UNDERSTANDING THE DIVERSE NEEDS OF SUBTITLE USERS IN A RAPIDLY EVOLVING MEDIA LANDSCAPE

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ABSTRACT

Audiences are increasingly using services such as video on demand and the web to watch television programmes. Broadcasters need to make subtitles available across all these new platforms. These platforms also create new design opportunities for subtitles along with the ability to customise them to an individual's needs. To explore these new opportunities for subtitles we have begun the process of reviewing the guidance for subtitles on television and evaluating the original user research. We have found that existing guidelines have been shaped by a mixture of technical constraints, industry practice and user research, constrained by existing technical standards. This paper provides an overview of the subtitle research at BBC R&D over the past two years. Our research is revealing significant diversity in the needs and preferences of frequent subtitle users, and points to the need for personalisation in the way subtitles are displayed. We are developing a new approach to the authoring and display of subtitles that can respond to the user requirements by adjusting the subtitle layout in the client device.

INTRODUCTION

Subtitles as an access service (also known as closed captions) were first broadcast on television in the UK over 35 years ago, using the Teletext system. Subtitles are now an integral part of the television service provided on all BBC programmes in the UK via digital television services and are used by around 10% of the viewing audience every day. However, most of the research on subtitles was conducted using the Teletext system or other legacy formats with similar constraints. This has meant that progress in subtitle research has been quite conservative in its approach and has failed to address the challenges being posed by the way television content is now being watched on computers, tablets and mobile phones. These new devices offer a very different experience to that of watching analogue television 30 years ago. Furthermore, recent research on same-language subtitles has been diverted by academics whose expertise is in translation and who focus on promoting the role of the subtitler, rather than the experience of the audience. Our research has attempted to address issues with previous work and pay careful attention to our audience's experience of subtitles. We have begun to build a new model of the experience of watching television with subtitles and are finding some considerable variation in the wants and needs of different subtitle users, depending on their sensory and cognitive abilities, and the way in which they use the subtitles. In order to best meet these diverse needs and the new media landscape we have proposed a new approach to subtitles that we are calling Responsive Subtitles.

BACKGROUND

Teletext subtitles first appeared on BBC Television in the UK in 1979 and live subtitles were first broadcast in 1984. In 2008 the BBC achieved 100% subtitling for all of its main channels and since 2012 BBC iPlayer has provided 100% subtitling on all capable platforms for its on-demand and downloadable content.

A large proportion of the UK television audience relies on subtitles. The BBC's audience research team has run two audience surveys for us over the past two years. Each used a representative sample of around 5,000 participants who were questioned on that day's viewing. The responses indicate that about 10% of the audience use subtitles on any one day and around 6% use them for most of their viewing. This equates to an audience of around 4.5 million people in the UK of which over 2.5 million use them most or all of the time. Importantly, not all subtitle users have hearing difficulties, some are watching with the sound turned off and others use them to support their comprehension of the programme, whilst around a quarter of people with hearing difficulties watch television without subtitles (1).

Research & Regulation

The original guidelines for subtitling in the UK were informed by research carried out in the late 1970s by a team based at Southampton University on behalf of the Independent Broadcasting Authority (IBA). This pioneering work was difficult because of the nature of available television equipment at the time and subtitled television was a novel experience for the participants (2, 3). The guidelines were published in 1982 and contained extensive guidance on how scripts should be edited to create subtitle blocks (4).

The Centre for Deaf Studies in Bristol reviewed the research on television subtitling in a report for the BBC and Independent Television Commission (ITC) in 1992. The report raised concerns about the existing research and the lack of follow up work in several areas including the issue of whether subtitles should be edited or presented verbatim (5). In 1996 the ITC commissioned research on viewers' preference for block subtitles or scrolling subtitles for news coverage. The report recorded no strong preference for block or scrolling subtitles but argued for edited subtitles, despite a majority of respondents preferring verbatim subtitles. It also highlighted problems with subtitles being delayed and obscuring other information (6). The ITC published new guidelines in 1997 which were updated in 1999 to include the new digital television services and the move to DVB subtitles. However, apart from specifying the Tiresias font the approach replicated the existing Teletext delivery (7).

In 1999 a book was published that attempted "to establish the common ground between intra- and inter-lingual subtitling." Based on research at the Centre for Deaf Studies the book deliberately conflated subtitles for access services with subtitling for translation (8). It seems to mark the start of the field of Audio Visual Translation where arts academics have focused on the subtitler and have been dismissive of user preferences, even framing them as "political" (9) or dismissing them as "a huge mistake" (10).

Since Ofcom took over from the ITC they have commissioned research on subtitling speed (11) with a view to revising the ITC guidelines, which they published following a public consultation in 2006. These new guidelines are considerably shorter than the ITC document, removing the guidance on editing and formatting of subtitles. However, they still

contain some legacy issues inherited from Teletext (12). Since 2013 Ofcom has been focusing on a programme of work measuring the quality of live subtitling (13).

The Changing Media Landscape

In 2009 BBC Online published a set of guidelines outlining the subtitling requirements for AV content presented on the bbc.co.uk web site (14). These were based on existing television subtitle guidelines and existing research (5, 6, 15). We have been reviewing the validity of this guidance for the new viewing platforms and viewing contexts. With television programmes available on computers and portable devices the context for television viewing is a more individual experience and increasingly portable. In fact, by the end of 2013 viewing of the BBC's iPlayer on tablets overtook viewing on computers (16).

As we reviewed the BBC Online guidelines we also found problems with the subtitling guidelines for television and the persistence of legacy constraints. The Teletext display grid of 24 rows by 40 columns was designed to for CRT displays with interlaced scanning. The font was fixed-width and a double height font was used for subtitles. This layout has been used to conduct most research over the past 30 years. In the UK the format for subtitle delivery to the home has moved on. Since October 2012, most UK broadcasters deliver subtitles in DVB format and iPlayer uses the TTML format.
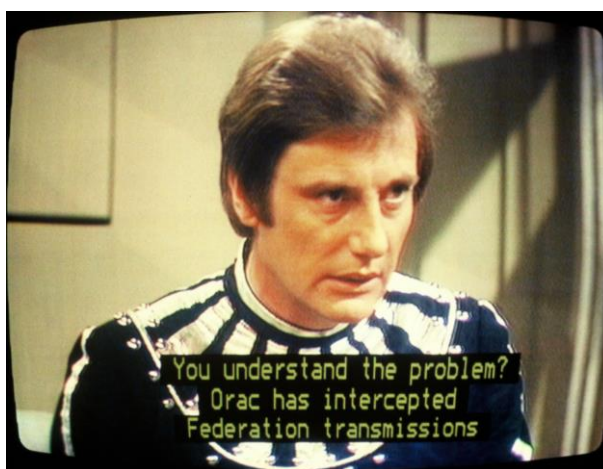

Figure 1 – Teletext subtitles on a CRT TV

There is pressure from audience (and regulators in some countries) to provide the ability to change the size of the subtitles and the demand is likely to increase as more people use a variety of screen sizes. The current approach, where each subtitle is authored and displayed as a fixed block of text, restricts the ability to personalise the subtitle display. Increasing the font size will result in more of the video image being obscured, the subtitle exceeding the width of the screen, or both.

New Challenges for Broadcasters

This changing media landscape is creating new challenges for the provision of subtitles. Since 2012 BBC iPlayer has provided 100% subtitling on all capable platforms for its on-demand and downloadable content, matching broadcast provision. However, subtitles for live-streamed content won't be available until 2016 and levels of subtitling for broadcast television are not currently being matched by the provision of subtitles for all video on demand services. The 2014 ATVOD services report shows that whilst public service broadcasters are making the most progress, in other cases the level of provision is patchy and nearly 15% of providers offer no subtitles at all (17). The campaign group Action on Hearing Loss has launched a campaign to improve subtitling provision for on-demand services (18). In the case of video clips on web sites the provision of subtitles by all broadcasters remains largely non-existent, a situation we are addressing with our work.

The issue of the quality of live subtitles continues to be a challenging problem. Action on Hearing Loss, drawing on feedback from its members, highlights the problems that subtitle

users face when watching television. The most frequently reported issue was the delay between speech and the subtitles, closely followed by accuracy. The lack of subtitles or intermittent subtitles was also reported at a similar rate with other issues some way behind, such as subtitles covering faces or subtitles being too slow or too fast (19). Recent work by the BBC and its subtitling partners has been making significant improvements in live subtitle quality, particularly with live news bulletins, and further work is on-going. Our work at BBC R&D aims to support these improvements by understanding the needs of the audience and helping understand where improvements can have most benefit.

OUR WORK

Our aim, as a research team at BBC R&D, is to provide the BBC with new knowledge about the use and experience of subtitles by our audiences and work out how best to develop subtitling for the new media landscape. We have been building a body of data on the quantity and quality of subtitling, both live and pre-recorded and we are now starting to create prototypes, which demonstrate a fresh approach to sourcing and providing subtitles. Our work in BBC R&D is guided by the approach in the BBC's Diversity Strategy, which includes the objective to, "Build in accessibility from the start when developing new products and services, and ensure sustainable and on-going accessibility" (20). We are aiming to build a better understanding of the issues that affect the subtitle viewing experience, from the availability of subtitles across devices and platforms to the aspects of quality, the impact of the viewing device and subtitles in a shared viewing experience.

Our work breaks down into three main areas, developing affordable and sustainable ways of increasing the availability of subtitles across all platforms, carrying out user research to understand the quality of the current user experience of subtitles for the audience and research aimed at utilising the characteristics of new platforms to improve the experience.

INCREASING SUBTITLE AVAILABILITY

The most important issue for the audience is the availability of subtitles. Whilst the BBC aims to subtitle all of its programmes and is now achieving the same level of service with its video on demand service iPlayer, subtitles are not currently available for the majority of clips on the BBC's web pages. It would be too expensive to manually subtitle all of this content, but many of these clips contain content that has been broadcast as part of a television programme and so have already been subtitled. We have been investigating ways in which we could locate and reuse broadcast subtitles. To demonstrate this, we have developed a prototype system, currently aimed at the BBC News web site, which searches for when a video clip is broadcast and retrieve the subtitles from our off-air recordings.

Our system works by searching an archive of off-air recordings to match the video clip to identify the time at which it was broadcast and extracting the subtitles for this time-segment. The speed of the search is improved by using data from the web page to reduce the number of programmes that need to be searched. The audio signal is used to perform the comparison because it relates directly to the words in the subtitles. Our system employs an audio fingerprinting algorithm to represent the broadcast content and web clips to speed up the search whilst providing sufficient temporal accuracy.

A snapshot was taken of the BBC News web site at one point in time in order to evaluate the proportion of clips that could be subtitled. The snapshot contained 346 video clips. Of these 40% could be found automatically on a first search, as these clips had not been

edited. When the search was extended to look for edited clips it found matches for a further 20%. Amongst the 40% of clips for which no match could be found the most common causes for these failures were identified as the clip not having been broadcast, too heavily edited or contained no audio.

An analysis of the results across the different sub-sections of the BBC News website found that different sections typically have different editorial requirements, resulting in differing levels of success, as shown in Figure 2. The highest success rate was found with 'Entertainment', 'Health' and 'Science' where clips wer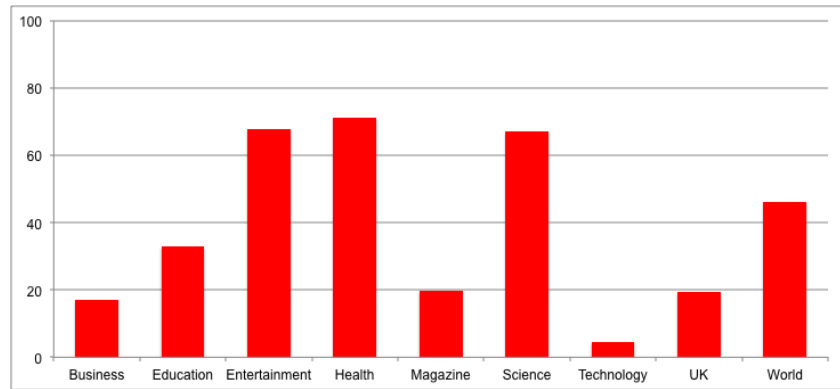e generally taken directly from broadcast while the 'Technology' section provided the lowest success rate. This section contains a high proportion of content that has been made specifically for the web. Whilst our approach cannot provide subtitles for all clips on the BBC News web site our results show the considerable advances that could be made in subtitling broadcaster's web sites in the future. This work was presented as a full paper at NAB earlier this year and a patent application has been made to cover this technique (21).

Figure 2 –Success rate across sub-sections (%age)

UNDERSTANDING THE EXPERIENCE OF OUR AUDIENCE

Our approach to user research has built on the well-established engineering approach to measuring audio and video quality and combined these with techniques for measuring user experience from the fields of human computer interaction (HCI) and accessibility research. This work is being aided greatly by working with university partners, particularly the University of Dundee, who bring with them a wealth of experience of HCI and accessibility along with experience of the issues of representing these user groups (22).

As we have reviewed the published user literature on subtitles some worrying patterns have emerged. We have identifies a number of common problems in previous research which misrepresent the experience of our regular subtitle users. These include:

• Test material shown without sound.

• Test material that excludes lip-reading such as cartoons, animation and dubbed content.

• The use of film content rather than content made for television.

• Tests carried out with convenience samples of participants who are not regular subtitle users and even the use of student subtitlers.

• Eye gaze measurements made with the participant very close to a computer monitor and using a chin rest to constrain head movement, resulting in excessive eye movements.

Unfortunately whilst many research teams clearly signal the limitations of their work, this is not always the case and these problems are compounded where these limitations are not mentioned when the work is referenced. Also, research carried out on subtitles for

translation is often referenced inappropriately in papers on same-language subtitles, and this is a particular problem from work in the field of Audio Visual Translation. The two types of subtitles have very different perceptual experiences. With translation subtitles the audio and lip movements bear little relationship to the text so the viewer is simply reading whereas with same-language subtitles the text acts in concert with hearing and lip-reading to enhance the viewer's understanding of the programme.

These differences have been made clear to us by many of the participants in our user research, all of whom are frequent users of same-language subtitles. Also our survey data showed that around 90% of people using subtitles also have the sound on. In this condition the sound, lip movements and subtitles work together to provide the viewing experience, in effect the subtitles are priming the auditory system. As one participant put it:

> "...*so I'm reading and hearing but the hearing only works if I'm reading – putting two and two together.*"

For this user, and many others the subtitles are providing perceptual priming enabling the person to recognise the words when they hear them spoken. This was reflected by another participant, who used subtitles so that he could watch with normal sound levels:

> "*I turn the volume up and people start complaining so* [I use subtitles] *to help hear*"

For others the subtitles act as a failsafe system, only glanced at when the hearing and/or lip reading doesn't provide the information:

> "*My hearing sometimes is not that great* [so I] *use* [subtitles] *to double check.*"

> "*So I'm watching, I'm lip-reading, and I'm reading the words to check.*"

Because of the issues we have found in previous research we have been particularly careful to make our tests as realistic as possible for our participants, using a test lab which replicates a living room environment along with a normal television or computer as appropriate. We have used structured interviews alongside quantitative measures to draw out the participants' experiences of using subtitles in general and their views on our test examples. Where we have used eye-gaze tracking equipment, it is with a normal television at a normal viewing distance. We have also used realistic test material, selected from our broadcast archive or created content that closely matches normal broadcasts. We use an external recruitment agency to provide test participants who represent of the wide range of subtitle users. We recruit based on subtitle use rather than hearing ability, giving us insight into the full range of user experiences for subtitle users with differing accessibility needs.

Delay and Accuracy

Our first major piece of user research into the quality of live subtitles was commissioned in an attempt to quantify the relative impact of delay and accuracy on the perceived quality of subtitles. This work was published at IBC2013 and showed the big impact that delay has on the perceived quality of subtitles and highlighted the importance of sound on the viewer's experience (23). This work helped stimulate significant improvements to the subtitling of news programmes in the UK and it is now commonplace to see subtitles being presented in sync with the newsreader on live television. This has been achieved by utilising the same script data that is driving the presenter's autocue, also improving accuracy. In addition, many packages are now subtitled in advance. These techniques cannot address delay and accuracy in segments of news programmes containing live interviews, and transitions between live and pre-scripted are especially difficult. However,

it is a vast improvement and there are now many short news bulletins broadcast in the UK that have fully accurate subtitles without any delay.

Monitoring the service

A further key to understanding the quality of the experience of watching subtitles is being able to continuously monitor the service. In parallel with Ofcom's surveys of live subtitle quality based on short samples of programmes selected by Ofcom every six months (13), we have developed a prototype subtitle monitoring system. This has enabled us to plot various parameters of the subtitles across all our main television services on a 24 hours a day 7 days a week basis (24). While our system cannot measure delay and accuracy, it gives a continual measure of the presence or absence of subtitles, the subtitle word rate, the subtitle format and the vertical position on the screen. This has provided baseline data on the service provided and helped identify a number of fault conditions. One of the issues that came to light was the issue of subtitle word rate and this lead to an important piece of research into the impact of word rate on subtitle enjoyment and perceived speed (25).

Dynamic Subtitles

In addition to the move to displaying video in smaller formats, larger television sets are now becoming more common. When viewing subtitles on a larger screen the angle between the main action and the subtitle increases. For this scenario we have tested a different approach where the subtitles are moved closer to the point of interest in the scene, rather than at the bottom, as shown in Figure 3.
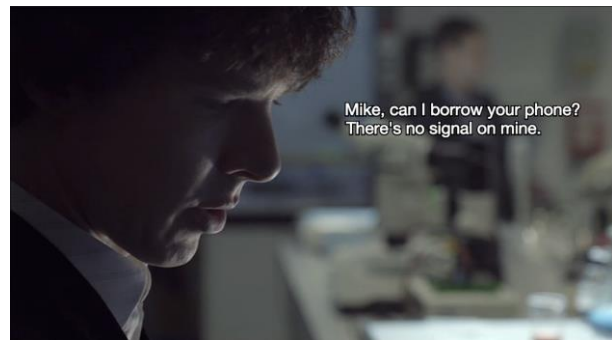

Figure 3 - Example of Dynamic Subtitles.

The video material for this test was a 1 minute 50 second clip from the TV drama "Sherlock". This segment contained 34 subtitle blocks. The subtitles were positioned according to a number of factors, the character speaking the line, the background, and the position of the previous and subsequent subtitles. The subtitles were displayed as white text with a slim black outline. Participants watched the clip on a 47 inch television and an eye-tracker, placed on a coffee table in front of the television, was used to record the gaze of participants as they viewed the clip.

Of the 26 participants there was a clear division of opinion over the experience of dynamic subtitles, of these 5 did not like them, 8 were broadly positive about the experience and 12 were very keen on having them. Interestingly the 3 participants who expressed the greatest dislike of dynamic subtitles all said that they did not rely on subtitles but used them to double check on words they didn't catch. By contrast those who were very keen on dynamic subtitles said that they helped them see the little social cues and body language that they often miss with traditional subtitles and helped greatly with identifying who was speaking and make more sense of conversations. One even commented that the experience of seeing dynamic subtitle would spoil the experience of normal subtitles for them now. The eye tracking data confirmed that the gaze patterns of participants were significantly closer to the eye gaze patterns for viewing without subtitles than normal subtitles and confirmed the results from an earlier set of tests (26).

OPTIONS FOR SUBTITLING ON WEB PAGES

New platforms for video content like video clips in web pages or on mobile devices bring both challenges and opportunities. Challenges come about because of the smaller size and resolution of the video display, whilst opportunities arise because of the increased processing power in the client. Our initial user tests have looked at the user experience of viewing subtitles in a video embedded in a web page.

Subtitle Positioning on a Web Video

One of the key differences between a video displayed on a television and a video clip in a web page is that the video only utilises part of the display area. This introduces the possibility of using part of the web page outside of the video area to display subtitles. One suitable approach might be to display the subtitles just below the video, however we could find little prior work that explored this approach. We conducted a piece of user research to find out if the user experience can be improved by changing the position of subtitles from within a video clip to below and whether this was affected by the size of the video on the page. It also looked at whether users perceived any value in the ability to control the position. The subtitles were displayed in a semi-transparent grey box in both locations giving a similar look and feel in both cases, see Figure 4.
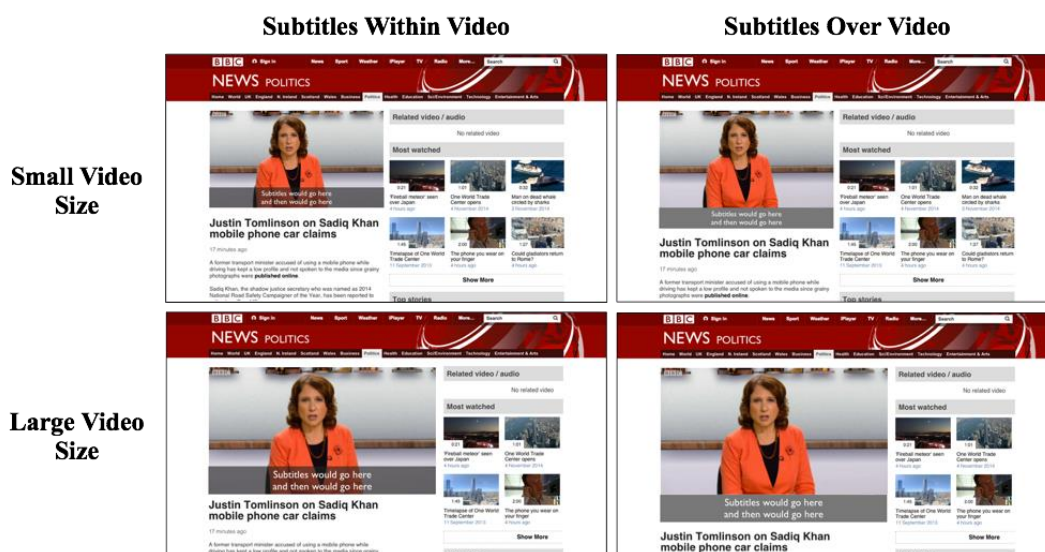

Figure 4 - Layouts used for testing subtitle position on a video in a web page.

The user tests were run with 26 participants who all used subtitles on a daily basis to watch television with sound and regularly used the Internet to consume news and current affairs content. The participants were introduced to the position control and shown four video clips in each of the formats in a balanced design. The user experience for each one was measured using 14 questions on a 5 point Likert scale. These questions were set in a framework of 7 measures of user experience - aesthetics, attention, involvement, familiarity, perceived usefulness, perceived usability and endurability. A semi-structured interview was then carried out to probe further into the user experience.

The scores for each of the 7 factors were combined to give an overall score for each condition. Statistical tests showed no statistical significance for the differences between the four individual cases, but when the scores were combined across the dimensions of

size and position there was no significant effect for size, but there was a small but significant improvement in user experience with the subtitles placed below the video rather than overlaying. Note that this is a different result for the small video in a web page when compared to the preference for large TV viewing above, underlining the need to adapt the subtitles to the viewing context. In the discussions on the control of the position of subtitles participants commented that they might select different positions for different types of content. Overall participants expressed a need and desire for a feature to override the position of subtitles to suite their personal needs according to the context and content (27).

Font Size

In a further piece of work on the display of subtitles on a video in a web page we looked at the impact of providing a control for changing the font size of the subtitles. The subtitles were formatted in the client in a responsive manner (see below) so the number of words displayed was changed to fit the space available whilst maintaining correct timing as the size of the font was adjusted. The participants viewed two video clips, the first from a magazine programme and the second from a drama series.
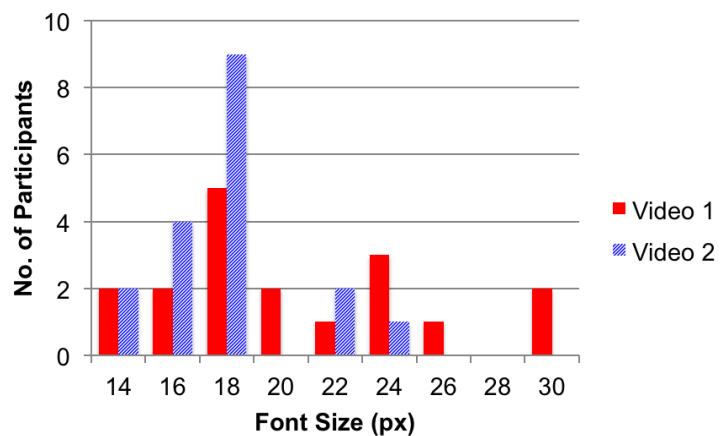

Figure 5 - Distribution of font size choices.

The initial results show that the size to which participants set the subtitles varied substantially, see Figure 5. Some preferred a smaller font as it allowed more words to be displayed at one time, as one participant put it, *"I like it like this with more information. It makes more sense rather than splitting up into shorter sentences."* Whilst others preferred having larger text, *"Its great being able to make it bigger, its almost like I can hear it better".* In all of these recent pieces of research we have found that subtitle users vary in their requirements from subtitles and that their needs vary according to the content they are viewing and the way in which they are viewing it. We have developed an approach which we think will enable the viewer to customise subtitles to best fit their needs and preferences, building on a wider Object Based Broadcasting approach which we are developing at BBC R&D (28).

A NEW APPROACH - RESPONSIVE SUBTITLES

The viewing of television content on computers and portable devices containing substantial levels of processing power opens up the possibility of providing personalised subtitles, tailored to the needs of the viewer and the constraints of the device. Furthermore, this fits well with the fact that viewing on these devices is more often a solo experience in contrast to TV viewing which is often a social activity.

The current subtitling paradigm is that subtitles are created as a complete text block laid over the video content with the assumption that what the subtitler creates will be replicated in what the viewer sees. Whilst the audience were all watching similar size television sets this one-size-fits-all approach was reasonable. However, as subtitles are distributed via many different platforms, translated into different formats and viewed on a wide range of devices this approach breaks down. Also, as we have seen from our research, there are clear differences between the needs of subtitle users. A common complaint of current TV systems is the inability to change the size of the subtitles. However, with current subtitle formats if the size of the subtitles is increased then they either obscure more of the video or spill off the edge of the screen, sometimes both.

We have approached this problem by taking a lead from the world of web design. We have based our work on the concept of Responsive Web Design where the content is rendered into the available space using a fluid method, filling the space available on the display up to a maximum column width or line length. We have called this technique Responsive Subtitles (29). In this approach the contents of the subtitle block is decided in the display device, using timings assigned to each word and rules that avoid orphaned words and uneven line lengths. The key advantage of this approach is that if the user changes the font or alters the size of the font then the subtitle blocks are adjusted to fit within a well-defined display area. If a large font is

Figure 6 – Responsive Subtitles Demo

used then fewer words are displayed on screen, for a shorter time and if a smaller font is chosen then more text can be made available for longer, see figure 6.

This approach opens up further possibilities for personalisation and enhanced display options. These can be under the control of the viewer, but broadcasters could also offer customisation options. For example, a broadcaster could provide location data that places the subtitles close to the speaker for a drama series as with (26) and even rendered subtitles as speech bubbles, but still retaining the option of a conventional subtitling experience. Further user research will be needed to validate this concept, understand how users will exploit it and highlight where we can make improvements. This approach may also provide a solution for subtitling companies that face the problem of having to author different versions of subtitles for different markets. By restyling subtitles using supporting metadata, providers could make multiple versions more efficiently (30).

CONCLUSIONS

Subtitles are a vital part of the viewing experience for a large proportion of the population in the UK. Subtitle research and regulation have changed over time, however, because of shortcomings in some of the previous research and the conflation of same-language subtitles for accessibility with the separate subject of subtitles for translation, there are still

major gaps in our knowledge. Therefore, a great deal more research is needed to fully understand the experience of viewing television with same-language subtitles and usefully update current guidance on subtitling. Our work in BBC R&D is based in the scientific method and on an understanding of human perception and the accessibility context. We are discovering a significant diversity in the needs of different subtitle users and we are exploring ways of providing personalisation for the audience.

Despite considerable changes in technology over the past 35 years, subtitling has been constrained by legacy standards, particularly Teletext and has only recently started to move forward with new formats. This situation contrasts with the developments in television distribution, viewing habits and viewing technology. New opportunities are opening up that can be used to further improve the experience of viewing subtitles by customising subtitles to fit individual preferences and display capabilities.

To meet these needs, we have developed an approach that renders subtitles in a flexible manner. Building on responsive web design we are therefore calling it Responsive Subtitling and we have developed a prototype system which is controlled by style sheets and thus offers a great deal of flexibility for both the user, the subtitle provider and broadcaster. Our approach is one that could be used to meet the needs of different subtitle users who may be watching the same content across a wide range of devices. It could also provides the option of personalisation to meet the individual subtitle user's needs.

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