Using translation process research to explore the creation of subtitles: an eye-tracking study comparing professional and trainee subtitlers

David Orrego-Carmona, Aston University/University of the Free State
Łukasz Dutka, University of Warsaw, Agnieszka Szarkowska, University of Warsaw/University College London

ABSTRACT

Although translation process research (TPR) has become one of the most active fields in Translation Studies in the last 20 years, the process of subtitle creation has received little attention. This subtitling process research study adopts TPR methods to explore the production of interlingual subtitles. We conducted two experiments: Experiment 1 comparing professional subtitlers and subtitling trainees using the same subtitling tool, and Experiment 2 comparing two groups of professional subtitlers, each using a different subtitling programme. We collected data from eye tracking, screen recording, mouse clicks and keystroke logging, and post-experiment interviews. In Experiment 1, professionals and trainees exhibited different subtitling processes, with trainees following a highly structured sequence of viewing, spotting, translation and revision stages. Professionals were slightly faster, but text condensation levels were similar for both groups. In Experiment 2, the options offered by the subtitling tool significantly affected the process. Additionally, the age and experience were suggested as relevant factors influencing the task. Our findings confirm the suitability of using TPR methods to study the production of subtitles and set the grounds for further studies in the field of subtitling process research.

KEYWORDS

Translation process research, audiovisual translation, subtitling process research, subtitle production.

1. Introduction

Most people know what it is like to watch a subtitled film, following the lines of text displayed at the bottom of the screen to understand foreign film dialogue. Yet, few people realise how subtitles are actually created. Numerous guidelines and standards regulate different technical aspects of subtitles, such as the maximum number of lines, number of characters per line, reading speed, etc. (Ivarsson and Carroll 1998; Díaz Cintas and Remael 2007 and Pedersen 2011). A host of experimental research on subtitling so far has looked into how subtitles are processed by viewers (Bruycker and D'Ydewalle 2003; Cambra et al. 2014; d'Ydewalle and Bryucker 2007; d'Ydewalle et al. 1991; Kruger and Steyn 2014; Kruger et al. 2014; Kruger et al. 2017; Mangiron 2016; Orero et al. 2018, Orrego-Carmona 2016; Perego et al. 2016; Romero Fresco 2011) and how certain subtitle parameters affect the viewing experience (De Linde and Kay 1999; Ghia 2012, Jensema 1998; Koolstra et al. 1999; Perego et al. 2010; Rajendran 2013; Szarkowska et al. 2011 and Szarkowska et al. 2016). Not many empirical studies, however, have delved

into the subtitle production process and addressed some basic questions: What exactly do subtitlers do when they subtitle? How different are their workflows? How much is the subtitling process software-dependent? What exactly is it that distinguishes professional subtitlers from trainees? In this paper, we address these questions in more detail by reporting results of an exploratory study on subtitling process we carried out on a group of professional and trainee subtitlers.

2. The exploration of processes in subtitling

Researchers in translation studies have relied on cognitive sciences, psychology, psycholinguistics, neuroscience, and neighbouring areas to study the process of translation (Jakobsen 2001, Hvelplund 2014; O'Brien 2015, Ehrensberger-Dow and Hunziker Heeb 2016). Aiming to understand how translators and interpreters process the information in the source while simultaneously or consecutively producing a target version, different modes of written translation and interpreting have been investigated using techniques such as direct observation, think-aloud protocols, keystroke logging, eye tracking and, more recently, fMRI and EEG (Saldanha and O'Brien 2013). This has led to a considerable amount of research describing different aspects of the translation process, the stages of the production of a translation and the strategies adopted by translators when completing their tasks. However, this movement towards the exploration of the cognitive processes involved in translation have almost completely eluded audiovisual translation in general and subtitling in particular (Kruger and Kruger 2017). Only now are we starting to see how audiovisual translators deal with polysemiotic texts, how they engage with the different semiotic codes in audiovisual texts and how they overcome the issues arising in the translation of audiovisual products.

When creating subtitles, subtitlers face the task of conveying the meaning that is transmitted not only through the verbal linguistic channel but also that of the signs transmitted through other semiotic channels (Chaume 2004:16). Subtitlers have to coordinate the linguistic input with the visual and acoustic information and then create a segmented target text that will function as part of the resulting polysemiotic text.

Subtitles are created using specialised software programmes, so a solid technological competence (EMT 2009) is required. Subtitling software makes it easier for the subtitler to manage the material (video file, source text transcription) and produce the subtitles; it makes it possible to segment and synchronise the subtitles and it allows an immediate visualisation of the results. Additionally, some programmes can also display an audio wave of the soundtrack, which provides a visual representation of the sound to help subtitlers in the process of segmenting and synchronising the text.

The translated subtitle output should additionally comply with a set of spatial and temporal constraints (Díaz Cintas and Remael 2007). Subtitlers normally work with a predefined guide that establishes the number of lines, characters per line and display time according to the product, medium, client or specific requirements. Subtitles are presented on the screen as segmented units of information, synchronised to the speech in the product. The onset and end of the utterances in the dialogues serve as a guide for defining the entry and exit times of the subtitles. Although subtitling guidelines include some rules on the segmentation and there are natural linguistic breaks in the speech that prompt subtitlers to end one subtitle and start another, segmentation is subjective to some extent and might vary depending on translator's personal preferences, particularly when dealing with continuous and fast-paced speech.

Apart from the differentiating aspects mentioned above, subtitling shares the essential characteristics with other forms of interlingual translation. During the subtitling process, subtitlers use the same resources used by other translators: a translation brief or a set of instructions, printed and online dictionaries, style guides or manuals, as well as reference works. Similarly to other types of interlingual translation, subtitlers must also be equipped with cultural competence to ensure that the final product is appropriate for the target audience.

Exploring the subtitling process can help us better understand how subtitlers operate when they face a series of stimuli from different semiotic channels and have to cope with an array of specific technical, linguistic and formal requirements that are part and parcel of subtitling. Tapping into the creation of subtitles and scrutinising the processes behind it offer benefits for subtitlers, trainers, trainees, translators and subtitling tool developers. This ultimately has implications for usability testing, subtitler training, and translation pedagogy.

To the best of our knowledge, only a handful of previous studies employed the translation process research framework in the field of audiovisual translation. In a study conducted in Brazil, Pagano et al. (2011) used screen recording and questionnaires to compare the performance of three professional and three novice subtitlers working with Subtitle Workshop. They analysed the tasks involved in the subtitling process using the three production phases proposed by Jakobsen (2002): orientation, drafting and end-revision. They found that "professionals enact a pattern of shorter total time for task execution, longer revision phase and attention to spotting during the end-revision phase" (Pagano et al. 2011:153).

In his study using seven MA students from the University of Copenhagen, Hvelplund (2017) used eye tracking to analyse the distribution of attention and cognitive effort involved in the process of translating audiovisual content for dubbing. He found that "novice dubbing translators spend the majority of the translation process working with the TT, followed by ST processing and then the audiovisual material" (2017). Pupil size indicators in his study suggest that, even though little time is dedicated to the video while translating, this seems to be the most cognitive-taxing task performed by the participants.

In a small-scale study on in-house professional subtitlers using TitleVision 2000 software in Denmark, Beuchert (2017) employed screen recordings and cue-based retrospective interviews. In terms of the subtitling process, she found that subtitlers tended to have a pre-spotting phase, where they roughly spotted a scene first, paying a lot of attention to shot changes, then filled the subtitles with translation and went on to improve spotting. The author also explored a myriad of aspects related to the work process of subtitlers: from workplace ergonomics, workflows, software, keyboard shortcuts, through linguistic and translation aspects, such as text reduction and condensation, to rates, subtitling brief, and employment conditions.

A study by Szarkowska et al. (forthcoming) examined the distribution of visual attention in intralingual respeaking during a live subtitling task. Using eye tracking and post-task interviews, the authors established that people with experience in pre-recorded subtitling managed their visual attention more efficiently by fixating on key screen areas, such as subtitles. They also had longer fixation duration on subtitles than other groups, which may be an indication of deeper processing and higher expertise (Holmqvist et al. 2011).

3. Overview of the study

The primary goal of this study is to explore the subtitling process, focusing on how it might be affected by experience and subtitling tools. With this goal in mind, relying on the translation process research framework, we conducted two experiments:

- **Experiment 1:** comparing professional subtitlers and trainees, using the same subtitling programme (EZTitles)
- **Experiment 2:** comparing professional subtitlers using two different subtitling programmes (EZTitles and EdList)[1]

We follow a mixed-methods approach combining qualitative and quantitative analyses to assess the data. In Experiment 1, we hypothesised that – given their technological and linguistic expertise – professionals would complete the task faster than trainees and that the subtitled text they produce would be a

more condensed version of the original. We were also interested in finding whether the subtitling workflow differs between professionals and trainees, and how each group allocated attention to the different areas of the screen. In Experiment 2, when comparing the professional subtitlers working with two different types of subtitling software, we wanted to see how the subtitling process was affected by the type of tool. For this, we used the two most common subtitling programmes used by subtitlers on the Polish market: EZTitles and EdList.

To the best of our knowledge, this study constitutes the first attempt to empirically analyse the subtitling production process with the use of eye-tracking technology. In this exploratory study, we shed some light on the process of creating subtitles and discuss a few methodological issues we encountered when applying translation process research methods to the study of subtitling. The study may have direct implications for subtitler training and subtitling software development; it may also bring improvements to the subtitler work environment.

3.1 Participants

A total ten professional subtitlers (9 women and 1 man) and five subtitling trainees (4 women and 1 man) took part in the experiments. Among the professionals, 6 participants used EZTitles and 4 used EdList. The mean age of the professionals using EZTitles was 29.33 years (*SD*=6.9), while for the professionals using EdList it was 42.75 years (*SD*=11.9). The trainees were 22.6 (*SD*=0.55) years old on average.

The professionals were recruited on the understanding that their main source of income is related to translation tasks. They were contacted through the mailing list moderated by the Polish Association of Audiovisual Translators (STAW). The trainees were all enrolled in the MA translation programme at the Institute of Applied Linguistics at the University of Warsaw. At the time of the experiment, all of them had completed an optional 30-hour subtitling course as part of their MA studies. All the participants worked with the English-Polish language combination.

3.2 Subtitling task and material

Participants were asked to spot and to translate a video from English to Polish. The video lasted 85 seconds and was taken from the first episode of the HBO series *The Newsroom* (Sorkin, 2012). The video segment was selected because it contained fast-paced dialogue with specialised terminology in a newsroom setting. The video was short in order to minimise fatigue. The participants were provided with the English transcription, which was 354-word (1778

characters) long and consisted of plain text only, without any subtitle segmentation or time codes.

3.3 Procedure

The participants were tested individually in a soundproof research lab (see Fig. 1) at the Institute of Applied Linguistics, University of Warsaw, in November and December 2015. Upon arrival, each participant received an information sheet about the study and signed an informed consent form. The session was divided into three stages. First, participants filled out a questionnaire covering the demographic information and professional experience. Then, they completed the subtitling task and finally, they had an interview with the researchers.

For the experiment, the participants could type on the laptop's keyboard or they could use an external keyboard and a mouse, depending on their preference. They were allowed to use the Internet. No time limit was set. The participants were instructed that when using the Internet, they needed to adjust the browser window so that it covers the entire screen. Thus, all the fixations that occur at times when the participant is using the internet are made inside the browser since nothing else is visible on the screen. All this information was explained to the participants before starting the recording and was also shown to them on the screen before starting the experiment and after the calibration of the eye tracker.

The participants were told to use the following settings in the subtitling software: maximum two lines in a subtitle and 37 characters per line, maximum reading speed of 15 characters per second (including spaces). Fifteen characters per second is a standard setting on Polish television (Szarkowska 2016), which was also confirmed by participants in post-test interviews.

3.4 Apparatus

The participants worked on a laptop connected to an SMI RED 250 mobile eye tracker, which was used to record their eye movements during the translation session. Participants' eye movements were recorded with the sampling rate of 250Hz. We used SMI software package Experiment Suite to create and conduct the experiment, and SPSS v. 24 to analyse the data.

Regarding the subtitling software used, in Experiment 1, the participants completed the task using EZTitles (manufactured by EZTitles Development Studio, version 4), while in Experiment 2, one group of participants used EZTitles and the other group used EdList.

Figure 1. Experimental set up.

The procedure and apparatus were pilot tested with an additional professional subtitler who fit the profile defined for the study. This test helped us to refine the protocols and ensure the setup was comfortable for the participants. Although we did not change the structure of the study, the results from this participant were not included in the analysis since she was not briefed following the same procedure as the remaining participants. After the pilot, additional on-screen tests were added to the experiment in order to make sure that the task instructions were clear for the participants.

3.5 Design

The study followed a between-subject design with group as the main independent variable: professionals vs. trainees in Experiment 1, and professionals using EZTitles vs. professionals using EdList in Experiment 2. The dependent variables used to assess the process of subtitling were categorised under three types of effort adapted from Krings (2001): temporal, cognitive and production (see also Table 1).

- Temporal effort was measured as task completion time, i.e. the total amount of time that participants took to complete the task. Longer times to complete the task could indicate less experience. We expected trainees to have significantly longer times than professionals in Experiment 1, but professionals in Experiment 2 to perform similarly.

- Cognitive effort was measured using two eye-tracking variables: mean fixation duration and dwell time[2], calculated based on different areas of interest (AOIs) on the screen, particularly the subtitles and the video. According to Hvelplund, "in translation process research using eye tracking data, fixation duration and fixation count are [...] often taken to

index cognitive effort" (2014: 212). Higher mean fixation duration and longer dwell time can be taken as an indication of higher cognitive effort (Holmqvist et al. 2011). We also measured the amount of time spent doing research on the Internet as a percentage of task completion time to examine the allocation of attention during the subtitling process.

- Production effort was operationalised using mouse clicks and keylogging, a traditional method to analyse effort in translation process research (Lacruz 2017). Keystrokes were recorded using SMI Experiment Center and analysed in combination with mouse clicks as events of user interaction with the software. Another production effort indicator of subtitling competence we included in the study was text reduction, basing on the assumption that it is one of the key aspects that novice subtitlers need to master (Díaz Cintas and Remael 2007). Text reduction was calculated as the difference between the number of characters in the English transcription (source text) and the number of characters in the subtitles (target text).

For the qualitative part of our study, we examined the structure of the subtitling process as a whole. We wanted to know how professionals and trainees divided the subtitling process and whether there were any differences in how they did it. With this goal in mind, we analysed the different stages of the process qualitatively and studied how the subtitlers tackled the different stages, such as the first viewing of the original video, spotting, translation and revision.

Type of effort	**Variable**	**Unit**	**Operationalisation**
Temporal	Task completion time	Minutes	Time taken to translate and spot the video, and to produce a target text subtitle file
Cognitive	Mean fixation duration per AOI	Milliseconds	Mean fixation duration for each AOI on the screen per participant
Cognitive	Relative dwell time per AOI	Percentage	Percentage of time spent in an AOI (subtitle and video) relative to the total task duration as an indicator of visual attention allocation
Cognitive	Relative time using the Internet	Percentage	Percentage of time spent using the Internet over the task completion time as an indicator of attention allocation
Production	Average interaction events	Number of interaction events	Average interaction events (the sum of all keystrokes and mouse clicks) per group

Production	Mouse clicks/ interaction events	Percentage	Average mouse clicks over total events ratio
Production	Text reduction	Number of characters	Average number of characters in the target text over the number of characters in the source text

Table 1. Operationalisation of dependent variables per type of effort

3.6 Data analysis

All eye tracking data were extracted from Areas of Interest defined on different areas of the screen (see Figure 2 and Figure 3): the toolbars, the audiowave, the subtitle panel (the list of the subtitles in the file), the subtitle area (where the text of the currently selected subtitle is shown and can be edited) and the video.

Participants with tracking ratio below 80% were excluded from the eye tracking analyses (but not from other analyses). Owing to the poor quality of eye tracking data, three participants had to be excluded from the eye-tracking data analyses: P02 and P12, who were professionals working with EZTitles, and N05, a trainee also working with EZTitles. These participants were not excluded from other analyses, such as task completion time or text reduction.

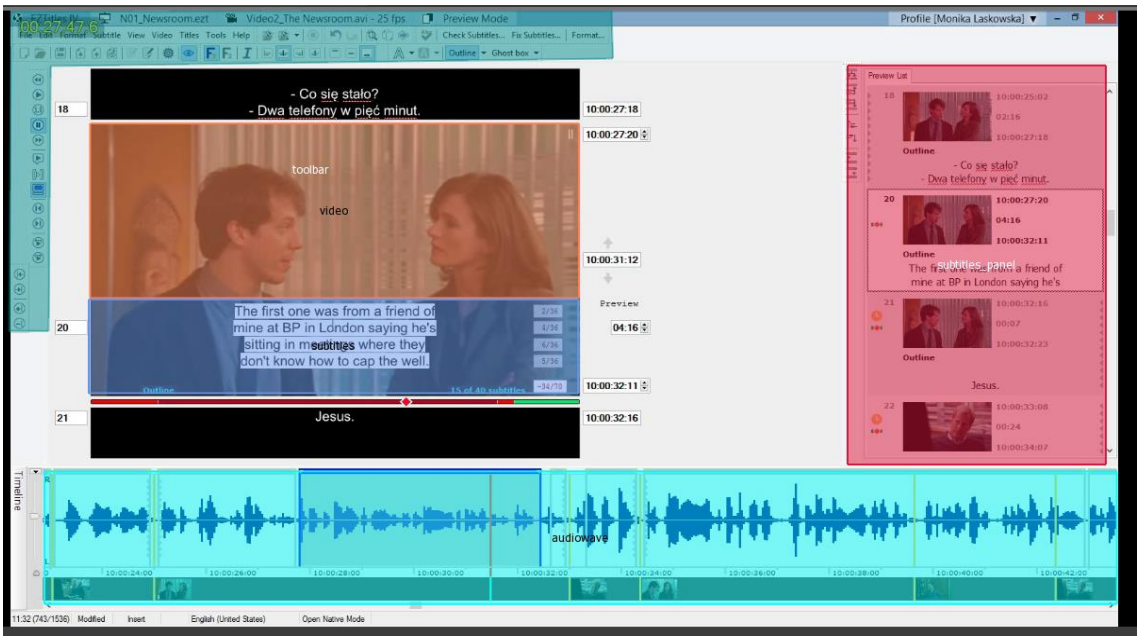

Figure 2. Areas of interest in EZTitles

In the case of EZTitles, given that the subtitle which is being edited is shown over the video (so that the subtitler can see how the subtitle would look like and how much of the image it would cover), the subtitle area and the video overlap. Thus, the video AOI for EZTitles refers to the part of the image which

is not being covered by the subtitle at a given time. As the subtitler was editing their translation, the part of the image that was covered changed. To take that into account, the video AOI and the subtitle area AOI were drawn as dynamic areas of interest, and they were adjusted to follow the editing process. A video clip illustrating how dynamic AOIs were adjusted depending on the participants' actions can be viewed here.

Figure 3 shows the initial screen setup used for EdList. The EdList window has limited resolution and the user cannot enlarge the software window to fill the whole screen. The participant's screen displays the transcription in English in a Word document side by side to the EdList window. For EdList, there were four AOIs: the toolbar, subtitles, video, and transcription.

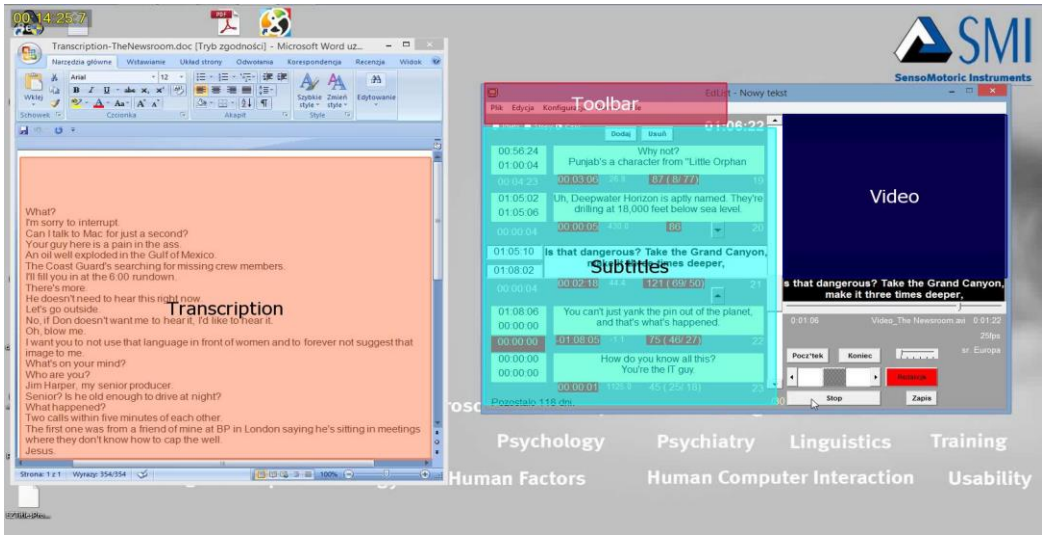

Figure 3. EdList setup

Both for subtitlers working with EdList and EZTitles, an additional area of interest was drawn for the entire screen when participants used the Internet.

4. Results and discussion

4.1 Experiment 1: Professionals and trainees

In this experiment, we compared the performance of six professionals and five trainees completing the subtitling task described in 4.1. Both groups of participants used EZTitles and followed the same procedure.

4.1.1 Temporal effort

Task completion time
To see whether professionals were faster than trainees, we measured how long it took both groups to complete the task (see Table 2). Using an independent-

samples T test, we found that the professionals (*M*=60.70 minutes, *SD*=13.38) were faster than trainees (*M*=76.84 minutes, *SD*=10.07). The difference was borderline significant (t(9)=-2.17, *p*=0.05), which we attribute to the small sample size.

Group	*n*	Mean (minutes)	SD	Minimum	Maximum
Professionals	6	60.70	13.38	39	74
Trainees	5	76.84	10.07	61	84

Table 2. Task completion time by group

A visual inspection of the results shows a large variation among participants. The fastest professional subtitler completed the task in about 39 minutes, but another person took as long as 74 minutes. In the case of the trainees, the task completion time ranged from 61 to 84 minutes. These results therefore need to be treated as indicative and replicated on a larger sample of participants. Time constraints are known to affect translation processes (Hvelplund 2011) and future studies could explore whether setting a time limit affects the subtitlers' work.

4.1.2 Cognitive effort

To find out if the subtitling process was more effortful for the trainees than for the professionals, we analysed their mean fixation duration and the time they spent looking at different screen areas. We also measured their use of the Internet as an indicator of attention allocation during the subtitling process.

Mean fixation duration on AOIs
As is typical in TPR (Hvelplund 2014), we compared whether there was any significant difference in the mean fixation duration between the two groups for each AOI. Table 3 presents the mean fixation duration for the AOIs averaged per participant. Independent t-test showed no between-group differences on any of the AOIs: Video (t(6)=-0.461, *p*=0.6), Subtitles (t(6)=1.805, *p*=0.1) or Internet (t(6)=0.971, *p*=0.4). Even though the results did not reach statistical significance, the descriptive statistics may point to some interesting differences. For example, mean fixation duration was longer on the subtitles AOIs for professionals compared to trainees, which may indicate deeper and more efficient processing. It is also in line with previous studies showing that expertise – in various fields like art, chess and goalkeeping – leads to longer fixation durations (see Holmqvist et al. 2011:383).

To uncover any potential differences in participants' cognitive load when looking at the different areas of the screen, we conducted a paired-samples T test. Descriptive statistics show that participants had a longer mean fixation

duration on the video area (*M*=213.4, *SD*=66.27) than on the subtitles (*M*=201.45, *SD*=30.59), but the comparison of the mean did not reach significant results (t(7)=-0.564, *p*=0.59). Yet, this may be an indication of different behaviours between professionals and trainees that could be explored in future studies on larger samples.

Participant	Toolbar	Audio wave	Subtitles	Video	Internet
P02	--	--	--	--	--
P04	206	184.4	198	198.3	203.2
P06	175.2	189.7	218.9	198.5	209.5
P07	293.2	223.5	232.2	213.2	210.3
P09	238.8	200.7	224.6	197.7	205.6
P12	--	--	--	--	--
Mean	**228.30**	**199.57**	**218.42**	**201.42**	**207.15**
T1	205.8	157	167.9	187.9	222.7
T2	172.9	151.2	143.6	145.9	174.5
T3	198.9	229.3	214.7	370	207.8
T4	175.6	210.6	211.7	195.7	177.5
T5	--	--	--	--	--
Mean	**188.30**	**175.66**	**184.47**	**224.87**	**195.62**

*Note: In Participant ID column, P stands for 'professional' and T stands for 'trainee'

Table 3. Mean fixation duration (in milliseconds) per area of interest

Dwell time on AOIs as a percentage of total dwell time

When comparing the time that participants spent on the subtitles and on the video, we considered the relative time they dedicated to these AOIs out of the total time spent on the task (Table 4).

	Dwell time (%) on subtitles	Dwell time (%) on video	Dwell time (%) on the Internet
P02	--	--	20.2
P04	21	4.9	22.5
P06	27.1	2.2	11.7
P07	24	6.3	28.1
P09	30	4.3	22.5
P12	--	--	19
Mean	**25.53**	**4.43**	**20.66**
T1	39	7.7	11.8
T2	28.6	2.8	9.5
T3	29.1	3.4	12.6
T4	27.1	4.3	7
T5	--	--	19
Mean	**30.95**	**4.55**	**11.98**

Table 4. Mean dwell time on the internet, subtitle area and video

The analysis of the percentage of dwell time on the subtitles did not show any significant differences (t(6)=0.566, *p*=0.15). On average, the participants spent about a third of their time gazing at the subtitles: the professionals looked at the subtitles for 25.53% of the time and the trainees 30.95% of the time. The time spent by both groups looking at the video was similar. Interestingly, the participants only looked at the video for about 4% of the total task duration, which may come as a surprise considering the importance of the images for subtitling. Finally, trainees spent relatively less time doing Internet search compared to the professionals, who devoted about 20% of their time to this stage of subtitling.

Relative time using the Internet

We also wanted to know how the two groups used the Internet for subtitling. Our assumption was that professional subtitlers would use Internet resources more than trainees, as expertise would make them more conscious not only about what they do not know but also about what they need to double check. An independent-samples T test showed a significant difference in the relative time using the Internet between professionals (*M*=20.66, *SD*=5.39) and the trainees (*M*=11.98, *SD*=4.49), t(9)=2.68, *p*=0.019, *d*=1.75. The professional subtitlers spent twice as much time as trainees on using Internet resources. Figure 4 shows a visual representation of the segmentation of the subtitling process. The blocks in navy blue depict the instances in which the participants used the internet.

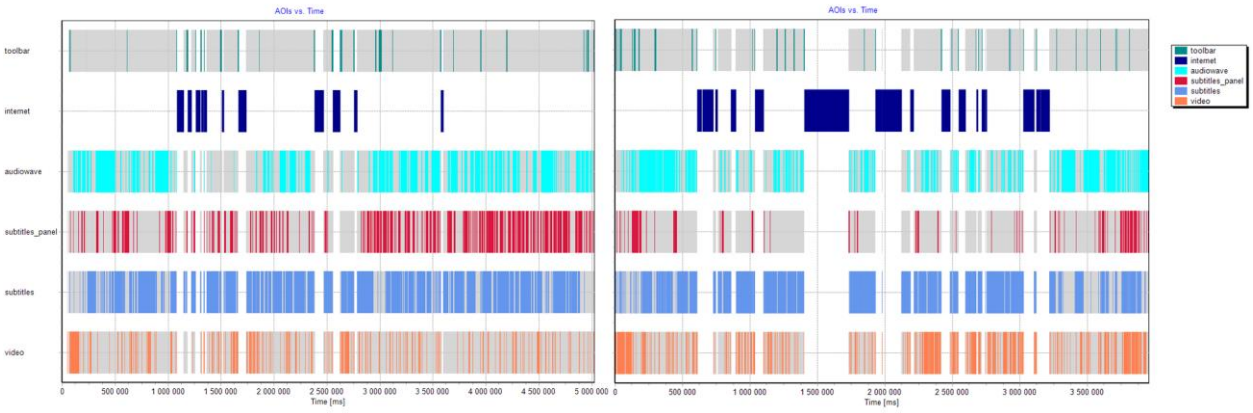

Figure 4. Distribution of attention between AOIs covering subtitling software ('toolbar,' 'audiowave,' 'subtitles panel,' 'subtitles,' 'video') and the browser ('internet,' shown in navy blue) for participants N02 (on the left) and P07 (on the right).

Despite our predictions, we found little variation between professionals and trainees in terms of the type of online resources used. Both professionals and trainees relied largely on Google and Wikipedia as their main sources of information. A typical pattern we observed in many participants was that they

looked for an English term in Wikipedia, and then switched language to Polish, as shown in Video 2 from a trainee using Wikipedia here.

Google was used both as a search engine to find websites providing information about the content of the video or to solve specific doubts and as a corpus to confirm equivalence and linguistic decisions. Some participants would search for specific dictionaries of synonyms or bilingual dictionaries, but in most cases, they would also rely on Google to open the dictionary websites rather than typing specific URLs. Only one participant used Proz.com in their term search to translate the term "rundown," as shown in Video 3.

4.1.3 Production effort

Mouse clicks/interaction events
In order to quantify the participants' production effort, we registered their keystrokes and mouse clicks. We were interested in any potential differences between the groups regarding how they interacted with the software. For long, keystroke logging has been used in TPR to empirically explore the translation process at a granular level (Jakobsen 2002, Hansen 2006) because it not only provides access to the final product but also makes it possible to scrutinise how the product comes to be and to quantify the effort needed for its production.

Keystrokes and mouse clicks are essential in subtitling. During the subtitling process, especially at the spotting stage, subtitlers could either use the keyboard shortcuts or the mouse to cue the subtitles and adjust their duration. Using keyboard shortcuts is considerably faster and more accurate, but requires internalising a number of key combinations. In contrast, using mouse clicks to cue subtitles is not as precise, but may be an easier option, particularly for inexperienced users. Importantly, excessive mouse use may result in repetitive strain injury (RSI), so it would be recommended for new users to master using keyboard shortcuts rather than rely on the mouse.

Group	*n*	Mouse clicks	Key presses	Total interactions	Mouse clicks/ interactions
Professionals	6	404.5	5277.67	5682.16	7.12%
Trainees	5	488.8	4306.8	4795.6	10.19%

Table 5. User events by group.

Table 5 summarises the results of user interaction events for professionals and trainees. Professionals had more key presses than trainees, whereas trainees had more mouse clicks than professionals. For professionals, out of the total 5682.16 interaction events with the software, 7.12% were mouse clicks. For trainees, the total number of interactions amounted to 4795.6 on average, out

of which 10.19% were mouse clicks. We ran independent-samples T tests comparing the average total interactions per group (t(9)=-0.482, *p*=0.64) and also the means of the mouse clicks/interactions ratio (t(9)=-1.006, *p*=0.34). Although these analyses did not reach statistical significance, we believe this is an interesting line of inquiry to be pursued in the future subtitling process research.

Text reduction

Condensation and text reduction are essential characteristics of the translation for subtitles (Díaz Cintas and Remael 2007). Considering the temporal and spatial constraints of subtitling, we looked at text reduction as an indicator of production effort that could be related to the subtitler's competence. To measure text reduction, we examined the number of characters in the subtitles produced by the participants and compared them with the original English transcription (See Table 6).

Group	*n*	Mean (characters)	SD	Reduction (%)	Minimum	Maximum
Professionals	6	1219.5	57.13	31.41%	1165	1325
Trainees	5	1239.8	26.55	30.27%	1212	1275

Table 6. Average number of characters in the subtitles by group.

We were particularly interested in comparing text reduction between trainees and professionals because trainees had only attended a 30-hour course in subtitling, and possibly had not yet developed the reduction skills required in the subtitling profession. However, the statistical tests did not show any significant differences between the average number of characters in the subtitles created by the professionals (1219.5) and that of the trainees (1239.8). This may be taken to show that text reduction was not a major issue for trainees in our experiment. However, we need to be cautious with these preliminary results and in the future compare the quality of text produced by both groups to draw more reliable conclusions on subtitling competence acquisition. Further studies could compare how professionals and trainees perform following different subtitling guidelines, using different software programmes and working under different reading speeds.

4.2 Experiment 2: Professionals using different subtitling software programmes

Experiment 2 follows the same structure as Experiment 1 described in section 4.1. In Experiment 2, we compare the performance of professional translators using two different subtitling programmes, EZTitles and EdList, as presented in 4.3.

4.2.1 Temporal effort

Task completion time
As a first step, we were interested in whether the type of subtitling software affects the time taken to complete the task (see Table 7). We expected the time between the two groups to be similar as participants were working on the software they were familiar with.

Group	*n*	Mean (minutes)	SD	Minimum	Maximum
Professionals EZTitles	6	60.70	13.38	39	74
Professionals EdList	4	66	21.25	39	90

Table 7. Task completion time by group of professionals

The professionals working with EZTitles were slightly faster than those using EdList, but the difference was not significant (t(8)=-0.490, p=0.63). In both professional groups, the fastest subtitlers completed the task in about 39 minutes, but there was one subtitler using EZTitles who took 74 minutes to complete the task and another one using EdList who took 90 minutes. We acknowledge that this wide range of possibilities might be representative of different working styles, expertise or competences and not necessarily related to the type of tool used.

4.2.2 Cognitive effort

Mean fixation duration on AOIs
Similarly to Experiment 1, here we also compared the mean fixation durations between the two groups (Tables 8.1 and 8.2). The statistical analysis of the mean fixation durations on the subtitles, the video and the Internet between the two groups of participants did not yield any statistically significant result. The fixation durations on the different AOIs were similar for all participants.
However, a paired-samples T test revealed interesting results when comparing mean fixation durations across AOIs. The difference between the mean fixation durations on the subtitles (222.43) and on the video (203.67) was statistically significant (t(7)=3.005, p=0.02, d=0.05). Similar results were found when comparing the mean fixation on the subtitles to the mean fixation on the Internet (208.23), although in this case, the results were borderline significant and the effect is small (t(7)=2.381, p=0.049, d=0.03). In both cases, the fixations on the subtitles are significantly longer than those on other AOIs. On the one hand, this may be taken to suggest that the processing of the video and the information on the Internet is less cognitively demanding than the processing of the information on the subtitle area. On the other hand, it may also indicate a deeper processing when producing subtitles (Holmqvist et al. 2011).

Participant	Toolbar	Audio wave	Subtitles	Video	Internet
P02	--	--	--	--	--
P04	206	184.4	198	198.3	203.2
P06	175.2	189.7	218.9	198.5	209.5
P07	293.2	223.5	232.2	213.2	210.3
P09	238.8	200.7	224.6	197.7	205.6
P12	--	--	--	--	--
Mean	**228.30**	**199.57**	**218.42**	**201.42**	**207.15**

Table 8.1. Mean fixation duration (in milliseconds) per area of interest / EZTitles.

Participant	Toolbar	Subtitles	Video	Transcription	Internet
P08	284.7	275.9	285.3	251.6	278.3
P10	182.4	172.2	156.1	146.3	128.7
P11	233.7	258.5	211	219.5	258.5
P13	179	199.1	169.3	180.7	171.8
Mean	**219.95**	**226.43**	**205.43**	**199.53**	**209.33**

Table 8.2. Mean fixation duration (in milliseconds) per area of interest / EdList.

As is typical in TPR, we wanted to compare whether there was any significant difference between the mean fixation durations on the source text dialogue transcription and the target text subtitles. Research on the distribution of attention in TPR suggests that processing the target text is more demanding as indicated by mean fixation duration (Sharmin et al. 2008) and pupil dilation (Hvelplund 2011). Unfortunately, we could not conduct such an analysis for all participants because in EZTitles the fixations on the subtitles and the transcription overlap: the subtitlers overwrite the transcription with the translation in Polish in EZtitles (as can be seen in Video 4).

Our setup allowed us to perform this comparison for the professional translators working with EdList. A paired-samples T test found a statistically significant difference between the mean fixation duration on the source text dialogue transcription and the target text subtitles, with a medium effect size ($t(3)=6.193$, $p=0.008$, $d=0.5$). The results coincide with previous studies indicating that the processing of the target text is more cognitively demanding than that of the source text.

Dwell time on AOIs as a percentage of total dwell time

When comparing the dwell times between the two groups of professionals, we found their behaviour to be very different (see Table 9).

	Software	Dwell time (%) on subtitles	Dwell time (%) on video	Dwell time (%) on the Internet
P02	EZTitles	--	--	20.2
P04	EZTitles	21	4.9	22.5
P06	EZTitles	27.1	2.2	11.7
P07	EZTitles	24	6.3	28.1
P09	EZTitles	30	4.3	22.5
P12	EZTitles	--	--	19
Mean		**25.53**	**4.43**	**20.66**
P08	EdList	25.7	13.2	5.8
P10	EdList	41.6	15.2	5.7
P11	EdList	41.4	10.8	3.6
P13	EdList	38.6	15.9	5.9
Mean	**EdList**	**36.83**	**13.77**	**5.25**

Table 9. Mean fixation duration (in milliseconds) per area of interest.

The professionals translating with EZTitles looked at the subtitles for 25.53% of the time, whereas the professionals using EdList 36.83% of the time. An independent-samples T test indicated that these scores were significantly higher for the EdList group ($t(6)=2.66$, $p=0.37$, $d=1.8$). The professionals using EdList also looked at the video for significantly longer than those working with EZTitles: those using EdList dedicated 13.77% of the time to the video, while subtitlers using EZTitles only looked at the video for 4.43% of the time ($t(6)=6.55$, $p<0.001$, $d=4.6$). We believe this result may be attributed to different design and functionalities of the two programmes. Whereas in EdList, the subtitles and the video are the two core components, in EZTitles there are also other important areas and functionalities that drew the attention of subtitlers in the process, such as the audiowave, which is an area that subtitlers fixate considerably when subtitling in EZTitles.

Relative time using the Internet

We expected to find similar reliance on the Internet in the two groups. However, the professionals using EdList used the Internet ($M=5.25$ $SD=1.1$) much less than the professionals using EZTitles ($M=20.66$, $SD=5.4$), ($t(8)=5.53$, $p<0.001$, $d=3.9$). Subtitlers using EZTitles spent about four times more time using the Internet than those using EdList.

In the post-test interviews, many professionals working with EZTitles confirmed they spent a considerable amount of time doing online research. One subtitler said: "I use online dictionaries a lot. Usually, I check many words. Usually, if I had any doubt how to write a word, I look it up in the dictionary just to make sure, so I'm very cautious about it." Another person explained that "I often search for synonyms on websites in the case of SDH and I use Wikipedia too… and of course, if there is nothing on Wikipedia or I'm not sure,

I use other sources to check some facts if I think that… or spelling, if I think that some characters or some fact is not well translated." While we are not sure how to interpret these differences in the use of the Internet, we acknowledge that they may not necessarily be related to the software, but rather to subtitler's age and habits they formed at the outset. Many EdList subtitlers, who are on average 13.42 years older than their counterparts using EZTitles, joined the profession in the pre-Internet era. Naturally, these preliminary observations need to be confirmed with larger groups of professionals and programmes.

4.2.3 Production effort

Mouse clicks/interaction events

Comparing user events between the two groups of professionals allowed us to delve deeper into their different working styles as affected by the two subtitling programmes. EZTitles offers an advanced array of functionalities intended to streamline the subtitling process. Many functions have key combinations for quick access so that subtitlers do not have to rely on the mouse. Users can also change existing key combinations and create new ones according to their needs and mastery of the tool. EdList, on the contrary, is much more restrictive. It relies primarily on mouse clicks, the number of shortcuts available is limited and it does not allow for customisation.

Group	*n*	Mouse clicks	Key presses	Total interactions	Mouse clicks/ interactions
Professionals EZTitles	6	404.5	5277.67	5682.16	7.12%
Professionals EdList	4	1313.3	2485.75	3799	34.57%

Table 10. User events by the professionals using EdList.

Using mouse clicks and keystroke logging as an indication of the production effort, we found important differences in how the participants interacted with the two programmes. The professionals using EZTitles had on average 5682.12 interaction events with the software, of which only 7.12% (404.50) were mouse clicks (see Table 5 and Table 10). In contrast, professionals working with EdList had 3799 interactions, of which 34.5% (1313.25) were mouse clicks. The EdList professionals used the mouse significantly more ($t(8)=4.63$, $p=0.002$, $d=3.1$), whereas the EZTitles professionals relied mostly on the keyboard ($t(8)=4.42$, $p=0.002$, $d=3$). The analysis of the ratio of the mouse clicks and total interactions events also yielded statistically significant results ($t(8)=7.19$, $p<0.001$, $d=4$). The results clearly show different forms of interaction with the software programmes. The activities of the professionals working with EZTitles relied primarily on the keyboard while those working with EdList, on the mouse. These differences however did not affect text reduction.

Text reduction

Given that we were dealing with two groups of professional translators, we expected their text reduction levels to be similar. However, an independent-samples T test showed that the subtitles produced by the professionals using EZTitles (M=1219.5 characters, SD=57.13) were, on average, significantly longer than those produced by the professionals using EdList (M=967.75 characters, SD=37.88), (t(8)=7.68, p<0.001, d=5.1).

While we are not sure how to interpret this result, we believe it may be related to the individual characteristics of the two groups of professionals. Subtitlers using EdList were on average more experienced and older than those using EZTitles. Having worked in the area for many years, EdList subtitlers were trained in the times when the maximum number of characters per line in a subtitle was lower (e.g. 32 characters in the analogue cinema) due to smaller TV screens and lower image resolution – all this called for higher reduction requirements. Most subtitlers using EZTitles entered the market later, which may explain their choice of the preferred software. It may also point to changes in the subtitling industry over the years (e.g. the arrival of Netflix with its maximum number of characters per line going up to 42).

Group	*n*	Mean (characters)	SD	Reduction (%)	Minimum	Maximum
Professionals EZTitles	6	1219.5	57.13	31.41%	1165	1325
Professionals EdList	4	967.75	37.88	45.57%	914	1003

Table 11. Average number of characters in the subtitles by professionals using EdList.

From the viewers' perspective, shorter subtitles should require less time to read and give viewers more time to look at the on-screen action, although the efficiency of subtitles also depends on presentation rate and language proficiency (Romero-Fresco 2015; Szarkowska et al. 2016). Character count is used in this study only as an indicator of the actions taken by the subtitlers, not as a quality indicator. More comprehensive analyses would be needed to understand whether it correlates with quality measures.

4.3 Subtitling process

In this qualitative part, we analyse the subtitling process from both experiments. The subtitling process can be divided into a series of stages involving spotting, translation and revision.

Following the exploration of the screen recordings, we found that professionals and trainees exhibited two different patterns in how they approached the task.

The trainees followed a clearly segmented process: they started by watching the whole clip first and then went through independent spotting and translation stages. In the end, they had a few rounds of revision and their revision process was not very structured: they revised the translation more than once and revisited some of the previous decisions.

The professionals, on the other hand, did not follow a clearly delineated path with independent subtasks; instead, their spotting, translation and revision stages largely overlapped. Most of them had just one round of thorough revision at the end, but some would only revisit specific parts of the clip that they had previously marked while translating. During their translation, professional subtitlers modified the text as needed, combining activities of what Jakobsen (2002) calls 'online revision', i.e. changes that occur as part of the text production and not as an independent revision phase. Similarly to Pagano et al. (2011), we also found that professionals invested less time in revision than trainees, yet they were more efficient. The strategy to have a solid revision stage has been reported before by Jensen and Jakobsen (2000) and Englund Dimitrova (2005) when testing translators.

Unlike the trainees, only three of the professionals watched the clip in its entirety before starting; others began translating straight away. This finding contradicts the results presented by Pagano et al. (2011) in which the researchers were able to clearly identify three different stages in the subtitling process: orientation, drafting, and revision. The reason why students watched the entire film first could be attributed to the instructions they received during the subtitling course. Their behaviour could also be a result of the Hawthorne or observer's effect (Fleiss et al. 2003) that occurs when people consciously decide to alter their behaviour because they are aware of the study. In this case, the students could have decided to follow a structured subtitling process to improve their behaviour while being tested in an academic setting.

Another important difference between the professionals and the trainees, possibly indicating varying technological competence, is discernible in their mastery of the subtitling programme. Let us illustrate this on the example of spotting: Video 5, spotting a professional subtitler and Video 6, spotting a trainee subtitler, show the spotting stage done by a professional and a trainee.

Whereas the professional is using the numeric keypad to insert the in and out times of the subtitles, the trainee is struggling with the space bar to complete the same task. In this case, the familiarity of the professional with the software allows her to complete the spotting in a single round. In contrast, the trainee's spotting requires a first round to set the times, and then a second round of revision for the preliminary spotting.

5. General discussion

In this study — which to the best of our knowledge is the first exploratory study of the subtitling process using eye tracking — we compared professional and trainee subtitlers on the one hand, and professionals working with two different subtitling programmes on the other. We examined several indicators of temporal, cognitive and production effort as well as the general structure of the subtitling workflow.

In line with our expectations, professional subtitlers were generally faster than trainees, although the results are borderline significant, possibly due to the small sample size. There was considerable variation between individual subtitlers, therefore larger groups of participants would be needed to test the actual implications of this variation. The results may also be taken to indicate that the main difference between professionals and trainees in our sample is not so much related to the time they invested in the subtitling task, but to the relevance they gave to one subtask over another. While among the professionals the subtasks of the process seemed to overlap, the different tasks were clearly marked and separated among trainees. One of the most salients differences was that the trainees decided to have a thorough orientation phase watching the whole clip and did not structure their revision phase, while professionals applied more refined revision strategies. The decisions regarding revision also seem to be indicators of the skills developed by the professionals. Although the number of interaction events was similar for both groups in Experiment 1, professional subtitlers invested less time in completing the revision phase. This hypothesis needs to be verified, however, on a larger sample of participants.

We also found differences potentially related to the software used. As pointed out by Alves and Hurtado Albir (2016), the familiarity with the technological tool can be considered a variable affecting subject profiling. In our study, we sacrificed the possibility of comparing the performance of all participants when using the same programme; had we decided to use just one tool, it would inevitably have affected the participants' performance and would make it impossible to assess the participants' regular interaction with the subtitling tool. As a result, however, Experiment 2 serves as a usability test of the two programmes. One of the main goals of TPR has been understanding how translators interact with the tools they have at their disposal in terms of usability, "understood broadly as the extent to which a user can achieve a certain goal with a given software tool" (Krüger 2016:115). Our analyses indicate that the options offered by the two programmes affect the way the subtitlers translate. The two groups of professionals exhibited different behaviours regarding their use of the keyboard and the mouse. The

professional subtitlers working with EZTitles had more interaction events in total, but the majority of those events were key strokes. In contrast, professionals working with EdList relied heavily on the mouse. However, task completion time did not vary significantly between the two group, which shows familiarity with the tool and proficiency in subtitling. The results are thought-provoking if we consider that the subtitlers working with EdList had a significantly higher production effort by using more mouse clicks but produced the subtitles with the highest text reduction rate. The excessive use of the mouse is concerning, however, from the point of view of ergonomics. Few studies in TPR have commented on the use of the mouse as an indicator of effort, but in their study of the cognitive ergonomics of translators Ehrensberger-Dow and Hunziker Heeb (2016) note that the use of the mouse to the detriment of the keyboard has the potential of not only being distracting, thus increasing the time required to complete a task, but also affecting the health of the translators (cf. RSI).

When it comes to cognitive effort measures with eye tracking variables such as mean fixation duration and dwell time, we found that the mean fixation durations made by professionals on the subtitle area were longer than fixations on the video and on the Internet browser. We believe this indicates a deeper level processing (Holmqvist et al. 2011). Furthermore, we also found that mean fixation durations made by professionals working with EdList on the target text were longer than those made on the source text. This suggests a higher cognitive effort for target text processing than for the source text and is in line with previous studies in TPR (Sharmin et al. 2008). These results point to important parallels between the work of subtitlers and other translators. TPR studies have shown that fixations on the target texts or the translation areas are longer, indicating higher cognitive effort when processing the target text (Hvelplund 2014).

Additionally, visual attention allocation has shown completely different working styles among the participants. The professionals using EdList dedicated a large part of their time to the subtitle area and also looked at the video for much longer than the professionals using EZTitles. This might help us understand how they achieved a much higher text reduction: since they spent more time looking at the subtitles and the video, it might be the case that they dedicated this time to assessing multiple options for their translations. In contrast, the subtitlers using EZTitles spent about a quarter of their time looking at the subtitle area, while about 20% of their task time was devoted to using the Internet. This seems to indicate different priorities: with the professionals using EZTitles accessing external resources, possibly to ensure the quality of the target text and its equivalence, while their counterparts using EdList focusing more on the video content and the subtitles possibly to ensure text reduction.

Text reduction results confirm that condensation is an important characteristic of subtitling. Contrary to one of Toury's (1995/2012) universals of translation, i.e. that translated text tends to be longer than the source text, the translations of all the participants were shorter than the English transcription. Experiment 2 showed that the professionals working with EdList achieved an average reduction of about 45%. In Experiment 1, the subtitles produced by both groups were about 30% shorter than the transcription. It needs to be noted here that we looked at text reduction merely as an indicator of a characteristic of subtitles. We do not claim that text reduction is by default an indicator of quality. More research is needed to show how training and professional experience influence the subtitler's ability to condense the text. At this stage, we did not look at the subtitles produced by the participants, except for text reduction, but an analysis of the quality of the subtitled product and its correlation with the time invested might shed more light into the development of the subtitler's competence.

5.1 Methodological considerations

One of the goals of this exploratory study was to assess how well traditional TPR methods can be applied to the study of the production of subtitles. Given the similarities between the processes involved in translation and subtitling, we showed that the data collection methods used in TPR to explore the temporal, cognitive and production effort can also be applied to subtitling process research. Further, we also found similarities between the behaviour of subtitlers and that of translators as reported in TPR literature. However, there are also important differences that make it difficult to simply copy all the methods developed in TPR to study the subtitling process. Two particularly problematic issues are translation units and pauses.

As much as they are debated, translation units have been essential for the exploration of the translation process (Lacruz 2017; Rodríguez-Inés 2017). Translation units can be defined both in terms of production, i.e. looking at lexical indicators or punctuation, and in terms of process, i.e. dividing the translator's activities into segments based on the translator's production process (Malmkjaer 2006). Text units, such as sentences or segments defined by CAT tools, are commonly used as a unit of analysis to study the translation process (Ehrensberger-Dow and Massey 2014). However, since subtitle segmentation varies between subtitlers, subtitles as such cannot be used as comparable reference units to study the process of subtitling. In a way, this adds a level of complexity to the study of the subtitling process since it makes it more difficult to draw direct comparisons between participants. The segmentation of the subtitles depends highly on the subtitler's judgement. A possible solution to this could be using a subtitle template and instructing all

subtitlers to follow the same segmentation without making any changes to the template. This solution, however, would eliminate the spotting phase and would at the same time add a restriction to the experimental design since subtitlers who are not used to templates would experience it as a newly emerging constraint which could affect the manner in which they engage with the task. Another option would be considering the whole subtitle file as a unit of analysis and performing the linguistic and spatio-temporal analyses in a structured manner. Some aspects of the subtitling might need to be overlooked or adjusted for an analysis of this nature, but it would help overcome the standardisation problem that using a template would pose.

The definition of translation units or segments is deeply intertwined with the idea of pauses. In TPR, pauses are considered indicators of cognitive effort (Kumpulainen 2015; La Cruz 2017), involving problem recognition and problem-solving processes. In subtitling, the idea of pauses cannot be directly applied to the exploration of the process, at least not without very careful consideration. As Kumpulainen puts it: "Pauses can be the result of cognitive processing, but can also manifest from a distraction that is unrelated to the text production process" (2015:1). It is common in the subtitling process to have long pauses during the translation since the translators stop to replay and watch the video. Also, as shown by our results, professional translators combine spotting, translation and revision activities, which can cause extra pauses due to the constant shifting between different screen areas and tasks. Considering the problems this poses, it would be necessary to refine these methods before adopting them on a wider scale in subtitling process research.

6. Conclusions

In this study, we compared three groups of participants while completing an interlingual subtitling task. The comparison between professionals and trainees has been essential in the development of Translation Process Research and has been a common topic in Translation Studies in general. We have shown that TPR methods can be applied to explore the production of subtitles and have the potential to help us understand how subtitlers operate and how their activities are affected by the type of software they use.

When comparing professionals and trainees, we found that trainees followed a more structured process, probably because they are yet to internalise the strategies required to complete the task smoothly. However, both groups achieved similar degrees of text condensation. In terms of time, the professionals were faster than the trainees, but larger sample sizes would be required to assess the effect of this difference. The comparison between two groups of professionals showed that their process seems to be heavily affected by the subtitling tool they use and possibly by their age and previous

experience. Further studies exploring these differences within a human-computer interaction framework would certainly improve our knowledge and provide insights into the development of better-suited subtitling tools.

We hope this study will entice AVT and TPR scholars into pursuing subtitling process research as an exciting research avenue. The limitations involved in our study allowed us only to test some general hypotheses. Our preliminary findings should, therefore, be treated as a springboard for further research rather than hard-and-fast evidence. Attempting to answer these emerging questions has the potential to teach us more about subtitling, help us improve the tools at our disposal and reinforce the training strategies that are currently in place.

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Biographies

David Orrego-Carmona is a Lecturer in Translation Studies at Aston University (UK) and an associate research fellow at the University of the Free State (SA). His areas of expertise include audiovisual translation and translation technologies. In particular, his research analyses how translation technologies empower users and how the democratisation of technology allows these users to become translators. Other interests include translation process research and the cognitive exploration of translation production and reception, mainly using eye tracking technologies.

Email: d.orrego-carmona@aston.ac.uk

Łukasz Dutka is an interpreter and audiovisual translator and is writing a PhD on respeaking competences and quality in live subtitling. As a practitioner of subtitling and a pioneer of respeaking in Poland, he contributes to research in these two areas on a regular basis. He studied issues of reduction levels and expected reading speed in subtitling as a part of "SDH for Digital Television" research project, and is currenlty working on the ILSA project (Interlingual Live Subtitling for Access). He is a member of Audiovisual Translation Lab (AVT

Lab), Polish Association of Audiovisual Translators (STAW) and European Society for Translation Studies (EST).

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Email: lukasz.dutka@uw.edu.pl

Agnieszka Szarkowska is currently Research Fellow at the Centre for Translation Studies, University College London (2016-2018), working on the project "Exploring Subtitle Reading with Eye Tracking Technology." Since 2007, she has been Assistant Professor in the Institute of Applied Linguistics, University of Warsaw. She is the founder and head of the Audiovisual Translation Lab (AVT Lab, www.avt.ils.uw.edu.pl) and specialises in audiovisual translation, especially subtitling for the deaf and hard of hearing and audio description.

Email:a.szarkowska@uw.edu.pl

Notes

1. Professionals using EZTitles were the same in both experiments.
2. Dwell time is the duration of all fixations and saccades inside an AOI, starting from the first fixation.