10 pueden verse las configuraciones de pantalla que usamos para este experimento.

Figura 10. Configuraciones de pantalla con inserción de ILS: tamaño pequeño, medio y grande



Fuente: elaboración propia.

Los clips que se utilizaron se obtuvieron escogiendo distintas noticias del Canal 24h de RTVE. Se montaron tres clips parecidos en cuanto a contenidos y duración de los mismos. El diseño utilizado fue un diseño en cuadrado latino, porque permite que los usuarios vean las tres configuraciones de pantalla, y evita que se combine siempre el mismo contenido con una misma configuración, lo que podría dar lugar a resultados sesgados: no sabríamos si los resultados obtenidos sobre las preferencias son debidos a la configuración de pantalla o a que el contenido ha orientado las preferencias de los usuarios. Por ello, es necesario variar entre los usuarios qué tipo de contenido ven con qué tipo de formato. En la Tabla 2 puede verse un ejemplo de la distribución de los participantes en un diseño de cuadrado latino. Las condiciones de las variables tamaño de la subpantalla y contenido del clip se alternan, de manera que no se repita la misma combinación para los mismos usuarios

Tabla 2. Ejemplo de distribución de nueve participantes en un diseño de cuadrado latino

	Clip 1	Clip 2	Clip 3
Tamaño 1	1, 4, 7	2, 5, 8	3, 6, 9
Tamaño 2	3, 6, 9	1, 4, 7	2, 5, 8
Tamaño 3	2, 5, 8	3, 6, 9	1, 4, 7

Fuente: elaboración propia.

Los resultados obtenidos en este estudio piloto indican que las preferencias de los usuarios son los tamaños medio y pequeño, que el tamaño relativo de las pantallas se ve más adecuado en los tamaños pequeño y medio y que el plano medio / largo utilizado era adecuado.

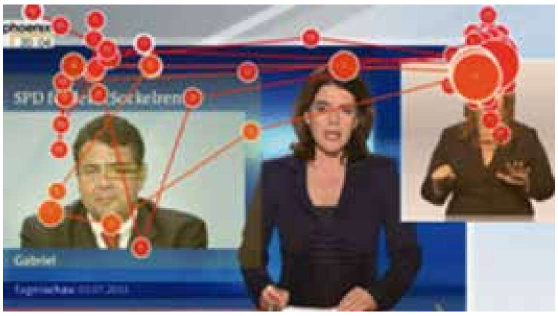
- **Estudio experimental**

A partir de estos resultados decidimos que los tamaños que se van a evaluar en el experimento serán los tamaños medio y pequeño y vamos a estudiar también el lado de la pantalla en el que se inserta la ILS.

En esta fase experimental, que empezará próximamente, vamos a utilizar el registro de los movimientos oculares con un *Eye Tracker*. Las variables independientes a estudiar son el tamaño de la ventana de inserción y el lado de inserción. La tarea va a ser la misma que en el experimento piloto: el visionado de cuatro clips con la combinación de las variables y responder tres cuestionarios bilingües, uno sobre preferencias, otro sobre comprensión del contenido lingüístico del clip y otro sobre memoria del contenido visual del clip.

Durante la visualización de los clips se registrarán los movimientos oculares de los participantes. Esta metodología permite estudiar el desplazamiento de la mirada de los usuarios sobre la pantalla, y de esta manera obtener información sobre el procesamiento que se realiza de la imagen y los puntos donde se concentra la atención. En la Figura 11 puede verse el aparato Tobii que registra estos movimientos, insertado bajo la pantalla que está mirando la chica, y en la imagen de la derecha se puede ver un ejemplo de datos obtenidos en un experimento anterior (Gutermuth, 2011): las líneas rojas indican los movimientos de la mirada y los círculos rojos indican las fijaciones de la mirada, dónde se han parado los ojos y durante cuánto tiempo, indicado por el tamaño del círculo.

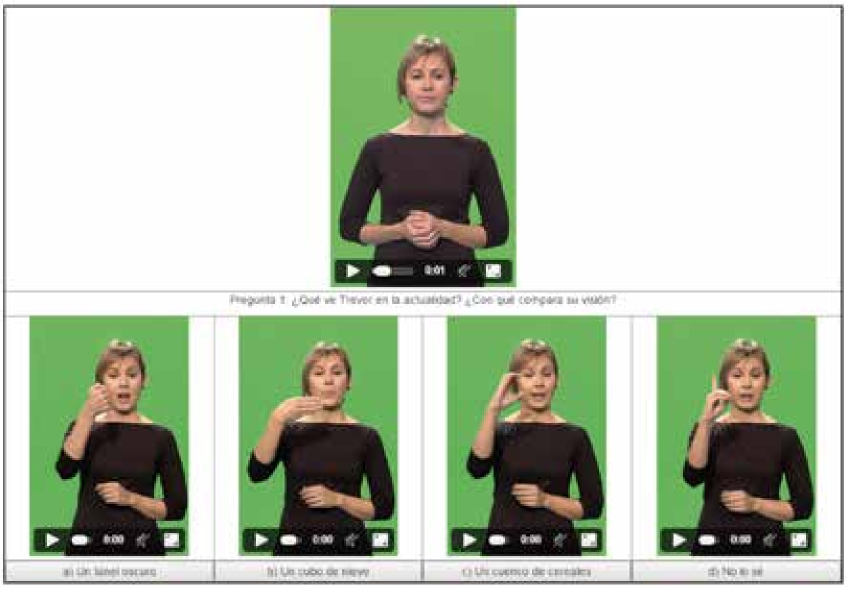
Figura 11. A la izquierda, configuración de los instrumentos en un experimento con Eye Tracker. A la derecha, la imagen muestra el desplazamiento de la mirada de un usuario sordo. Los círculos indican dónde se han producido fijaciones y su duración (tamaño del círculo)



Fuente: elaboración propia.

Para que los usuarios puedan ver y responder los cuestionarios de la manera más accesible posible, cada pregunta y las opciones de respuesta han sido interpretadas en lengua de signos y grabadas en vídeo. Los compañeros del Grupo de Aplicación de Comunicaciones Visuales de la UPM nos han ayudado a preparar la interfaz. En la Figura 12 puede verse ver un ejemplo de las preguntas del cuestionario. Esta sería una captura de pantalla en la que vemos arriba la interpretación de la pregunta, y abajo las cuatro respuestas posibles a esta pregunta. En la interfaz, la interpretación en señas se activa pasando el ratón del ordenador por encima de la imagen.

Figura 12. Captura de pantalla del cuestionario posterior al visionado. Este ejemplo corresponde a una pregunta sobre la memoria



Fuente: elaboración propia.

Este experimento va a llevarse a cabo gracias a la colaboración de la Federación de Asociaciones de Sordos de Cataluña (FESOCA) y la amable participación de usuarios desinteresados.

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Appendix 4.2 Design and development of sign language questionnaires based on video and web interfaces

Artificial Intelligence for Engineering Design, Analysis and Manufacturing

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Research Article

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Author for correspondence:
Juan Pedro López, E-mail: juanpelopez@gmail.com

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Design and development of sign language questionnaires based on video and web interfaces

Juan Pedro López[1], Marta Bosch-Baliarda[2], Carlos Alberto Martín[1], José Manuel Menéndez[1], Pilar Orero[2], Olga Soler[2] and Federico Álvarez[1]

[1]Grupo de Aplicación de Telecomunicaciones Visuales, Escuela Técnica Superior de Ingenieros de Telecomunicación, Universidad Politécnica de Madrid, 28040 Madrid, Spain and [2]Faculty of Translation, Universitat Autònoma de Barcelona, 08193 Bellaterra, Barcelona, Spain

Abstract

Conventional tests with written information used for the evaluation of sign language (SL) comprehension introduce distortions due to the translation process. This fact affects the results and conclusions drawn and, for that reason, it is necessary to design and implement the same language interpreter-independent evaluation tools. Novel web technologies facilitate the design of web interfaces that support online, multiple-choice questionnaires, while exploiting the storage of tracking data as a source of information about user interaction. This paper proposes an online, multiple-choice sign language questionnaire based on an intuitive methodology. It helps users to complete tests and automatically generates accurate, statistical results using the information and data obtained in the process. The proposed system presents SL videos and enables user interaction, fulfilling the requirements that SL interpretation is not able to cover. The questionnaire feeds a remote database with the user answers and powers the automatic creation of data for analytics. Several metrics, including time elapsed, are used to assess the usability of the SL questionnaire, defining the goals of the predictive models. These predictions are based on machine learning models, with the demographic data of the user as features for estimating the usability of the system. This questionnaire reduces costs and time in terms of interpreter dedication, as well as widening the amount of data collected while employing user native language. The validity of this tool was demonstrated in two different use cases.

Introduction

Sign languages (SLs) are natural, communication-structured systems that emerged independently of spoken languages wherever a deaf community is found (Sandler and Lillo-Martin, 2001). Even though SLs are fully fledged languages, myths and misconceptions surrounding them persist, which impact on their users (Lane and Grosjean, 2017). SLss are the primary communication systems for SL communities around the world (De Meulder *et al.*, 2018). The SL community as a linguistic minority group does not discriminate against individuals on the basis of their hearing status. SL community members are not only deaf signers but also deaf-blind, hard-of-hearing, both deaf and hearing people; such as SL interpreters, other professionals, or the hearing family members of deaf SL users.

The methodology adopted for research with deaf populations needs to take into consideration the linguistic diversity of SLs. In terms of accuracy, reliability, and validity of results, both SL research and research involving deaf signers must adequately guarantee the cultural and linguistic aspects at all stages (Allen, 2015). At the same time, it is necessary to protect ethical standards in research within the deaf populations and to promote accessibility to guarantee human rights (Ewart and Snowden, 2012; Berghs *et al.*, 2016).

Although authors generally agree that accessibility plays a central role in human rights in this framework, it is still unclear how it should be understood. Greco (2016) defined this dilemma as a Human Right Divide Problem (AHRD Problem). The AHRD problem highlights the fact that accessibility is an unequivocal human right, as well as an instrument for the fulfillment of human rights. The World Federation of the Deaf (WFD) aims to ensure equal human rights for deaf populations around the globe (World Federation of the Deaf, 2018). According to the figures, there are more than 70 million deaf people worldwide and more than 300 different, national SLSL. For that reason, the WFD defends bilingual education and SL rights, due to the diversity they bring to society. Deaf users who consider SL as their first language have the right to use it as their everyday means of communication. In contexts such as education and research, new technologies are necessary for the provision of innovative, inclusive learning environments towards social, emotional, academic, and linguistic

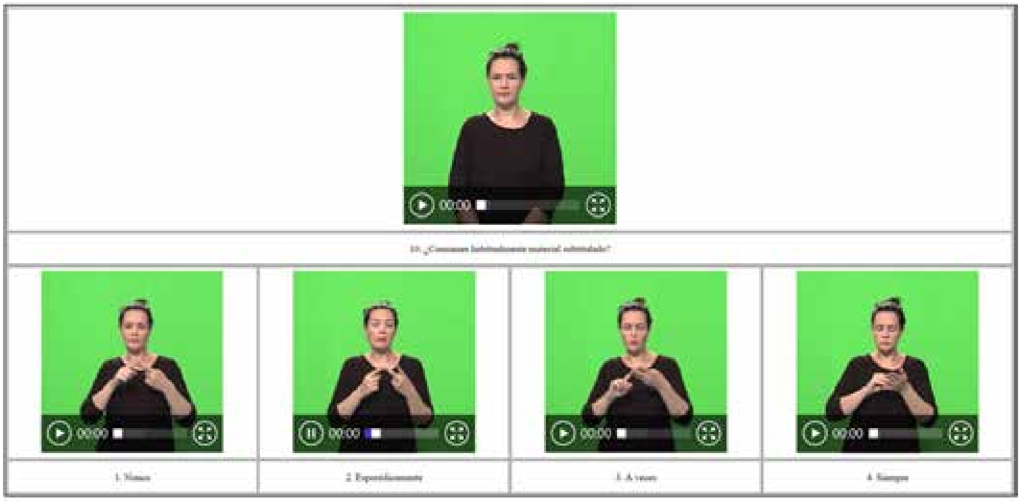

Fig. 1. Example of SL Questionnaire interface for Spanish/LSE languages.

development (Domínguez, 2017). With this aim, the present research proposes a new design and generation of interfaces for questionnaires based on SL video presentation.

The questionnaire presented here is an online tool developed as a data collection tool for research activities on SL tests with deaf SL participants. The design of cross-modal, bilingual SL/written language, grants the accessibility of content for deaf users whose preferred means of communication is SL, and controls bias by the use of an SL interpreter during the tests. This accessible design also provides better linguistic and cultural concordance between researchers and participants (McKee *et al.*, 2013) and promotes inclusive research (Guardino and Cannon, 2016). An example of the cross-modal, bilingual questionnaire appears in Figure 1, in the version implemented for the pairing of Spanish/Spanish SL.

Usability assessment is a challenging issue in various areas, such as eLearning platforms and web interfaces, especially in cases where accessibility is specifically required (Oztekin *et al.*, 2013). Machine learning based evaluation methodologies are used for assessing the usability of applications and online systems because these techniques are flexible and effective, as well as scalable when the number of users increases (Bibal and Frénay, 2016). Typical outputs for statistical measurement of usability include the number of errors and success rate or the average time to complete tasks (McGlinn *et al.*, 2017). For that reason, the inclusion of estimation models for assessing usability proposed in this paper employs demographic data, timestamps, and tracking the interaction for predicting the average time to complete a questionnaire or each individual question.

Objectives and methodology

The objective of this research is towards the creation of machine learning estimation models for assessing the usability of a system based on SL questionnaires that are created to facilitate SL understanding during activities in environments, such as education or research. These activities include a wide variety of functionalities. For example, the testing of new configurations for presenting SL interpreting on television, or the assessment of the acceptance of a new 3D SL avatar, with the advantage of avoiding the intervention of an interpreter while employing user native language and fulfilling the informational needs. The storage of tracking interaction in relation to the sociodemographic data answered by the user allows the creation of Artificial Intelligence models, used for estimating the usability of SL questionnaires. The questionnaire, which is easily available via web browsers, uses translations on SL recorded in video and displayed with HTML5 players. With this innovative tool, it is possible to generate an integrated testing environment accepted by the deaf community.

The process included the following phases:

1. *Definition of requirements.* The preliminary set of requirements of the system has been defined after interviews with SL-native users and from the experience acquired by members of the interdisciplinary research group after working with the targeted end-users. The basic requirements of the system include: (a) a need for creating systems adapted to users who consider SL as their native language, (b) a generation of interpreter-independent systems for increasing the volume of signed contents, (c) the utilization of human interpreters instead of 3D avatars or other kinds of virtual models, (d) high usability and accessibility for a variety of audiences. And, with regards to the SL questionnaire itself: (a) fluidity in the playback of the contents, (b) intelligibility of SL videos through a good perception of the face and upper-body, (c) the development of human–computer interaction (HCI) techniques for the improvement of usability.
2. *Definition of the questionnaire structure.* The structure of the questionnaire involves different types of questions for obtaining qualitative and quantitative data.
3. *First approach for the interface development.* A first version of the interface based on web technologies was developed with the inclusion of databases for the storage of answers and

information about tracking in order to obtain feedback from user interaction.
4. *Pre-test for refinement of the interface.* Based on feedback obtained after usability and accessibility tests with target users with the aim to improve the final result.
5. *Design and development of a testing plan that allows the assessment of the system.* The testing plan with the target end-users is defined for training the ML models and assessing the system.
6. *Final test performance with the targeted end-users.* A set of users completes the SL questionnaires in order to train and test the ML models, assessing the validity of the system.
7. *Definition of predictive algorithms for assessing usability.* The use of demographic and interaction data from the users as features of the machine learning model allows the estimation of the system's usability. The data obtained in the tests performed are used as input for the training for the models and as a consequence, for testing these ML models.
8. *Drawing conclusions about the successful or unsuccessful fulfillment of the initial hypotheses.*

For testing the estimation models, two experiments involving SL are designed as questionnaire prototypes, in order to simulate an environment as realistic as possible:

1. Experiment 1: Documentary "Joining the dots". Four videos with their corresponding SL translation with different configurations of size and position are presented to the user for an analysis of the level of comprehension in each of these configurations.
2. Experiment 2: Avatar (virtual model). A weather forecast program with a corresponding SL video developed by a 3D-model avatar is presented to the user to assess the quality and comprehension related to the expressiveness of the animation.

Related work

The evolution of methodologies used for empirical research requires valid and replicable tests (Orero *et al.*, 2018). For that reason, in empirical research related to audiovisual content, it is mandatory to apply direct translation, especially in multilingual environments where the language is the target and factor to be considered in this research. A typical human interaction with a computer is conducted in the native language, and the same should happen during the interaction from the point of view of the deaf community (Smith *et al.*, 2010). Nowadays, the creation of deaf-friendly interfaces and applications that allow access to information for all is a challenge for the Information and Communication Technologies (ICT) society. There is a need to improve the designs for the translation and adaptation of content, avoiding stereotypes, and the lack of involvement of people with disabilities in the requirements definition phase in most designs (Lazar *et al.*, 2017). The design of interfaces applied to ICT systems must encompass human factors, computer science, and cognitive sciences for improving the interaction with content and information (Helms *et al.*, 2006).

The iterative refinement during the design of these communication systems requires a process of feedback from the target users (native signers and interpreters) to help developers improve the accuracy and efficiency of the system. Unlike other developments, the proposed system relied on collaboration with real end-users so as to obtain the best refinement based on real feedback. This, in turn, helped to improve its application and adaptation to their basic needs.

Videos with human signers are generally the preferred media to present SLs (Tran *et al.*, 2014). It allows for the application of different techniques in order to increase the ontologies and variety of sentences in the systems. Intelligibility associated with this type of technique is important in order to transmit SL content, including video encoding analysis and quality assessment, especially in environments with limited bandwidth such as mobile streaming (Cavender *et al.*, 2006; Tran *et al.*, 2011). Intelligibility of SL videos must be assessed in different environments, including television, mobile phones, or tablets, to ensure encoding quality processes and resolutions for end-users (Ciaramello and Hemami, 2011). As the proposed system is based on SL videos, the intelligibility of these videos should be carefully analyzed, according to state-of-the-art developments in this field and to previous research (Tran *et al.*, 2015). Issues such as size, resolution, and encoding quality of the videos should be considered, allowing for different configurations adapted to user preferences with optional, full-screen playback and not excessive compression, as it reduces loading time but at the expense of viewing quality.

Some researchers (Haug and Mann, 2007; Haug, 2011, 2015) have analyzed the adaptation of tests for SL environments based on a mixture of concepts that include linguistic, cultural, and psychometric factors. The design of solutions corresponding to teaching and research environments is important in order to equate the SL with the written language through full bilingual systems. This improves learner motivation in terms of vocabulary and conversational matters. The aim of bilingualism in accessible tools oriented to experimental designs and surveys is to minimize the error in comprehension and, consequently, the nonresponse bias, that is, the rate of "DK/NA" ("I Do not Know, No Answer") answers. The design of interfaces with social objectives should never overlook leisure and amusement factors (Shneiderman, 2004) and the advantages of Connected TV and interactive platforms could contribute to this goal (Vinayagamoorthy *et al.*, 2012). Proposals for these types of tools are scarce and adapted to the target environment. Our proposal allows adaptation to different environments and is based on generic software tools resulting in a powerful system, adaptable for different purposes and configurations; similarly, a web interface makes it easier to access the network without requiring new technological demands on the user.

Machine learning provides the basis of data mining, extracting information from data, and organizing it in structural descriptions, which are used for prediction, explanation, or understanding of existing problems. The result of this process of learning is a description of a structure that is valid for classifying new examples (Witten *et al.*, 2016).

The machine-learning methodologies are employed for different purposes based on the creation of models for solving existing problems in a variety of environments. The development of these models focuses on establishing quantitative structure–activity relationships (Liu et al., 2017).

Assessing the usability of interfaces in the fields of web design and interaction requires the inclusion of features related to end-users and the context of application. The perception of usability can be treated as a classification problem that employs supervised machine learning methodologies (Longo, 2017). Supervised ML classification techniques are used in usability environments and other research fields in order to produce computational, data-driven models for prediction of output features, such as mental workload measurement (Moustafa *et al.*, 2017) or human cognitive performance in problem solving (Yoshida *et al.*, 2014).

For the correct characterization of participants and definition of models for the estimation of usability, it is necessary to include demographic questions regarding the age at which they became deaf and their knowledge of signed or written languages. These data are used for classification purposes in the process of training the model. This research counted on the collaboration of end-users from prestigious associations for deaf people, testing HCI issues, and using their feedback as input for the system improvement process, as well as the input data for the trained ML models.

Implementation of SL questionnaires

This section describes concepts about the implementation of the SL questionnaire, from the structural design of the questions in Section "questionnaire design", to the technical proposals put forth in sections "HCI and intelligibility of SL videos", for improving HCI and intelligibility of the videos, topics which are necessary to introduce before understanding the ML models for estimation of usability corresponding to Section "definition of models for estimating elapsed time based on demographic data".

Questionnaire design

Different methodologies were analyzed towards creating surveys involving both people with disabilities and multilingual environments. Extensive, state-of-the-art research defines the techniques for obtaining qualitative and quantitative information, considering factors such as question type, the type of collected data, and the target population (Ferber *et al.*, 1980). Fontaine (2012) proposed the use of mixed-mode methodologies with different types of questions for assessing multiple factors in quantitative research surveys. Finally, as the research employs the use of web technologies, it is necessary to follow methodologies applied to HCI in the SL questionnaire (Lazar *et al.*, 2017).

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With these premises, the content of the questionnaire is designed in four sections:

- Section Introduction: Welcome Video**.** This section introduces the questionnaire to the user through a video that contains instructions to be followed during the process, while presenting relevant information about the research for obtaining informed consent. This section is mandatory for motivating and engaging users in the completion of the questionnaire, as well as for ethical requirements.
- Section Objectives and methodology: Demographic Questionnaire. The demographic questions have two aims: (a) obtaining statistical information about the user and (b) collecting data from the user, which are needed for the classification in the creation of ML models, in order to understand the influence of user environment and features in the usability of the system. These questions seek to obtain information about:
  o gender
  o age
  o technological experience
  o level of studies
  o age at which the person became deaf
  o level of understanding of each specific SL or written language, accessibility tools experience, especially those associated with multimedia content (device used for the completion of the SL questionnaire)
- Section Related work: Targeted Video and Memory Questionnaire. The memory questionnaire is designed to evaluate the recalled information after watching complex, on-screen, visual stimuli. This includes the information offered by the SL video and the content images on the main screen. A recommended set of 5–20 different memory questions (10 in our experiments) is associated with each targeted video. Each question is intended to recall the sign-interpreted content in the interpreter window. This is focused on the visual recall of non-verbal information from the main video clip.
- Section Implementation of SL Questionnaires: User-experience Questionnaire. After the memory test, a set of user-experience questions is presented in order to obtain the feedback on the usability and readability of each screen configuration. Feedback is also obtained from user interaction, the difficulties found during the completion of the questionnaire, and their personal opinion about the test and its development.

Technical design and implementation

Having introduced the aspects of SL surveys and the HCI goals, the design and development process of the SL questionnaire and its functioning will be presented.

The interface is based on HTML5 technology, while the interaction and programming of the interfaces are based on JavaScript language capacities. HTML5 (HyperText Markup Language, version 5) (World Wide Web Consortium, 2017) contains libraries and is fully equipped to show different types of videos in an organized way, adjusting the sizes and order of the videos in the interface. JavaScript language (MDN Web Docs, 2019) presents different tools for the automatic playback of videos, including playing, pausing, or forwarding of the content, and other advanced functions, such as displaying contents in full-screen by using the basic commands of the platform.

The questionnaire is based on a JSON (JavaScript Object Notation) (Internet Engineering Task Force, 2014) file that contains all the specific content related to the video and to the written information of the questionnaire. This content is organized into a set of questions. The questionnaire is defined by general attributes, including the author and title of the questionnaire, the language used, and the objective. These attributes contribute to the multilingual character of the experiment in one file, which is useful for international research where countries with different, official written and SLs are concerned. The instrument components are designed to be self-administered.

The function of each questionnaire is summarized in Figure 2. Firstly, a random identifier ("id") is assigned in order to guarantee the anonymity and confidentiality of the user. The "id" is associated with the initial temporal instant (timestamp), with the aim of tracking the time taken to complete the questionnaire. If the questionnaire presents different models, such as a multilingual character or multiple choice, as in "Experiment 1", where four different configurations are available, the selection is automatically randomized and assigned at the beginning of the session.

According to Tran *et al.* (2015), the success of an online survey depends on its accessibility and usability. For this reason, it was mandatory to cover different factors related to the target audience, composed of deaf signers, and to the linguistic structure of the SL

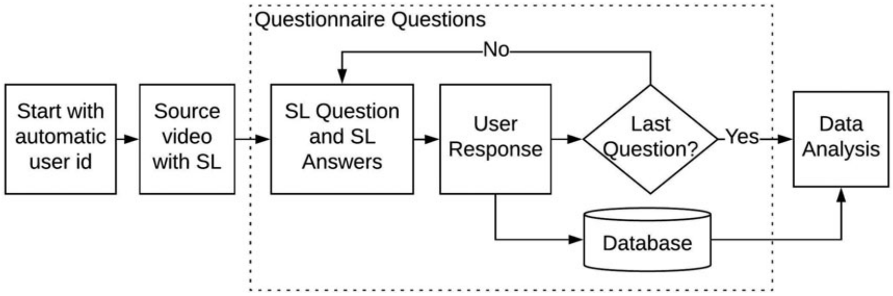

Fig. 2. Questionnaire functioning scheme.

grammar and lexicon, as it is different from the structure of written language. The interface had to meet the requirements of usability and intuitiveness. Thus, the basic question interface was designed to present the bilingual content in both SL and its corresponding written language. The generation of bilingual survey instruments increases the target audience, including both native and non-native signers, regardless of their literacy and SL skills. For example, some users might prefer the written text, as is the case with hard-of-hearing and late-deafened individuals. The font of the text should fulfill the requirements of W3C Guidelines (Cooper *et al.*, 2016, section G17), presenting enough contrast, in this case, black over white, in a readable size and with a "sans serif" font (Arial or Helvetica, for example). The computerized video questionnaire requires a specific layout and technical design. An example of the implemented bilingual question formats is included in Figure 3.

Additionally, the W3C Guidelines (Cooper *et al.*, 2016, section G54) recommend including "a mechanism to play the video stream full-screen in the accessibility-supported content technology". Consequently, an interactive, easy-to-use menu was included in the videos. This allowed each video in full-screen to be played and repeated or paused if necessary.

Another remarkable aspect of the interface design is the ability to work online, as the questionnaire is based on HTML5 and JavaScript libraries and available on conventional browsers. When online research is carried out, it becomes easier to increase the participation in the recruiting process and to reach users that would have been difficult to contact through face-to-face interviews, especially in the case of people with disabilities (Petrie *et al.*, 2006). The online questionnaires' anonymity and privacy is an advantage, which avoids the influence of the interviewer during the process (Lazar *et al.*, 2017).

Human–computer interaction

The techniques for creating an easy and intuitive method of interaction will now be presented. The first question that needed solving was the input of the interaction with the questionnaire. As the questionnaires were designed to be answered via computers or laptops, it was considered that users would interact through a conventional, manual mouse. A methodology was thus designed for saving time in the process of interacting with the visual interface: when the mouse pointer hovers over the framework of a video, the video is played; when the mouse pointer moves away from the video framework, the video playback pauses.

Questions are answered by clicking on either the video or the text box of the selected answer. Once the choice has been made, the interface displays a blue box surrounding the framework, as in Figure 4. The user can change the answer by clicking on a different option and also by clicking once more on the previously selected response item in order to deselect it.

The methodology for playing video and clicking on the answer was tested in pre-tests. Testers, during the pre-test period, showed confidence in the use of this technique, which was considered acceptable to the users. Initially, the interface included an automatic video-playback loop, but some users complained about this, so it was discarded. It is important to mention that, as the system is a multi-screen web interface, the computerized questionnaire is available on conventional browsers on all different types of devices, including computers, laptops, televisions, mobile phones, and smartphones. Testing was conducted in controlled environments on computers with 17-inch screens.

Intelligibility of SL videos

Video SL Intelligibility is necessary for a correct visualization. For that reason, the SL videos were professionally filmed at a Spanish Broadcasting studio. Attention was paid to lighting and contrast with the background of the picture. A green panel for chroma-key was used to add transparency to the background or a change in the color if needed. Green offers enough contrast with the black outfit of the signer in order to make the face and hands distinguishable from the background.

According to the W3C Guidelines for SL video creation (Cooper *et al.*, 2016, section G54), "If the video is too small, the SL interpreter will be indiscernible". For that reason, unnecessary space in the image was reduced and human content was highlighted. Determining the signing space was carried out with care, that is, how much of the signer was visible in the video frame was carefully assessed. Following this section G54 of the W3C guidelines, it was decided that only the area extending from the top of the head to the hips would be filmed, rather than the full body of the signer (Pyfers *et al.*, n.d.).

Videos were originally recorded with the aspect ratio 16:9 at resolution 1920×1080 at 25 frames per second (fps) and at an interlaced rate. This is one of the most common formats of high definition video. In the post-production phase, a decision was taken to crop the lateral air of the source images in order to reduce the number of display pixels. In the first approach, the content was adapted by cropping the image to an aspect ratio of 2:3 and by not introducing any kind of distortion or deformation of the content, only cropping. The first iterative

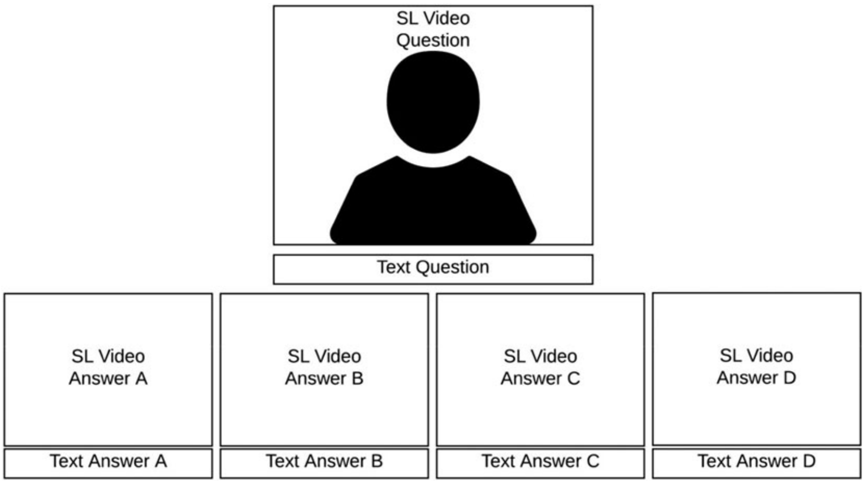

Fig. 3. Example of interface for SL question with four answers adapted to 16:9 screen.

Fig. 4. Example of interaction when answering a question in the SL Questionnaire.

testing with users suggested that the lateral air was not acceptable because the arms of the signer were not visible the whole time. For that reason, the image was cropped to obtain square frames, that is, aspect ratio 1:1. This was well received by the end-users when queried during the testing process. The changes in the presentation of SL videos are summarized in Figure 5.

Due to limitations of bandwidth and device display features, encoding was also an issue. Compression and distortion factors should be taken into account when assessing video quality so as to prevent the appearance of artifacts due to motion and high frequencies in the face and arms of the interpreter. It is also necessary to reduce the size and use compression for reducing the video encoding bitrate. This will allow for a faster video loading time, even when the user suffers poor network conditions. Videos were encoded in H.264 standard at a minimum encoding bitrate of 1 Mbps, and the resolution was reduced to 320×320 pixels, in accordance with the minimum requirements demanded in similar studies (Tran *et al.*, 2015). Testing with users revealed that the quality in these conditions was enough for intelligibility requirements.

Question design and technical formats

Different types of questions and responses are used in the survey. The type of questions can be classified in different categories depending on the content (demographics, memory, and user experience) and the question format. Question formats vary according to the number of answers (in enumerated or fixed choice response options), the number of eligible answers (single-choice or multiple-choice), and the type of answer (close-ended, a number, a percentage, versus open-ended, such as a short sentence, phrase, or free text).

Different technical format designs are implemented for survey questions depending on the type of answer and responses items offered to the users. The interface must be adapted to a high-definition resolution of 16:9 aspect ratio, as a basic requirement

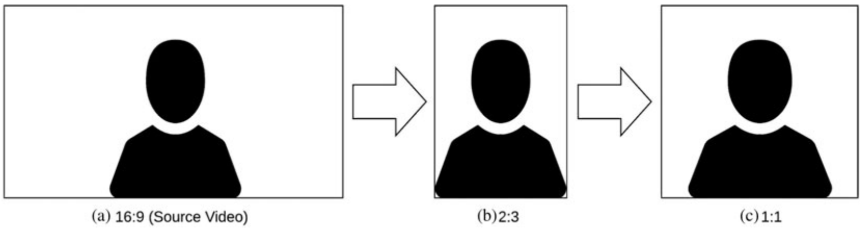

Fig. 5. Aspect ratio changes for the creation of content: (a) Source video filmed in 16:9, (b) first approach cropping to 2:3, (c) second approach cropping to 1:1.

used in laptops and commercial televisions. Following this premise, the layout is divided into two horizontal rows. The top row includes the SL video for the question and its corresponding written translation. The bottom row contains the answers, including both text and video response items. In all surveys, the question is displayed more prominently than the response options.

The layout is simple, avoiding any extra information that could distract, introduce bias, or further increase reading time. Only the button for "next question" is included at the bottom of the screen. The user has to click it to submit an answer. Clicking this button before selecting a response will prompt an error so as to prevent missed questions. This basic layout may be further adjusted and formatted for specific question and response types. Most question formats displayed several video clips for both the question and the response. However, questions with a number scale response, open-ended text response, and multi-part questions (e.g., day/month/year) only display one signed video clip.

Definition of models for estimating elapsed time based on demographic data

The main motivation for the use of machine learning models is based on finding a robust prediction for the usability of the interface through the generation of patterns associated with the different features of the end-users, such as age, level of studies, or knowledge of a language, based on the patterns found in the process of completion of the SL questionnaire. The completion of the questionnaire is parameterized by calculating a weighted average for the prediction, based on the estimations provided by the different models.

Assessment of the user's interaction gives essential information regarding the analysis and prediction of a usability evaluation paradigm based on the concept that the more data stored, the higher the accuracy of the results.

The analysis obtained by the application of SL questionnaires is not only related to the answers of the questions themselves. Data mining techniques enable the acquisition of information from data generated by the users during the process of interaction, which is relevant for understanding the problems and issues that may be presented to the user. The analysis of the time it takes to complete the survey and each individual question can reveal important information about the difficulties found, the level of user attention in the answering process, as well as the usability during the process.

A database based on SQL (structured query language) technologies is used for storing the data. Simple queries developed by the analyzer of the survey can be used to access the information extracted from each questionnaire, for comparison, other user responses with similar or differing profiles which can then determine trends in the use of technology and usability of the system.

The generation of time estimation models is based on the exhaustive analysis of test results. The dataset containing more than 60 users with demographic values, such as age, level of studies, knowledge of SL and written languages, or the consumption of accessibility contents, was used to find patterns in the analysis of time spent in the process of completion of the SL questionnaire. The analysis of time is important because it reveals the usability and intuitiveness of the interface.

By removing the data of outliers and variance timings, a cleaning process was developed from the original database. Sixty samples were available for analysis with 18 non-categorical features corresponding to each of the answers in the demographic questionnaire. These features are used for selecting the most relevant responses in order to reduce the complexity of the machine learning models. In order to highlight the most relevant features, a univariate feature selection is performed on the data by finding patterns from the demographic set. Through this process of cross-validation (Kohavi , 1995), the selection of the most useful parameters was based on reducing error and finding linearity before applying mathematical models to the process. As demonstrated in Figure 6, the most relevant parameters in the analysis of the time of completion of the SL questionnaire are associated with age and level of studies.

The use of a non-linear regression model based on one or two of these features was initially contemplated, but the technique was discarded due to a need for a more robust estimation, relative to the increased information in demographics. A coefficient associated with each feature selected from the list of demographic answers after the cleaning process was found by following the Lasso regression modeling developed by Eq. (1).

$$\hat{Y} = \beta_1 \sum_{i=1}^{N} \beta_i x_i + \lambda \sum_{j=1}^{M} |\beta_j| \qquad (1)$$

λ represents the parameter of a penalty and β_1. …., β_i, β_j indicate the set of coefficients associated with each demographic answer of the model after the training development procedure.

A second approach to increase the complexity of the estimation of the usability model consisted of a XGBoosting (Xtreme Gradient Boosting) procedure; gradient Boosting benefits from the addition of regression models in order to fit simple, parameterized functions following a sequential tree structure. Iterations aim to reduce the residual error following Eq. (2) as defined in

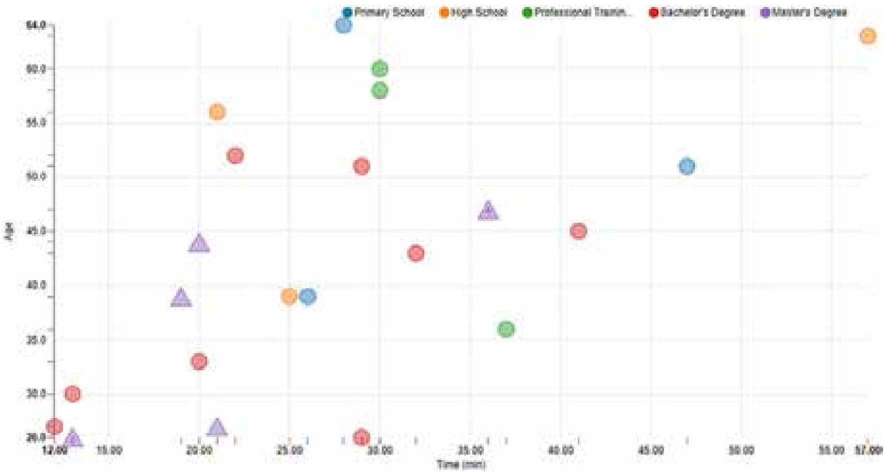

Fig. 6. Questionnaire completion time in minutes related to age and level of studies.

(Friedman, 2002).

$$F^{*}(x) = \arg\min_{F(x)} E_{y,\,X}\,\Gamma(y,\ F(X)) \quad (2)$$

$\{y_i\ ,\ X_i\}_1^N$ represents a set of training samples, made up of varied features corresponding to the demographic answers identified as $X = \{x_1,\ \ldots,\ x_k\}$, k being the number of questions. On the other hand, $F^*(X)$ is the goal function obtained by mapping each pair $(y,\ X)$ with the gradient boosting algorithms, to find the combination where the loss function $\Gamma(y,\ F(X))$ is minimized.

Finally, an approach based on artificial neural networks was developed. The neurons are processing units that interconnect through different coefficients or weights and organize the set of parameters into different layers. Layers combine the inputs corresponding to the answers of the 18 demographic questions in order to obtain timings associated with usability during the selection process.

The models generated for estimation of usability employ a set of input features based on demographic data collected during the completion of the questionnaire. On the other side, the estimated outputs correspond to times for completion of the questionnaire and times for completing each individual question, distinguishing demographic questions from the rest, due to the immediacy aspect in the response of this type of question. The summary of the characteristics of the models is included in Table 1.

Table 1. Summary of usability estimation models

Description	Value
Input features	Age, gender, level of studies, device, age at which the person became deaf, accessibility tools consumption.
Estimated outputs	Time to completion, time to complete a demographic question, time to complete a memory or user-experience question
Model methodology	Non-linear regression, XGBooster, ANN
Number of users	60

Table 2. Description of experiments developed with SL Questionnaires

Value	Experiment 1	Experiment 2
Source video	Documentary “Join the dots”	Weather forecast
SL configuration	4 different configurations	SL Avatar
Number of users	32	28
Ages	17–74 years old	18–65 years old
Size of display screen	20″	17″
Aspect ratio of display screen	16:9	16:9

Empirical results and discussion

The effectiveness of SL questionnaires depends on the way in which users are able to interact with the interface and, consequently, on the time spent completing each individual question. The feedback obtained in pre-tests with targeted users helped in the design of two experiments used to evaluate this effectiveness, which is strongly linked to usability. These two experiments aim to collect information about user satisfaction with the interface by tracking their interaction. Additionally, the design is able to test their capacity for observation and retention of content when visualizing the main source video with a simultaneous, corresponding SL translation, as well as assessing the loss of information as a result of this process. The accuracy of the answers to the “Memory Questionnaire” (as described in Section “questionnaire design”) is not the subject of study in this investigation, but the inclusion of this type of question is needed to fulfill the initial requirements and to help assess the usability of the SL interface. A summary of the basic description of the experiments is included in Table 2, along with the demographic data about the

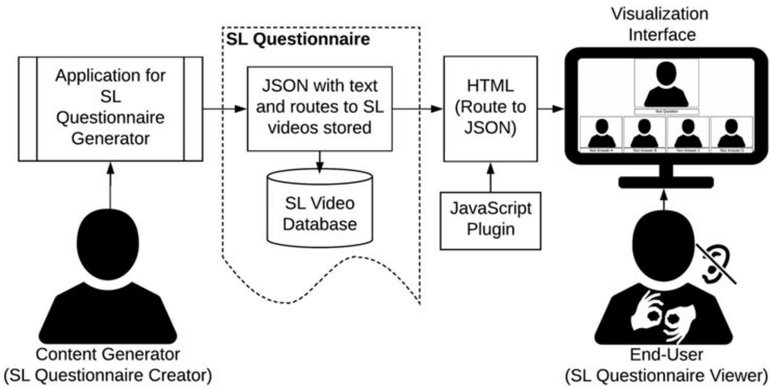

Fig. 7. Images from the videos in the experiments: joining the dots (left), weather forecast (right).

users involved in the process and additional information about their environment.

Experiment 1 consisted of presenting fragments of the documentary *Joining the dots* in parallel with the video corresponding to the SL translation in four different configurations of positioning and size. Figure 7 (left) shows an example of this first experiment. The SL questionnaire for this experiment consisted of 18 demographic questions including gender, age, level of studies, knowledge of textual and SL languages, consumption of accessibility tools or age of becoming deaf, among others; 10 retention/observation questions including both verbal and visual memory questions; and, finally, 12 experience related questions. A sample of 32 deaf users from the metropolitan area of Barcelona participated in this study, ranging in age from 17 to 76, all of whom have knowledge of and frequently use LSC (Catalan Sign Language) to communicate.

On the other hand, Experiment 2 presented fragments of a weather forecast simultaneously with a video that included the SL translation developed by a virtual avatar. An example is shown in Figure 7 (right). The questionnaire for this experiment included queries of the following sort: 18 demographic questions similar to the ones used in the questionnaire in Experiment 1; 10 retention and observation questions, including both verbal and visual memory questions; and 13 experience related questions designed to obtain information about the quality of the SL avatar. A sample of 28 deaf users from the metropolitan area of Madrid participated in this study with an age range of 26–54. All of them had knowledge of LSE.

Results obtained through tracking data and interaction

This section collects the results extracted after carrying out the experiments on a sample of users from two different locations. The demographic information associated with the sample of users is shown in Figure 8 revealing the characteristics of the sample. According to the demographic questionnaire, a majority of female users participated in the experiments for the SL questionnaires [Fig. 8 (right)]. The users were divided into three different groups according to age range [Fig. 8 (left)]: the youngest population was considered under 36 years old, while the advanced age users were considered from 50 and upwards. The distribution of users into these three groups assures the variety of populations necessary for this type of study. The selected ages allow for the differentiation of three user groups with different technological skills, which are representative enough for the analysis. In accordance with the times taken to answer the questions, it can be inferred that the younger population is more experienced with technology use. For this reason, the range of ages is a mandatory feature because it is related to experience in the use of technologies.

Another parameter to highlight in the assessment is the level of studies (Fig. 9), which is a mandatory feature for classifying the users. Based on an initial hypothesis, the formative level is decisive when estimating the usability and facility for interaction with the interface. Adaptations in the SL questionnaires are recommendable for people with different levels of studies or in a higher age range in order to improve the statistical results of future approaches. 367

Data mining and the analysis of information regarding user interaction is one of the most powerful aspects of the architecture of SL questionnaires, because it presents the researcher with extra information that could not be processed by hand. Storage of timing associated with each interaction produced by SL questionnaire completion when clicking a button or playing a video is necessary in order to draw conclusions, which would be difficult to obtain without this tracking information. It is important to emphasize that to draw reliable conclusions regarding this experiment, development of the tests in controlled environments is recommended. This fact requires verification if the user is observing the SL videos or just reading the text associated with each SL video. In other test environments, such as sending the questionnaire online to users belonging to the deaf community, it is recommended to observe the user-experience answers to ensure that the questionnaire has been adequately filled in.

The general time of completion in the SL questionnaire is part of the preliminary data, highlighting relevant information that is interesting to analyze when doing the final research (Fig. 10). As empirical data, the average end-user needs between 20 and 30 min to complete the survey in a controlled environment. However, users with less technological experience tend to present more difficulties in the completion of the survey and spend between 30 and 40 min on this task. Furthermore, there are users that need less than 20 min to complete the full SL questionnaire, because they consider it more efficient not to watch all the videos and thus save time, making a second visualization unnecessary.

Fig. 8. Demographic data of users participating in the experiments with SL Questionnaires: age ranges and gender.

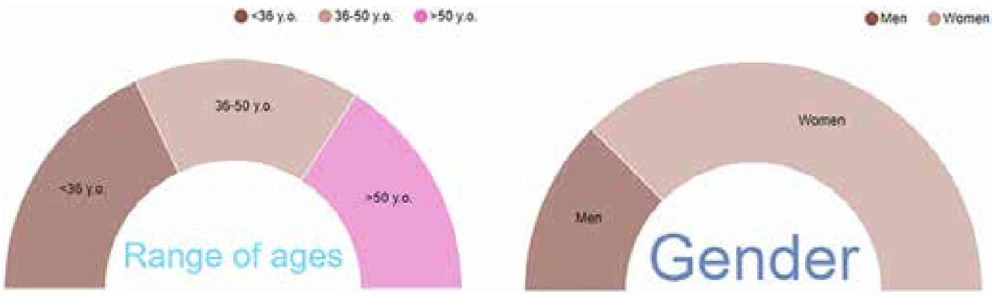

Fig. 9. Demographic data of users participating in the experiments with SL Questionnaires: level of studies.

Fig. 10. Distribution of time to completion of the SL Questionnaire about the avatar.

Finally, a small group of users spent more than 40 min on this task, representatively more than the average time. This occurred due to external factors affecting the users, which should be factored in order to have them potentially considered as outliers.

These data can also be interpreted in a context where the age range or level of studies is considered in order to corroborate the initial hypothesis that these two factors affect the usability of the interface. The average time for completing the SL questionnaire and the average individual times for answering the demographic, observation/retention, and experience questions revealed an increase in the time for solving this task, which corresponded with age (Table 3) and level of studies (Table 4). Younger users and those with higher formative levels needed less time to answer the SL questionnaire and each individual question, as demonstrated with empirical data. Finally, it is necessary to mention that no users with a Doctorate Degree completed the survey, for that reason there is no data for this case study. Reflecting on the absence of this type of population, it is hoped that this is not due to the difficulty of integration in this field.

Table 3. Average time to completion for the Avatar SL Questionnaire per age range

Range of ages (y.o.)	Avg. time in Questionnaire (min)	Avg. time in demographic question (min)	Avg. time in observation or experience question (min)
18–34	17.5	0.18	0.46
35–49	29.3	0.35	0.86
50–75	39.7	0.49	1.21

Table 4. Average time to completion for the Avatar SL Questionnaire per level of studies

Level of studies	Avg. time in Questionnaire (min)	Avg. time in demographic question (min)	Avg. time in observation or experience question (min)
Primary school	33.4	0.32	0.76
High school	22	0.25	0.61
Professional training	29	0.34	0.85
Bachelor's degree	24.6	0.28	0.70
Master's degree	21.8	0.24	0.61
Doctorate degree	–	–	–

The accuracy of the three ML models generated for the purpose of estimating usability is over 80%, when using 80% of the SL questionnaires for training and the remaining 20% for testing the algorithms, while considering the three fundamental demographic parameters (age, gender, and level of studies) as input features for the models. This fact indicates the trends in behavior of these features in the system. For assessing the usability of the interface, the three output features correspond with the time spent in the completion of the SL questionnaire, the time spent in answering each demographic question, and the time spent in answering any other type of question. In the case of a new user completing the SL questionnaire, the system estimates the time of completion and the time of answering each question in accordance with their demographic features with an accuracy of 80%.

Conclusions

SL Questionnaires received a good reception among the deaf and hard-of-hearing audiences that communicate in SL languages and that consider this way of communication in their native language. Most users during the testing phase highlighted the necessity of this type of tool as a symbol of integration and diversity in the access to information.

The techniques employed in HCI demonstrated the improvement in usability and intuitiveness that the presented interface offers. The organization of contents and interaction with the video for playing, pausing, or clicking the correct answer was well received during the iterative testing phase, and in the subsequent experiments based on the feedback transmitted by participants. The online character of the interface and the structure of the SL questionnaires facilitate multilingualism and the expansion of this survey in order to reach a higher number of users, although the first tests were developed in controlled environments with supervised attention.

The demographic information classifies users with a set of features helping to draw conclusions about usability, which is very important in the definition of ML models. In that sense, the data stored in the database on interaction and timing of the process is very helpful for understanding the process of HCI in this environment, allowing for estimations to be made about the quality and usability for the user in accordance with the SL questionnaires.

The generation of estimation models based on patterns found in the process of computing data according to the demographic data, such as level of studies or age, is an important issue derived from the use of this type of tool. The time spent on answering a demographic or memory question can be assessed in relation to the regression function, using different machine learning techniques, including Lasso Regression that includes a model based on the weight of different demographic parameters; XGBoosting (Xtreme Gradient Boosting) following a sequential tree structure to compute these parameters or Artificial Neural Networks.

As demonstrated by the empirical results (Fig. 6 and Tables 3 and 4), the age and level of studies of the end-user influence the time of completion of the questionnaire, because the formation and familiarization with technologies are paramount in regards to the usability of the interface. Nevertheless, users with little education and of an advanced age were capable of interacting with the application, indicating good interface usability.

For future work, the use of this tool is anticipated for the generation of SL questionnaires, to create new surveys about the consumption and use of innovative accessibility tools associated with multimedia contents. The online character of this survey will allow the distribution across different countries in Europe and will include a presentation in four different languages simultaneously.

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Juan Pedro López has been a Telecommunication Engineer since 2007, he received the International Doctor's Degree at Universidad Politécnica de Madrid in 2016 with his thesis focused on quality assessment for 2D and 3D stereoscopic video. His professional interests include video encoding, compression formats, high- and ultra-high-definition television, signal processing, and innovation that relates to technology with environments, such

as accessibility, education, healthcare, and art. Since 2008, he has complemented teaching with working in national and international research projects focussed on video encoding, quality of experience, broadcasting, accessibility, and HbbTV technologies. He received the Bachelor of History of Art from UNED University in 2017.

Marta Bosch-Baliarda is a sign language linguist and interpreter who has worked as a trainer for sign language interpreters, sign language teachers, and communication support workers. She has been involved in the Catalan deaf community since 1998 and specialized in Deaf studies at the University of Barcelona. She is currently a research assistant for TransMedia Catalonia, a research group working on audiovisual translation and media accessibility at Universitat Autònoma de Barcelona. She is studying for a PhD on sign language accessibility and SL interpretation on TV and works with deaf-blind people within the vocational training program for communication support workers.

Carlos Alberto Martín obtained the telecommunication engineering MS (ABET accredited) in 2004 by UPM and the Master of Advanced Studies in the PhD programme of signals, systems, and radio communications at the same University in 2007. In 2014, he graduated in social and cultural anthropology at UCM. Currently, he is expanding his PhD thesis on media accessibility for people with disabilities. During his career, he has been involved in more than 50 research and development projects, including European, national and private contracts, formerly in the Visual Telecommunication Application Group (GATV) of UPM and currently in Atos Research Innovation.

José Manuel Menéndez is a professor at the Signal, Systems and Radio communications department at E.T.S. Ingenieros de Telecomunicación of the Universidad Politécnica de Madrid. Director of the Visual Telecommunication Application Research Group – GATV since 2004, and director of the chair of the Spanish public broadcaster RTVE at UPM since 2015. He has extensive experience in participation and coordination of research projects (more than 150), both at Spanish and European level, in topics dealing with Communications, Digital TV, and Computer Vision. He has more than 200 international scientific publications and has attended more than 70 conferences as invited speaker.

Pilar Orero, PhD, teaches at the Universitat Autònoma de Barcelona (Spain). Member of the TransMedia Catalonia research group. Recent publications include two co-edited books on audio description (with Maszerowska and Matamala, 2014, Benjamins; with Matamala, 2016, Palgrave Macmillan). Pilar Orero participates in ITU IRG-AVA and is a member of ISO/IEC JTC1/SC35 and Spanish UNE working group on accessibility. Leader of EU projects HBB4ALL, ACT, UMAQ, and partner in EasyTV and ImAC (2017–2021). She is an active external evaluator for many worldwide, national agencies (South Africa, Australia, Lithuania, Belgium, US, UK, etc.). Co-founder of MAP (Media Accessibility Platform).

Olga Soler is an Associate Professor at Universitat Autònoma de Barcelona, where she teaches psycholinguistics and cognitive processing to undergraduates in Psychology and Speech Therapy. With a background in language processing, her research has focused on online measures of handwriting in preschool and school children, and she is connected to international networks working in literacy (COST IS1401). Within the Transmedia projects, she is currently setting up experiments on different accessibility services: quality of perception of Sign Language on TV and emotional involvement of users of Audiodescription and AudioSubtitling.

Federico Álvarez is a Telecom Engineer (2003) and PhD (2009), both by the Universidad Politécnica de Madrid. He is working as Assistant Professor lecturing in UPM and he develops his research within the GATV. He is currently the coordinator of EasyTV and FI-GLOBAL and technical coordinator of ICT4LIFE in H2020. In the last 10 years, he has also been leading the UPM participation in several EU-funded projects, such as the SEA, SIMPLE, AWISSENET, RESCUER, FI-PPP project XIFI, etc. and coordinated the projects nextMEDIA, INFINITY, and FI-LINKS. He is the author and co-author of (70+) papers in journals, congresses, and books.