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From disabilities to capabilities: testing subtitles in immersive environments with end users

De discapacidades a capacidades: testando subtítulos en medios inmersivos con usuarios

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Abstract: User testing in Media Accessibility has often profiled users based on their disabilities. Subtitles for the deaf and hard of hearing, for instance, have been generally tested with their expected target audience, which is deaf and hard-of-hearing users. This article argues that selecting users based on sensory disabilities may not be the best strategy to obtain relevant results, as other capabilities—for instance, technological capabilities—may have a greater impact on the results. Moreover, the article argues that access services should not be exclusively for persons with disabilities but also for other audiences. If accessibility is mainstreamed, and ideally integrated in the creation and production processes, testing should expand beyond an exclusive approach based on accessibility to a more general approach based on usability where users with diverse capabilities are considered.

To illustrate this point and propose a new approach to user testing in Media Accessibility, moving from a disability to a capability model, specific examples from the European Union funded project ImAc (Immersive Accessibility) are shown in a chronological order. Then, the article presents the initial testing, targeting persons with disabilities, and describes the poor data results leading to a new approach. A new testing focus is proposed, and the methodological shift is justified. After that, the second test in which the new approach is implemented is described, using the same stimuli but users with different levels of knowledge regarding new technologies. The article finishes with conclusions and final remarks in which the door is opened to move from an accessibility approach to testing to a usability approach.

Keywords: subtitles, subtitling for the deaf and hard of hearing, immersive content, Media Accessibility, user profiling.

Resumen: En las pruebas con usuarios en los estudios de accesibilidad en los medios, generalmente se define el perfil de los usuarios en relación con su discapacidad: los subtítulos para sordos, por ejemplo, se suelen probar con usuarios sordos o con problemas de audición. En este artículo, se defiende que seleccionar a los usuarios según sus discapacidades sensoriales puede no resultar la mejor estrategia para obtener resultados relevantes, ya que otras capacidades (capacidades tecnológicas) pueden suponer un impacto mayor. Además, se argumenta que los servicios de accesibilidad no deberían estar destinados exclusivamente a las personas con discapacidades, sino que el público general también puede beneficiarse. Si los servicios de accesibilidad están cada vez más presentes en la vida de los usuarios e, idealmente, se integran en el proceso de creación y producción, las pruebas con usuarios deberían cambiar hacia un enfoque general basado en la usabilidad en lugar de exclusivamente la accesibilidad, en el que se consideren usuarios con diferentes capacidades.

Para ilustrar este marco conceptual y proponer un nuevo enfoque a la hora de abordar pruebas con usuarios en el área de accesibilidad en los medios audiovisuales, en el que se evoluciona de un modelo basado en las discapacidades a un modelo basado en las capacidades, se mostrarán ejemplos específicos en orden cronológico del proyecto ImAc (Immersive Accesibility) financiado por la Unión Europea. En la sección 2, se presentan las pruebas iniciales, que se desarrollaron con usuarios con discapacidades, y se describen los resultados insuficientes que se tradujeron en la adopción de un nuevo enfoque. En la sección 3, se propone un nuevo modelo para las pruebas con usuarios y se justifica el cambio metodológico. La sección 4 describe la segunda prueba en la que se puso en práctica este enfoque, usando los mismos estímulos, pero con usuarios con diferentes capacidades tecnológicas. En las conclusiones, se deja una puerta abierta que propone la evolución de un enfoque de pruebas con usuarios basado en la accesibilidad a un enfoque basado en la usabilidad.

Palabras clave: subtitulación, subtítulos para sordos, contenido inmersivo, accesibilidad en los medios, definición de perfil de usuarios.

INTRODUCTION[1]

Media Accessibility (MA) has been recently labelled by Greco (2016) as a field of research on its own merits. The various modalities, or access services, related to MA have been traditionally studied by different fields in order to understand them in all their complexity. Subtitling, dubbing, voice-over, audio description, audio subtitling and sign language interpreting have been approached from diverging perspectives, but two fundamental elements have always been at the centre of pioneering research: the focus on technology and on end users. Technology is basic, because it determines the service, its production, distribution and reception, and also has direct implications to quality (Bernard, Chia & Mills, 2001; Utray, Ruiz & Moreiro, 2010). Understanding the effect of various modalities on users is also fundamental, as access services are aimed at fulfilling audience needs. Audience reception has often determined the scope and approach of the research (Orero, 2008; Di Giovanni & Gambier, 2018).

Subtitling, the most popular access service, has been researched from the field of psychology (D'Ydewalle, Pollet & van Rensbergen, 1987; D'Ydewalle, Praet, Verfaillie & van Rensbergen, 1991; D'Ydewalle & Gielen, 1992; D'Ydewalle & Pavakanun, 1997; D'Ydewalle & van de Poel, 1999; De Bruycker & D'Ydewalle, 2003; Perego, Del Missier, Porta & Mosconi, 2010) to understand reading patterns and define quality in legibility and readability. From Audiovisual Translation (AVT) Studies, research has been focusing on how to produce quality content for the access services (Neves, 2007; Arnáiz-Uzquiza, 2008; Romero-Fresco, 2009; Bartoll & Martínez-Tejerina, 2010; Pereira, 2010; Romero-Fresco, 2010; Szarkowska, Krejtz, Kłyszejko & Wieczorek, 2011; Romero-Fresco, 2015; Szarkowska, Krejtz, Pilipczuk, Dutka & Kruger, 2016). In the field of engineering, attention has been paid to technical aspects of subtitles (Lambooij, Murdoch, Ijsselsteijn & Heynderickx, 2013; Hu, Kautz, Yu & Wang, 2015; Hughes, Armstrong, Jones & Crabb, 2015; Brown, 2017; Brown & Patterson, 2017; Brown et al., 2017).

Regardless the specific field and methodological research approach, technology and end user reception are always two central elements. Traditionally, however, MA services have been tested on persons with disabilities, regardless their technological capabilities (Orero & Tor-Carroggio,

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2018). This user profiling approach responds to the United Nations Convention on the Rights of Persons with Disabilities (CRPD) requirement "nothing about us without us". This article aims to challenge this exclusive approach, as it may not be always the only strategy possible to get useful results. In fact, it is argued that mainstreaming accessibility and involving user profiles beyond persons with disabilities may be more relevant in certain situations. The lack of capabilities linked to disability may have less impact than the lack of capabilities linked to other aspects such as technology. Additionally, access services are not only used by persons with disabilities. The approach in this research is in the realm of Universal Design and Design for All. Access services benefit the whole community from an inclusive perspective, hence the proposed move from accessibility to usability for diverse audiences. To prove this point, and to open up scientific debate on the need for a different approach to user profiling in MA research, the experience gained through the ImAc (Immersive Accessibility) project is put forward and discussed.

ImAc[2] is a Horizon 2020 project funded by the European Commission. It aims to research how access services (subtitling, audio description, audio subtitles, and sign language interpreting) can be integrated with immersive media, specifically 360-degree videos. 360º contents are a type of virtual reality experience. Users can both hear and look around synthetic worlds in 360° often with stereoscopic views (Mateer, 2017). The project research methodology was designed following a user-centric methodology (Orero & Matamala, 2016). End users were involved from the beginning of the project in defining system requirements for the different access services. Their input has been gathered through a series of qualitative tools, namely focus groups and interviews, in an iterative process. In the first stage (see Figure 1), general preliminary feedback was gathered from end users through a series of focus groups. Two types of users were identified as end users: professional users (i.e. professionals creating the access services or dealing with technology) and home users (i.e. persons with disabilities using the services who had some technological expertise) (Matamala et al., 2018). Focus groups were the methodological tool chosen for two reasons: they guarantee a close interaction, and there was no prototype available for testing. Therefore, open questions were put forward in order to encourage a lively discussion among the participants to trigger various possible scenarios and user interactions.

The second stage (see Figure 1) followed also in the form of focus groups and one-to-one qualitative interviews, depending on the service. To this aim, specific examples were developed for subtitles, audio description and

[2] http://www.imac-project.eu

sign language interpreting. These were shown to participants, who were asked to provide feedback before implementation and further extensive testing.

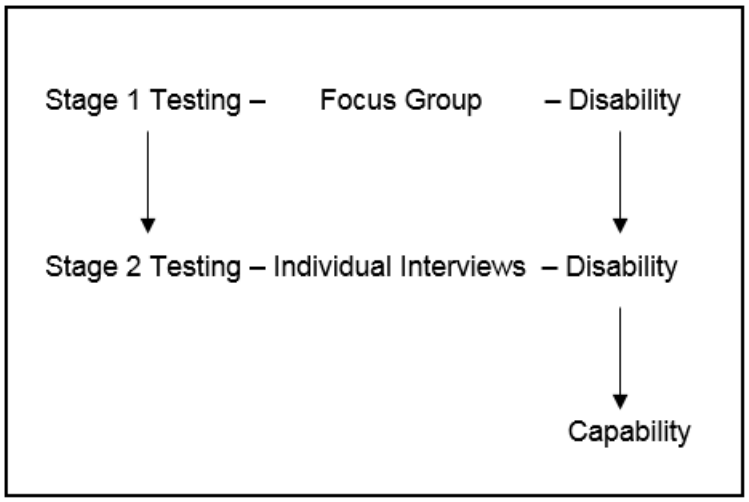

Figure 1. Testing workflow

This article reports on subtitling, because each accessibility service has a specific behaviour in immersive environments. The article discusses the methodological challenges found in this second round of user testing through interviews. Traditional profiling of persons with disabilities was initially used, leading to the deaf and hard-of-hearing community. Results, however, were unsatisfactory and the user profiling method was questioned. Consequently, the medical model of disability is challenged as the testing background for MA (Orero & Tor-Carroggio, 2018). This article aims to put forward a new approach to user profiling based on the methodological lessons learnt and shows the usefulness of the results provided by a group profiled following this new approach.

This article is developed in a chronological order following the two stages defined above in Figure 1. This choice was made to understand the process that led to a new profiling solution and presents the stages with its challenges. Section 2 of the article will present the methodological approach taken in the first tests and how the results led to rethink testing focus, moving from disabilities to capabilities. Section 3 will propose a capability-based approach when profiling end users. Section 4 will describe how this new approach was implemented using the same stimuli but different user profiles.

In Section 5 test results are presented to prove the usefulness of the new approach.

1. THE BACKGROUND: TESTING USERS WITH DISABILITIES

In the first stage of the project, immersive environments were presented to users. No prototype was available, and users identified their needs concerning subtitles for the deaf and hard of hearing (SDH) in immersive environments. This was achieved through two focus groups in which users engaged in a lively discussion guided by a facilitator. From the many suggestions two aspects were prioritised (as a precondition) for further user interaction in the second stage:

- the comfortable field of view for reading subtitles, and
- the speaker location identification.

Speaker identification and location—who is talking and where—in a 360-degree environment are paramount. The user needs to be given this basic information to navigate in the immersive world. It is taken for granted that speech carries the largest semantic load and having access to the speaker also offers secondary semantic markers such as emotions, or information regarding the speaker. Hence locating where is the person speaking who in turn is subtitled has been identified as a pre-condition (Brown et al. 2018). Similarly, the definition of the comfortable field of view to consume subtitles for 360-degree media format was considered a priority. This is because there are no standardised comfort values. Some broadcasters and content creators such as The New York Times or the BBC have developed 360-degree videos with subtitles, but still their solution is not openly shared, tested, or standardised.

For the two conditions, different alternatives were produced based on user suggestions given during the focus group sessions in the first stage. It was considered that prior to extensive experimental testing, it would be interesting to narrow down the number of possibilities through an early rating of the different alternatives. This second intervention was performed through individual interviews.

1.1. Stimuli

Two three-minute videos were recorded in German using a 360º camera. The video takes place in a radio station where two people engage in dialogue: the interviewer and interviewee. Speakers were located in such a way that users could not see both speakers in one field of view at the same

time. This setup was designed to elicit user search for speakers in the 360º content. Subtitles were generated in Catalan following ISO 20071-23 recommendations regarding the number of lines (maximum of 3) and character limitation, as well as the background box and the use of Spanish colour coding to identify the different speakers (AENOR, 2003).

Figure 2. Different colours are used to differentiate the speakers

To test the comfortable field of view, the video was split into six parts. Each part was 30 seconds long and one of the six viewing field comfort levels was applied (30, 40, 50, 60, 70 and 80 per cent), departing from the value 16:9 as the natural field of view (NFV) ratio. Subtitle font size was adjusted according to the size of the field of view.

Figure 3. Different field of views and font sizes

The edges of each field of view were indicated with three different positions of the subtitles. Giving that reading is performed left to right in the writing system used for the subtitles, subtitles were prepared to be positioned: 1) bottom/centre, 2) bottom/left aligned, and 3) top/centre.

Figure 4. Different positions to delimit the different levels of the field of view

To test preferences regarding different methods for speaker location identification, the video was split in three 30-second clips. The three different options to identify the location of the speaker were indicated by: 1) an arrow, 2) a compass, and 3) sided text. For the arrow and the compass, the subtitles were presented at the bottom and centred.

Figure 5. Different speaker identification solutions

The arrow and compass icons were positioned next to the subtitle and were aligned horizontally. For the sided text, the subtitles were positioned in the centre when the speaker was in the field of view. If the speaker was outside the field of view, subtitles were aligned to the right or left edge (depending on the location of the speaker).

The stimuli above were integrated in a series of still images to guarantee the same procedure was followed by all participants. The order of presentation was not randomised, since this was planned as qualitative one-to-one interviews rather than experimental testing.

Each clip had an introduction in which the user was advised on what would be shown: a still image with the text "Level X – starts now", in which the level was indicated, was used for comfortable field of view videos. A still image with the text "Video – Guide to speaker with arrow/compass/subtitles positioned right and left – starts now" was used for the second part.

Clips were played one after another without interruption. After each part, another still image was used to display an evaluation question. For the stimuli concerning the comfortable field of views, the question was "How comfortable was viewing the subtitles? Do not take into consideration the device used but the viewing experience. Please rate it on a 5 to 1 scale." For the stimuli concerning the speaker location identification, the question was: "How useful were the arrow/compass/subtitles positioned right and left to guide to you to the speaker? Please rate it on a 5 to 1 scale." Participants were expected to produce a reply orally. All questions were asked in Catalan, as it was the language of the participants.

1.2. Procedure

The test was carried out as follows. First, each participant was welcomed. The facilitator briefly explained the context and the ImAc project and the aim of the interview. Then, a consent form was handed to the participants to be signed, in order to comply with ethical procedures. After filling in a pre-questionnaire with demographic data, participants were asked to watch each video and rate the different solutions, as explained above. An Oculus Rift HMD was used for this test. At the end of each part, and at the end of the test, they were also given the opportunity to make any comments, suggestions or recommendations regarding any aspects of subtitles in immersive media.

1.3. Participants

The expected participants were deaf and hard-of-hearing users, and it was recommended that five or six people be recruited. No further instructions

on their profile was given. Involving end users with disabilities proved to be very challenging, and only two users finally turned up for the Barcelona test. This low turn-up challenged the validity of the test. Moreover, users were not familiar with virtual reality, nor were they technologically proficient. The users were Catalan speakers and with ages ranging from 50 to 60. Their feedback was biased, because they seemed to be distracted by the novelty of the interaction and did not pay attention to the main goal of the tests. The users were not comfortable with the technology and refused to move and explore the possibilities of virtual reality. One even claimed to be afraid of moving and standing up. This lack of engagement with the technology was a hindrance for the running of the test.

Other concerns were raised as a result of this test. The pre-questionnaire administered to participants also proved to be insufficient to account for all the user profiles. Although extensive work was put into designing the questionnaires for ImAc (Matamala et al., 2018) and adapting them to user needs, when participants were asked how they would define themselves, the options still followed a medical model and provided the following replies: blind person, low-vision person, deaf person, hearing-impaired person, blind-deaf person. Although this pre-questionnaire was piloted with users, when testing there were some users who did not identify themselves with any of the options.

These two methodological setbacks showed that the user profiling approach for the test might have been unsuitable. Addressing persons with disabilities with experience with immersive technologies may have been a solution. The reality is that immersive content is not accessible and, therefore, it is difficult to find experienced users. Additionally, the aim of the test was to assess usability for the field of view and the speaker location indicator, and being deaf and hard of hearing is not a requirement for carrying out such a usability test. Consequently, it was decided to change the user profiling strategy from disabilities to capabilities and to include hearing users. The next section discusses the rationale behind this methodological shift, in which the study moves away from an exclusive disability-based approach and adopts a new capability-based model.

2. SHIFTING THE APPROACH: FROM DISABILITIES TO CAPABILITIES

From early research in AVT and MA, the model chosen for user profiling was and still is the medical approach. Most studies have focused either on the collective sensory disabilities: sight and hearing. Most studies started, and they still do, with an overview defining the medical conditions of the expected or intended audience (Díaz-Cintas, Orero & Remael, 2007; Neves, 2008). In

terms of metrics such as health-adjusted users-services and quality-adjusted services, there have been some studies but no debate (Romero-Fresco, 2015; Miquel-Iriarte, 2017). Shortcomings of the studies and doctoral theses point to two commonalities. The first is the heterogeneity of profiles and conditions within a group, for example the deaf and hard of hearing (Arnáiz-Uzquiza, 2012; Oncins Noguer, 2014; Tsaousi 2017; Miquel-Iriarte 2017). Choosing a testing group by one of their disabilities does not mean more homogeneous participation than choosing other demographic feature such as age (children or the aged with no disabilities), or groups of people with low levels of literacy. A person with a hearing disability who reads slowly may end up reading faster than someone who is illiterate or does not speak the language. Also, it may be the case that a person has both hearing and vision impairments, and reading becomes cumbersome and tiresome. This last example is a good illustration of the ageing population, who are not profiled in any of the sensory disability group, yet they form the highest population of users of MA services.

Moreover, while SDH is purposely designed for this single group defined by its medical pathology (Bartoll 2004, 2008, 2012), the fact is they are not the main users. Up to 85 per cent of social media video consumers watch it muted with the aid of subtitles (Patel, 2016). There is also a lack of coherence between broadcasters' claim to fulfilling deaf and hard-of-hearing requirements, while the subtitles on offer are not SDH as can be seen in the 2016 EBU report (Linder, 2016). The BBC has probably the best record, as a public broadcaster, for subtitle provision, and in 2008 claimed 100 per cent of its programmes, live or recorded, were subtitled[3]. The BBC blog suggests that their subtitles are produced for the deaf and hard-of-hearing community, yet they are more or less adapted transcriptions, with little, if any, compliance to SDH features (Neves, 2008; ISO 20071-23). A similar situation is found in the subtitles produced by broadcasters in Scandinavian countries, where subtitles have no added features, yet they are considered to cater for the deaf and hard of hearing. Video streaming platforms such as HBO, Amazon Prime Video and Netflix, champion of SDH production, still abound with irregular subtitling styles and are often no better than transcriptions. This is the case for popular series such as *Breaking Bad* where mixed styles and conventions were used across the episodes, and even within the same episode.

The lack of service terminology agreement (caption/subtitle/SDH) and a heterogeneous population constantly challenge and impact on scientific studies in MA. As this article shows, and it adds to the list of failed studies, profiling end users within a medical framework (Marks, 1997) to perform tests on human interaction capabilities does not make sense. In 2001, the UN World

[3] https://bbc.in/2zeBkw3 [retrieved 20/05/2018]

Health Organisation published the International Classification of Functioning, Disability and Health (ICF). The ICF was intended to complement its sister classification system, the International Classification of Diseases (ICD) (Brown & Lent, 2008). The ICF model sees disability as the result of a combination of individual, institutional and societal factors that define the environment surrounding a person with an impairment (Dubois & Trani, 2009). It is operationalised through the World Health Organization Disability Assessment Schedule II (WHODAS II) and it covers all types of disabilities, for various countries, languages and contexts, which makes it suitable for cross-cultural use. Dubois and Trani (2009) consider the ICF to be limited in its scope and use, as its primary purpose is classification. They believe the complexity of disability requires a wider and more comprehensive analytical view. Ellis (2016) raised also this issue underlying the difference between disability and impairment, offering examples where, under the same conditions – a noisy party –, the deaf and hard-of-hearing person stands more chance of good communication than a hearing person, because they can read lips, or in a dark room a blind person will be able to navigate better than a sighted person. Ellis presents the environment as the disabler, and not the physical condition. This concept was adopted by the UN agency International Telecommunication Union (ITU). In 2017, they released a report addressing access to telecommunication/Information and Communication Technologies (ICT) services by persons with disabilities and with specific needs that stated the following:

> Besides the more commonly used "medical model of disability", which consider disability "a physical, mental, or psychological condition that limits a person's activities", there is a more recent "social model of disability," which has emerged and is considered a more effective or empowering conceptual framework for promoting the full inclusion of persons with disabilities in society. Within the social model, a disability results when a person who (a) has difficulties reading and writing; (b) attempts to communicate, yet does not understand or speak the national or local language, and (c) has never before operated a phone or computer attempts to use one – with no success. In all cases, disability has occurred, because the person was not able to interact with his or her environment. (ITU, 2017: 2)

This implies that it is of little or no use to profile by disabilities according to a medical model in MA studies. The ITU is calling for a new social model approach that analyses different aspects of each individual that might have an influence on what researchers are testing.

However, the social model falls short when offering a framework to define and profile end users for tests, as the object of study is the performance

of the person given a task under a determinate condition. It will be the competence to perform the task that should be analysed, and questionnaires should be defined accordingly. In other words, defining the users to perform the tasks should not be based on a medical condition, but the capability to perform the task. Selecting relevant capabilities or "functionings" to form an "evaluative space" is needed (Mitra, 2006). The approach should continue by drafting a set of "functionings" (or capabilities), a method to measure them, and a threshold below which a person is considered to have a deprivation. This can be applied to people with similar personal characteristics, commodities, and environment (Orero & Tor-Carroggio, 2018). This has already been found relevant in previous studies such as Romero-Fresco (2015) who pointed out that reading subtitles was related to a person's educational background rather than to their hearing impairment. This is the starting point when revising the user-centred research on MA and implementing a new capabilities model.

3. IMPLEMENTING THE NEW CAPABILITIES PROFILING

Given that tests with end users profiled using a disability-based medical model were not as successful as expected, it was decided to carry out tests using the same stimuli and methodology but changing user profiling and focusing on technology capabilities rather than on sensory disabilities. The main reason behind this choice is that immersive content consumption requires advanced knowledge of technology, specifically immersive technologies that are not mainstream. Immersive content is currently not accessible and, therefore, most users are not familiar with the technology. It was consequently considered that users were to be recruited depending on their capabilities regarding technology rather than on their sensory disability. Moreover, it was thought that subtitles would not only benefit persons who cannot hear the original but also persons who do not understand the language (German in this case). In this regard, rather than testing for accessibility, testing was focused on usability. Accessibility had already been taken into account for prototyping, and access solutions had been implemented based on the feedback from end users with disabilities. The priority was to find users with different levels of technology knowledge to evaluate user interaction with subtitles in immersive media, regardless of their hearing abilities, in order to suggest the best strategies for all users and mainstream access services.

3.1. Methodology adjustments and participants

Three different age ranges were considered when recruiting participants following the Prensky (2001) classification: from digital native to digital immigrant. It was expected that this would have an impact on their

interaction and familiarity with immersive technology: children/teenagers (from 12 to 18 years old), young adults (from 25 to 30 years old) and adults (from 52 to 60 years old). User-profiling through a pre-questionnaire addressed two main capabilities: technological proficiency (can the user interact with the technology?) and subtitles consumption (can the user read subtitles?). It was assumed that children/teenager and young adult groups would be more capable with technology and subtitles than the adult group, which was expected to be more technology disabled, or digital immigrant. This assumption was later confirmed with the demographic pre-questionnaires.

To inform the different profiles, the demographic questionnaire designed at the beginning of the project was modified, only asking questions that were capability-relevant. Some adjustments were needed:

- Demographic questions related to sex, main language and disability were removed, since they were not considered to have an impact on the results for this usability test.
- Demographic questions related to age and level of studies were retained, since they were considered to have an impact on the results for this usability test.
- Other questions related to technology were also maintained:
    - What technology do you use on a daily basis?
    - Do you own any device used to access virtual reality content?
- New questions related to technology/subtitles habits and knowledge were included, such as:
        - How often do you watch virtual reality content (such as 360-degree videos)?
        - If you have never or only occasionally used virtual reality content such as 360-degree videos, please indicate why.
        - Please state your level of agreement with the following statement: “I am interested in virtual reality content (such as 360-degree videos).”
        - Do you like watching the following types of content on television or online?
        - When subtitling is available, do you activate it for the following type of content?
        - If it is available and you do not activate it, please select the reasons why.
        - How many hours a day do you watch subtitled content?
        - What do you use subtitles for?

New questions were aimed at profiling end users' capabilities related to reading subtitles or addressing the technology at stake. According to Orero et al. (2018), questions about TV viewing habits should always be included in AVT research questionnaires. This could be applied to other technologies apart from TV, such as immersive media.

Six users participated in the one-to-one interviews, two for each age group. Two participants (one young adult and one teenager) had previous experience with immersive contents. Two young adults and one teenager used subtitles frequently, and all users were familiar with subtitling practices. All users were engaged with the technology and showed interest in it. However, interaction with the technology differed among the profiled groups. Digital natives (teenagers and young adults) felt confident and behaved naturally when testing the different solutions. Digital immigrants (adults) seemed restrained by the technology and behaved more cautiously.

4. RESULTS FOR SUBTITLES IN IMMERSIVE MEDIA

The results from the test after adopting this new methodological approach are presented below, to show its relevance. Regarding comfortable field of view, level 5 (70 per cent of NVF) and level 6 (80 per cent of NVF) got the highest rating, followed by level 4 (60 per cent of NVF) and level 3 (50 per cent of NVF). Levels 1 and 2 were too small and difficult to read for all users.

Comfort	**Level 1**	**2**	**3**	**4**	**5**	**6**
P1	3	3	2	1	1	2
P2	2	2	3	3	4	4
P3	1	1	3	3	3	3
P4	1	2	3	3	4	1
P5	1	1	2	3	3	4

P6	1	1	2	3	4	5
Mean	1.5	1.7	2.5	2.7	3.2	3.2

Table 1. Ratings from users regarding comfortable field of view

Regarding subtitle placement, users generally preferred subtitles at the bottom of the field of view, because they claimed to be used to that position. Some also argued that reading the subtitles located at the top of the field of view was tiring and uncomfortable. Moreover, they did not like it when subtitles covered part of the image as they found it annoying and frustrating. As for the font size, for most users the biggest font was easier to read. A balance is required between font size and not covering the images, however. In any case, it seems that personalisation for font size may be the best solution.

Some users reported double vision when reading the subtitles. This was due to the implementation of the subtitles: they were too close to the eyes and need to be closer to the image to avoid depth issues. It was agreed with the development team that implementation needs to be improved in this aspect. Finally, one user also reported colour blindness issues. Personalisation for font colour therefore should be implemented.

As far as the speaker location identification is concerned, which was assessed through a second video, the following preferences for the different approaches applied: 1) arrow 2) compass and 3) sided text.

Guiding	**Position**	**Arrow**	**Compass**
P1	1	4	2
P2	1	5	3
P3	1	3	4
P4	1	3	3

P5	1	2	3
P6	1	4	1
Mean	1	3.5	2.7

Table 2. Ratings from users regarding methods for speaker location identification

Regarding the implementation of speaker location identification methods, some suggestions for improvement were offered. For example, one user noticed that the vertical axis (up and down) was missing from all options and should be implemented. Also, researchers realised that further tests on how to implement directions when two speakers (or more) are talking at the same time in different locations need to be carried out. This was confusing for the users. As far as the display of the indicators is concerned, most users preferred the arrow. They would prefer it to be clearer, though: bigger and in a colour different from the subtitle, to make it more noticeable.

Finally, two users claimed that all the three methods that were presented were unclear and confusing. One user suggested that, apart from the arrows, an indicator close to or above the speaker (for example, a red dot) could be implemented. This way, the users can be sure about who is talking once their eye has reached the speaker in the image. This was suggested by a user from the digital immigrants. The solution could be helpful for both digital immigrants and deaf users, for example, if the mouth of the speaker cannot be seen in the image.

5. EVALUATING THE NEW APPROACH

The results presented in the previous section show that the input provided by participants in the test with the new approach was relevant, even if participants did not have hearing impairments. Age and technological capabilities proved to be a determining factor in the participants' feedback. Teenagers and millennials generally found the systems in place usable. As for the implementation of subtitles, they suggested some improvements in terms of aesthetical characteristics and smoothness of use of the system. They also required further enhancements to the presented solutions. Digital natives are given a solution and they automatically look for improvements and additional features. However, they are not worried about accessibility, because they can

usually find workarounds. Adults, on the other hand, were not completely happy with the usability of the subtitles nor the speaker identification systems, which they found uncomfortable and sometimes confusing. They suggested possible solutions to make the subtitles more accessible to technology impaired population.

Thanks to this new approach, an implementation issue regarding sight (and not hearing) was detected. Two users reported seeing the subtitles duplicated. Further research shed some light on this issue. Convergence capacity and prismatic effect caused by lenses can provoke double vision. This can consequently impact on how the subtitles are seen in an immersive environment when wearing a head-mounted display and solutions need to be implemented.

Changing the focus from disabilities to capabilities in MA research when access services are heavily dependent on technology seems to be a fruitful approach. In this test, the most important questions to be addressed were: 1) can you read the subtitles? If so, which is the most comfortable solution?; and 2) can you identify where the speaker is? If so, which is the most usable and efficient solution? Also, user interaction was crucial, due to the novelty of immersive technologies. That was the reason for profiling different user groups depending on technological knowledge, to look for and find different user needs, prioritising the access to the content. Depending on the service and technology to be tested, different capabilities may need to be considered when selecting users. ImAc has moved from a medical model based on a sensory disability to a model based on capabilities, in this case related to technology and subtitle reading.

6. Conclusion

Some authors claim that access services should not be considered as an afterthought, but rather they should be part of the design from the beginning of the development process (Udo & Fels, 2010; Romero-Fresco, 2013). This can be applied to filmmaking, and it is also valid when it comes to making new media technologies accessible. This was the possibility that was raised during the ImAc project: implementing access services in 360-degree content before the technology and contents were fully mainstreamed, through the cooperation of experts from different fields.

Regarding SDH, feedback was initially gathered from end users in a focus group, to anticipate their needs before implementing the access service in the new medium. From the draft requirements and further technical discussions, two aspects were prioritised for a second round of user testing:

comfortable field of view for reading subtitles and different methods for identifying speaker location. Then, these two elements were tested by a reduced group of users to fine-tune the implementation specifications for SDH in immersive media. The results suggested that users preferred 70 per cent and 80 per cent of the natural field of view (16:9) and the largest font size. This might be due to the lack of habit in reading subtitles in immersive media, as bigger fonts usually are easier to read. However, users also raised their concern about the blocking effect of subtitles when consuming contents in immersive media. Sometimes, subtitles covered the image, and this was received as a negative effect. Implementation solutions need to focus on preventing blocking from occurring. Also, users preferred the arrow system for speaker location identification, although some improvements for usability were suggested.

Beyond the specific results obtained in the user testing which was limited due to the number of participants, the article has illustrated the challenges of designing and implementing access services following a user-centred methodology when access services are heavily dependent on technology. It has shown how a model based on disabilities may yield unsatisfactory results, especially when the technology and the content are not mainstreamed, and users are not familiar with them. It is precisely within this context that another approach to user profiling has been proposed as the central element in this article.

MA research has traditionally used the medical model to profile end users for their experimental research (Orero & Tor-Carroggio, 2018). A report issued by the UN agency International Telecommunication Union (ITU) (2017), however, calls for a new approach that substitutes the medical model for disabilities. In this new approach, different individual aspects such as literacy, language, and technology proficiency also impact on user interaction with technology. In this study, it became clear that the medical model needed to be adapted to meet the needs of emerging technologies, such as immersive media. The capability approach goes one step forward and explains that what needs to be considered is not the users' disabilities, but their capabilities given a specific task in a specific environment and with a specific technology (Orero & Tor-Carroggio, 2018). This approach, in which user profiling is adapted to match technology capabilities, has been successfully applied in this research.

In the same way, in a move from a model based on disabilities to a model based on capabilities, MA research may also benefit by moving from an exclusive accessibility-based approach to a more general usability approach in which the needs of different types of users are considered. SDH has the potential to benefit not only persons with hearing impairments but all users. If SDH is mainstreamed, usability tests may be more relevant than

accessibility tests alone. As argued by Tullis and Albert (2013: 229), "accessibility is really just usability for a particular set of users", namely "users with different types of disabilities" (ibid: 230). If there is a move from disabilities to capabilities, the focus should be on usability tests in which users with different capabilities, who are relevant to the object of research, are taken into account. Therefore, an interesting development of this study in future research would be to consider users with different key capabilities in relation to the actual content and technology tested, namely persons with different technological capabilities, persons with different hearing capabilities, and persons with different subtitling capabilities. This approach would also help overcoming current obstacles in MA research such as the low number of participants and the lack of statistical significance (Orero & Tor-Carroggio, 2018.

Changes in how MA is understood are necessary. Subtitles are a valid service to many users, not only persons with disabilities, so a broader user profiling should be adopted, moving from disabilities to capabilities and moving from accessibility to usability. In a constantly evolving world with new technologies being implemented at a fast pace, a flexible and adaptable workflow that favours the implementation of access services from the outset needs to be established. The collaboration between different stakeholders (broadcasters, engineers, media access scholars, end users) may offer the possibility of improving not just the quantity of accessible media, but also the quality, because access services would be approached from different perspectives, enriching the final outcome.

7. BIBLIOGRAPHY

Asociación Española de Normalización y Certificación (AENOR) (2003). *Subtitulado para personas sordas y personas con discapacidad auditiva. Subtitulado a través del teletexto* (Norma UNE 153010). Retrieved from https://bit.ly/2z0fD3t.

Arnáiz-Uzquiza, V. (2008). La Objetividad en el Subtitulado. Justificación de los Parámetros Formales Mediante EyeTracking. In A. Pérez-Ugena, and R. Vizcaíno (Eds.), *ULISES: Hacia el desarrollo de tecnologías comunicativas para la igualdad de oportunidades. Retos y perspectivas para sordos signantes* (pp. 73-85). Madrid, España: Observatorio de las Realidades Sociales y de la Comunicación.

— (2012). *Subtitling for the deaf and the hard-of-hearing: Some parameters and their evaluation* (Doctoral thesis). Universitat Autònoma de Barcelona, Spain. Retrieved from: https://bit.ly/2PvBXvr

Bartoll, E. (2004). Parameters for the classification of subtitles. In P. Orero (Ed.), *Topics in Audiovisual Translation* (pp. 53-60). Amsterdam, Netherlands and Philadelphia, USA: John Benjamins.

— (2008). *Paràmetres per a una taxonomia de la subtitulació* (Doctoral thesis). Universitat Pompeu Fabra, Spain. Retrieved from https://bit.ly/2zXK1KQ

— (2012). *La subtitulació: Aspectes teòrics i pràctics*. Barcelona, Spain: Eumo.

— & Martínez-Tejerina, A. (2010). The positioning of subtitles for the deaf and hard of hearing. In A. Matamala, and P. Orero (Eds.), *Listening to Subtitles: Subtitles for the Deaf and Hard of Hearing* (pp. 69-86). Bern, Switzerland: Peter Lang.

Bernard, M., Chia, H. L., and Mills, M. (2001). The effect of font type and size on the legibility and reading time of online text by older adults. In *CHI EA'01 Extended Abstracts on Human Factors in Computer Systems* (pp. 175-176). New York, USA: ACM.

Brown, A. and Patterson, J. (2017). *Designing Subtitles for 360° Content*. In BBC Research & Development blog. Retrieved from https://bbc.in/2qPLJd9

— (2017). *User Testing Subtitles for 360° Content*. In BBC Research & Development blog. Retrieved from https://bbc.in/2RV43Nx

—, Turner, J., Patterson, J., Schmitz, A., Armstrong, M., and Glancy, M. (2017). Subtitles in 360-degree Video. In *TVX '17 ACM International Conference on Interactive Experiences for TV and Online Video* (pp. 3-8). New York, USA: ACM.

—. Turner, J., Patterson, J., Schmitz, A., Armstrong, M., and Glancy, M. (2018). *Exploring Subtitle Behaviour for 360° Video*. [White Paper]. Retrieved from https://bbc.in/2S0EdI3

— & Lent, R. (Eds.) (2008*). Handbook of Counseling Psychology*. New Jersey, USA: Wiley.

Díaz-Cintas, J., Orero, P., and Remael, A. (Eds.) (2007). *Media for all: subtitling for the deaf, audio description, and sign language*. Amsterdam, Netherlands: Rodopi.

Dubois, J. L., and Trani, J. F. (2009). Extending the capability paradigm to address the complexity of disability. *ALTER, European Journal of Disability Research, 3*, 192–218.

D'Ydewalle, G., Pollet, J., and van Rensbergen, J. (1987). Reading a message when the same message is available auditorily in another language: the case of subtitling. In J.K. O'Regan, and A. Lévy-Schoen (Eds.), *Eye Movements: From Physiology to Cognition* (pp. 313-321). North Holland, Netherlands: Elsevier Science Publishers.

—., Praet, C., Verfaillie, K., and van Rensbergen, J. (1991). Watching Subtitled Television: Automatic Reading Behaviour. *Communication Research*, *18*(5), 650-666.

—. & Gielen, I. (1992). Attention Allocation with Overlapping Sound, Image, and Text. In K. Rayner (Ed.), *Eye Movements and Visual Cognition* (pp. 415-527). New York, USA: Springer Verlag.

— & Pavakanun, U. (1997). Could enjoying a movie lead to language acquisition? In P. Winterhoff-Spurk and T.H. van der Voort (Eds.), *New horizons in media psychology* (pp. 145–55). Opladen, Germnay: Westdeutscher Verlag.

— & van de Poel, M. (1999). Incidental foreign language acquisition by children watching subtitled television programs. *Journal of Psycholinguistic Research, 28*, 227–244.

De Bruycker, W.Y., and d'Ydewalle, G. (2003). Reading Native and Foreign Language Television Subtitles in Children and Adults. In J. Hyöna, R. Radach, and H. Deubel (Eds.), *The Mind's Eye: Cognitive and Applied Aspects of Eye Movement Research* (pp. 671-684). Amsterdam, Netherlands: Elsevier Science Publishers.

Di Giovanni, E., and Gambier, Y. (Eds.) (2018). *Reception Studies and Audiovisual Translation*. Amsterdam, Netherlands: John Benjamins.

Ellis, G. (2016). Impairment and Disability: Challenging Concepts of "Normality". In A. Matamala and P. Orero (Eds.), *Researching Audio Description* (pp. 35-45). London, UK: Palgrave Macmillan.

Greco, G. M. (2016). On Accessibility as a Human Right, with an application to Media Accessibility. In A. Matamala, and P. Orero (Eds.), *Researching Audio Description*. London, UK: Palgrave Macmillan.

Hu, Y., Kautz, J., Yu, Y., and Wang, W. (2015). Speaker-Following Video Subtitles. *ACM Transactions on Multimedia Computing, Communications, and Applications, 11*(2).

Hughes, C. J., Armstrong, M., Jones, R., and Crabb, M. (2015). Responsive Design for Personalised Subtitles. In *W4A '15 Proceedings of the 12th Web for All Conference*. New York, USA: ACM.

International Organization for Standardization (forthcoming). *Information technology -- User interface component accessibility -- Part 23: Visual presentation of audio information (including captions and subtitles)* (Standard no. ISO/IEC FDIS 20071-23). Retrieved from https://bit.ly/2qOSJH1

International Telecommunication Union (ITU) (2017). *Question 7/1: Access to telecommunication/ICT services by persons with disabilities and with specific needs* [Report]. Retrieved from https://bit.ly/2Q1VyD3

Lambooij, M., Murdoch, M. J., Ijsselsteijn, W. A., and Heynderickx, I. (2013). The impact of video characteristics and subtitles on visual comfort of 3D TV. *Displays 34*(1), 8-16.

Linder, G. (2016). *ACCESS SERVICES PAN EUROPEAN SURVEY 2016* [Report]. Retrieved from https://bit.ly/2Drvb2L

Marks, D. (1997). Models of Disability. *Disability and Rehabilitation, 19*(3), 85-91.

Matamala, A., Orero, P., Rovira-Esteva, S., Casas-Tost, H., Morales, L. F., Soler-Vilageliu, O., Agulló, B., Fidyka, A., Segura, D. and Tor-Carroggio, I. (2018). User-centric approaches in Access Services Evaluation: Profiling the End User. In I. Schuurman, L. Sevens, V. Yaneva, J. O'Flaherty (Eds.), *Proceedings of the LREC 2018 Workshop. "Improving Social Inclusion using NLP: Tools, Methods and Resources"* (pp. 1-8). Miyazaki, Japan: ISI-NLP 2.

Mateer, J. 2017. Directing for Cinematic Virtual Reality: How the Traditional Film Director's Craft Applies to Immersive Environments and Notions of Presence. *Journal of Media Practice 18*(1), 14-25.

Miquel-Iriarte, M. (2017). *The reception of subtitling for the deaf and hard of hearing: viewers' hearing and communication profile & Subtitling speed of exposure* (Doctoral thesis). Universitat Autònoma de Barcelona, Spain. Retrieved from: https://bit.ly/2QPz5WU

Mitra, S. (2006). The Capability Approach and Disability. *Journal of Disability Policy Studies, 16*(4), 236-247.

Neves, J. (2007). There is Research and Research: Subtitling for the Deaf and Hard of Hearing (SDH). In C. Jiménez (Ed.), *Traducción y Accesibilidad. Subtitulación para sordos y audiodescripción para ciegos: Nuevas modalidades de Traducción Audiovisual*. Frankfurt, Germany: Peter Lang.

Neves, J. (2008). 10 fallacies about Subtitling for the d/Deaf and the hard of hearing. *The Journal of Specialised Translation, 10*, 128-143.

Oncins Noguer, E. (2014). *Accessibility for the scenic arts* (Doctoral thesis). Universitat Autònoma de Barcelona, Spain. Retrieved from https://bit.ly/2BcMKlt

Orero, P. (2008). Three different receptions of the same film. The Pear Stories applied to Audio Description. *European Journal of English Studies 12*(2), 179–193.

— & Matamala, A. (2016). User-centric audio description: a topsy-turvy research approach. In A. Manco, and A. Mancini (Eds.), *Scrittura brevi: segni, testi e contesti. Dalle iscrizione antiche ai tweet* (pp. 376-387). Naples, Italy: Università degli Studi di Napoli "L'Orientale".

—, Doherty, S., Kruger, J.L., Matamala, A., Pedersen, J., Perego, E., Romero-Fresco, P., Rovira-Esteva, S., Soler-Vilageliu, O., and Szarkowska, A. (2018). Conducting experimental research in audiovisual translation (AVT): A position paper. *The Journal of Specialised Translation, 30*, 105-126.

— & Tor-Carroggio, I. (2018). User requirements when designing learning e-content: interaction for all. In E. Kapros and M. Koutsombogera (Eds.), *Designing for the User Experience in Learning Systems* (pp. 105-122). Switzerland: Springer International Publishing.

Patel, S. (2016). 85 percent of Facebook video is watched without sound. In *DigidayUK*. Retrieved from https://bit.ly/2tZlgdv

Perego, E., Del Missier, F., Porta, M., and Mosconi. M. (2010). The Cognitive Effectiveness of Subtitle Processing. *Media Psychology 13*(3), 243–272.

Pereira, A. (2010). Criteria for elaborating subtitles for the deaf and hard of hearing adults in Spain: Description of a case study. In A. Matamala, and P. Orero (Eds.), *Listening to subtitles* (pp. 87-102). Vienna, Austria: Peter Lang.

Prensky, M. (2001). Digital Natives, Digital Immigrants. *On the Horizon, 9* (5), 1–6.

Romero-Fresco, P. (2009). More haste less speed: edited vs. Verbatim respeaking. *Vigo International Journal of Applied Linguistics, 6*, 109–133.

—. (2010). D'Artagnan and the Seven Musketeers: SUBSORDIG travels to Europe. In A. Matamala, and P. Orero (Eds.), *Listening to subtitles* (pp. 175-189). Vienna, Austria: Peter Lang.

— (2013). Accessible filmmaking: Joining the dots between audiovisual translation, accessibility and filmmaking. *The Journal of Specialised Translation, 20*, 201-223.

— (ed.) (2015). *The Reception of Subtitles for the Deaf and Hard of Hearing in Europe*. Bern, Switzerland: Peter Lang.

Szarkowska, A., Krejtz, I., Kłyszejko, Z., and Wieczorek, A. (2011). Verbatim, standard, or edited? Reading patterns of different captioning styles among deaf, hard of hearing, and hearing viewers. *American Annals of the Deaf, 156*(4), 363-378.

—, Krejtz, I., Pilipczuk, Dutka, L., and Kruger, J.L. (2016). The effects of text editing and subtitle presentation rate on the comprehension and reading patterns of interlingual and intralingual subtitles among deaf, hard of hearing and hearing viewers. *Across Languages and Cultures, 17*(2), 183-204

Tsaousi, A. (2017). *Sound effect labelling in Subtitling for the D/deaf and Hard-of-Hearing: An experimental study on audience reception* (Doctoral Thesis). Universitat Autònoma de Barcelona, Spain. Retrieved from: https://bit.ly/2OQ4yGR

Tullis, T., and Albert, B. (2013). *Measuring user experience. Collecting, analyzing, and presenting usability metrics*. USA: Morgan Kaufmann.

Udo, J. P., and Fels, D. I. (2010). The rogue poster-children of universal design: closed captioning and audio description. *Journal of Engineering Design, 21*(2-3), 207-221.

Utray, F., Ruiz B., and Moreiro, J.A. (2010). Maximum font size for subtitles in Standard Definition Digital Television: Tests for a font magnifying application. In A. Matamala, and P. Orero (Eds.), *Listening to Subtitles: Subtitles for the Deaf and Hard of Hearing* (pp. 59-68). Bern, Switzerland: Peter Lang.