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Live subtitling for access to education: A pilot study of university students' reception of intralingual live subtitles

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ABSTRACT

According to the United Nations Convention on the Right of Persons with Disabilities, education is an area where accessibility must be ensured, not only for hearing-impaired students, but also for students whose mother tongue is not the language of instruction. Live subtitling can make lectures more accessible by simultaneously removing physical and linguistic barriers. However, the reception of live subtitles in an educational context has barely been researched. The aim of this research was therefore to investigate whether intralingual live subtitles produced through respeaking influenced the performance of Flemish university students. The impact of subtitling on performance and perception was investigated during two real lectures among two student groups: students with Dutch as a mother tongue and students with another mother tongue or who do not speak Dutch exclusively at home. The students' performance and perception were measured post hoc via online questionnaires consisting of comprehension and retention questions for their performance, Likert-scale and open questions for their perception. We compared the subtitled with the unsubtitled condition in a mixed design. The results indicate that, generally, the students performed significantly better when provided with subtitles than without subtitles.

KEYWORDS

Intralingual live subtitling, inclusive education, accessibility to higher education, respeaking, cognitive theory of multimedia learning.

1. Introduction

In everyday life, the term 'accessibility' is usually associated with the physical accessibility of buildings for wheelchair-users or visually impaired patrons, for instance. Accessibility is much broader than that, however; it is related to "the idea of full access to our globalized world as a human right" (Remael 2012: 95). Consequently, it does not come as a surprise that "accessibility" is one of the principles of the United Nations Convention on the Rights of Persons with Disabilities, the aim of which is to "enable persons with disabilities to live independently and participate fully in all aspects of life" (United Nations 2008). In Article 24 of the convention, education is mentioned as one of the areas where accessibility must also be ensured (United Nations 2008). In this context, access barriers can be physical, but they can also be of a linguistic and/or cultural nature. An example of a service that can remove sensorial and linguistic barriers in an educational context is live subtitling. This method can make lectures more accessible to a variety of students, such as deaf or hard-of-hearing students and those whose mother tongue is not the language of instruction.

1.1 Intralingual live subtitling: definition, production and projection methods, and context of use

Intralingual live subtitling is a relatively recent phenomenon that emerged at the end of the 20th century (Romero-Fresco 2018b). Unlike subtitling for television, which is mainly pre-recorded and interlingual, intralingual live subtitles are produced in real time, without preparation time, and in the same language as the programme. As far as the language is concerned, these live subtitles are similar to subtitles for the deaf and hard of hearing (SDH, also called "closed captions" in the United States).

Intralingual live subtitles can be produced using different methods. Generally, respeaking has overtaken stenography as the preferred method of producing live subtitles for television around the world; however, the situation varies greatly depending on the country (Romero-Fresco 2018b). Respeaking is:

> a technique in which a respeaker listens to the original sound of a (live) program or event and respeaks it, including punctuation marks [...], to a speech recognition software, which turns the recognized utterances into subtitles displayed on the screen with the shortest possible delay (Romero-Fresco 2011: 1).

Other methods are: (1) different variants of fast typing, such as stenography; (2) trained automatic speech recognition (t-ASR) of the speaker's voice, thus without the intervention of a respeaker, but with speech recognition (SR) software trained in the speaker's voice; and (3) fully automatic speech recognition (ASR) (i.e. without training in the speech recognition software). Respeaking and stenography are currently considered the most efficient methods of producing intralingual live subtitles.

As far as the projection method is concerned, intralingual live subtitles can be provided in different ways, depending on the context of use and the country. On television, they can be provided as 'ordinary subtitles' in a block of two lines or in scrolling mode[1]. At live events, such as a conference or a university lecture, they can also be provided in a block of two lines for the whole audience above or under the PowerPoint slides used by the speaker. Alternatively, they can be provided as scrolling text for the whole audience on a separate screen or as scrolling text on an individual device, such as a tablet or a laptop, made available to the students who need the support.

As stated above, intralingual live subtitles can be offered on television, but also at live events, such as at conferences, talks, and even for university lectures. In Europe, intralingual live subtitling in education is rare, being offered in some countries only, such as the United Kingdom, Austria, Germany, Italy and Switzerland (Nachtrab and Mössner 2017). In Belgium, and in Flanders in particular, this practice is, to our knowledge, non-existent.

1.2 Research in intralingual live subtitling reception

The reception[2] of intralingual live subtitles has barely been investigated to date:

> Broadly speaking, reception studies on live SDH are scarce and mostly limited to user surveys commissioned by regulators and user associations (Matthews 2013 and Ofcom 2013 in the UK, CESyA 2014 in Spain or ACMA 2016 in Australia) (Romero-Fresco 2018a: 215).

In contrast, as Romero-Fresco (2018a) also explains, reception research on *pre-recorded* SDH started in the United States in the early 1970s – that is, a decade before subtitles were used for the first time on television and a series of studies were carried out on the topic – but they were largely overlooked in the audiovisual translation (AVT) literature.

The few studies there have been into the reception of live subtitles, with generally positive results (i.e. a positive effect on the viewer), mainly involve live subtitling on television and not in an educational setting (e.g. Eugeni 2008; Romero-Fresco 2010, 2012). There are admittedly a few studies on the reception of live subtitling in an educational context (e.g. Ranchal *et al.* 2013), but they have a narrow focus: they are concerned with subtitles in English in the United States and Canada mainly, and are produced with t-ASR, therefore *without* a respeaker. These studies have shown that the quality of the live transcription with ASR is low and that its provision is therefore perceived negatively (e.g. as distracting) by the students (Ryba *et al.* 2006). Similarly, researchers have shown that the quality of the transcription produced is such that considerable editing has to be done afterwards (i.e. 3 : 1 ratio of audio data to correction time) to render the transcription usable as notes (Bain *et al.* 2002).

Consequently, in the absence of many studies on intralingual live subtitling in an educational content, it is important to focus on studies investigating the effects of intralingual *pre-recorded* subtitling on learning. Much of the research into the beneficial effects of subtitles on learning is based on Mayer's (2014: 47-52) cognitive theory of multimedia learning (i.e. building mental representations from words and pictures). Mayer (2014: 47-52) explains that this theory has three underlying assumptions, derived from cognitive science: (1) the *dual channels assumption*, that is, human beings possess separate channels for processing visual and auditory information (Paivio 1986; Baddeley 1992); (2) the *limited capacity assumption*, that is, human beings are limited in the amount of information that can be processed in each channel at once (due to their limited working memory) (Baddeley 1992); and (3) the *active processing assumption*, that is, human beings engage in active learning by attending to relevant incoming information using their sensory memory (Mayer 2014: 47-52). They do so by organising selected information into coherent mental representations in

their working memory and by integrating mental representations with other knowledge from their long-term memory (Mayer 2014: 47-52).

According to Mayer (2014: 59–61), the theory also identifies three types of demand on a learner's information-processing system or capacity during learning: (1) essential processing, (2) extraneous processing, and (3) generative processing. Essential processing refers to cognitive processing aimed at mentally representing the presented material in working memory and is related to the complexity of the material (also termed 'intrinsic cognitive load'). Extraneous processing refers to cognitive processing that does not support the instructional goal (also called 'extraneous cognitive load'). Finally, generative processing refers to cognitive processing aimed at making sense of the presented material; it is related to the learner's motivation to learn (also called 'germane cognitive load') (Mayer 2014: 59-61).

Mayer (2014: 61–63) further explains that the aim of good multimedia instruction is to reduce extraneous load by respecting several principles: for instance, the *redundancy principle* (i.e. avoid presenting an additional source of information that offers nothing new for learners), the *modality principle* (a mixed-mode, i.e. partly visual and partly auditory presentation of information, is more effective than a single-mode, i.e. either visual or auditory presentation of the same information) and the *temporal and spatial contiguity principles*, meaning that words and pictures should be presented simultaneously and close to each other.

In an educational design, subtitles are generally believed to increase extraneous cognitive load (CL), having a negative impact on learning due to the redundancy effect (e.g. Mayer *et al*. 2001)[3]. The reasoning behind this is that subtitles are an additional source of information with nothing new for learners because they already receive the information orally. However, in other fields, such as second language acquisition (SLA) (for an overview, see Gambier *et al*. (eds) 2015; Garzelli and Baldo (eds) 2014; Ghia 2012; Incalcaterra McLoughlin 2018; Orrego-Carmona 2018) or in the few studies on the beneficial effects of subtitling in a non-SLA context (Bird and Williams 2002; Moreno and Mayer 2002; for an overview, see also Kruger 2016), subtitles have been shown to decrease CL, thanks to the visual support they provide. In other words, subtitles affect learning positively, which is in line with the *modality principle* – that is, combining images with verbal information improves information processing. For example, Kruger *et al*. (2013) observed a significant difference in CL between two groups of students watching a recorded academic lecture either with or without subtitles, with the unsubtitled condition creating higher CL compared to the subtitled condition. Furthermore, a significantly higher level of frustration arose from the unsubtitled condition. They concluded that intralingual subtitles in an education context "seem to reduce CL and [do] not lead to cognitive overload as some theories suggest"

(2013: 65). Consequently, there is no redundancy effect, but there is a modality effect. However, they later found that the presence or absence of subtitles did not have a significant impact on performance (Kruger *et al*. 2014). Similarly, Kruger and Steyn (2013) admit that although they could not prove that the mere presence of subtitles improved the performance of students, they state that "subtitled audiovisual material may still add significant value to education because of the high correlation between subtitle reading and performance" (2013: 118). So, they did not find any redundancy effect. Finally, Liao *et al*. (2020) found no significant difference in comprehension between the subtitled and the unsubtitled condition, but they found no redundancy effect either, so no negative effect on learning. They concluded that

> the effects of redundant information on comprehension are, to some extent, dependent on viewer's ability to evaluate the momentary value of different layers of redundancy, and actively select and integrate different sources of redundancy based on their individual and dynamic needs to achieve their learning goal (2020: 92).

This finding is in line with the need to incorporate the role of metacognition in multimedia learning better, as expressed by Mayer (2014) – metacognition being defined as the "learner's awareness and control of cognitive processing during learning" (2014: 65).

In the light of these results, we can state that the reception of intralingual live subtitles produced through respeaking merits investigation in an educational context in Flanders. First, the reception of intralingual live subtitles in an *educational* context has barely been investigated and when it has, it has been limited to English and t-ASR as a production method. Second, whereas studies have shown that intralingual *pre-recorded* subtitles do not cause cognitive overload, this might not be the case with intralingual live subtitles because of the delay inherent in the respeaking production method. The reason is that the delay goes against the temporal contiguity principle, with the visual input (the subtitles) not appearing simultaneously with the oral input (the words of the lecturer). Consequently, if there is cognitive overload, it could affect learning, and thus performance, negatively.

1.3 Aim and research questions

The aim of this study was therefore to initiate research into the reception of intralingual live subtitles in a Flemish educational context. The research questions in this article consider student reception mainly with regard to *performance* (i.e. the results of a comprehension and retention test based on the content of two lectures in Dutch), although *perception* (i.e. the way students perceived intralingual live subtitles in terms of appreciation, helpfulness and perceived performance) will also be reported on, albeit mainly in the form of descriptive statistics. Our research questions were:

- **RQ1**: Do students perform better, that is, comprehend and remember the content of a lecture in Dutch better, when intralingual live subtitles are provided, compared to when no intralingual live subtitles are provided?
- **RQ2**: Does performance vary between students who have Dutch as their only mother tongue (called 'Dutch L1 students' in our study), and students who do not have Dutch as a mother tongue or who do not speak Dutch exclusively at home ('Dutch L2 students')?
- **Additional RQ:** How do students perceive the presence and quality of subtitles (e.g. disruptive, helpful, distracting, qualitative) and the impact of subtitles on their performance?

2. Methodology

2.1 Experimental design

We examined student performance and perception in an authentic viewing situation. Our study consisted of two consecutive two-hour lectures in Dutch from the course Babel: An Introduction to Linguistics, Translation Studies and Literary Theory. This course was an obligatory course in the first year of the BA in Applied Linguistics and the BA in Linguistics and Literature at the University of Antwerp in the academic year 2019–2020. The second lecture was conducted one week after the first, at the same time in the afternoon, and in the same lecture room.

At the beginning of lecture 1, the students filled in a short demographic questionnaire related to their personal profile (e.g. age, gender, Dutch as L1 or L2, self-reported proficiency in Dutch). As shown in Table 1, during each lecture, two fragments of approximately 15 minutes each were subtitled (through respeaking) and two fragments were not. In lecture 1, fragments 2 and 4 were subtitled (1B and 1D), whereas in lecture 2, fragments 1 and 3 were subtitled (2A and 2C). We ensured that the first fragment of the lecture was once unsubtitled and once subtitled. The same applied to the first fragment after the break. Subtitled and unsubtitled fragments alternated, in counter-balanced order across both lectures, to reduce potential order, memory and fatigue effects. At the end of each lecture, as shown in Table 1, the students were asked to fill in a performance and perception questionnaire via the online survey software Qualtrics[XM]. They did so on their laptops or smartphones.

Time (min.)	**Fragment**	**Lecture 1**	**Fragment**	**Lecture 2**
10		*Demographic survey*		
15	1A	Unsubtitled	2A	Subtitled
15	1B	Subtitled	2B	Unsubtitled
10	Break			
15	1C	Unsubtitled	2C	Subtitled
15	1D	Subtitled	2D	Unsubtitled
20		*Performance and perception test 1*		*Performance and perception test 2*

Table 1. Experimental design

Consequently, this study had a mixed design consisting of one within-group variable and one between-group variable. The within-group variable is subtitling, with two levels, that is, unsubtitled and subtitled. The between-group variable is the student language, that is, Dutch as a mother tongue or not, therefore a further two levels.

2.2 Participants

The results are based on 146 students who took part in both lectures: 119 students who have Dutch as their mother tongue (Dutch L1 students) and 27 students who reported to have another mother tongue or not to speak Dutch exclusively at home (Dutch L2 students).

In the demographic survey that students filled in at the beginning of lecture 1, all the students were asked to self-assess their Dutch language proficiency for each competence on a scale from 1 (A1) to 6 (C2), corresponding to the six different proficiency levels of the Common European Framework of Reference for Languages (Council of Europe 2001). On average, their self-reported proficiency corresponded to a C1 level (score of min. 5) for interaction, listening comprehension and speaking and almost a C1 level for reading and writing (see Table 2, score just under 5). It may be surprising not to have a C2 level for native speakers of Dutch. However, the survey described C2 as 'mastery'. It is probable, though, that students studying languages are aware of the fact that they do not master their mother tongue perfectly, otherwise it would not be necessary to have compulsory courses dedicated to the Dutch language in the first year of the BA in Applied Linguistics in Flanders. This is the case in all translation and interpreting departments in Flanders.

	Interaction	Reading	Listening	Speaking	Writing
Dutch L2	5.12	4.94	5.12	5.24	4.82
Dutch L1	5.08	5.02	5.01	4.99	4.81
Whole group	5.09	5.01	5.03	5.03	4.81

Table 2. Mean self-reported language proficiency scores per competence

2.3 Material

2.3.1 Lecture content and comparability

In this mixed design, with one within-group variable, it was fundamental that the lectures and their fragments were as comparable as possible. The lectures had been carefully prepared 'on paper', that is, the lecturer had written down all she wanted to say in the lecture as a sort of script. The lectures were delivered live by the lecturer, who tried to adhere faithfully to her script.

The two lectures covered the same topic: metaphors of translation. When dividing the lecture into fragments with and without subtitles, we made sure that, per lecture, there were approximately as many words (in the script) in the unsubtitled fragments as there were in the subtitled fragments. Therefore, almost exactly half of the lecture words were subtitled and the other half were not. Finally, we also ensured that the content of every lecture formed a well-rounded unit.

2.3.2 Subtitles

Live subtitling was provided by an experienced respeaker who is the manager of the translation and subtitling department of the Flemish private broadcaster, VTM. She used the speech-recognition software Dragon Professional Individual (v15). The subtitles (scrolling over two lines) were projected underneath the PowerPoint of the lecturer via a Text-on-Top wireless captioning kit. The respeaker did not receive the complete 'scripts' before the lectures but had access to the summarised course material on which the script was based so that she could prepare the terminology in Dragon.

Since the quality of the subtitles produced could influence the performance of the students in the performance tests, we measured the quality of the subtitles using the NER accuracy rate (Romero-Fresco and Martínez 2015). After comparing the respoken subtitles with the transcription of the lecturer's words, all the subtitled fragments reached at least 98% (1B: 98.57%, 1D: 99.29%, 2A: 99.29% and 2C: 99.15%)[4], 98% being the threshold considered accurate by Romero-Fresco and Martínez (2015: 32). We also examined the delay. A few sample measures showed a delay of approximately 5 s, which is in line with the delays in the literature on live

subtitles delay. According to Romero-Fresco (2018b), the average delay of live subtitles is around 5–7 s for respoken subtitles with on-air corrections. Since there were only 18 and 21 slides for lectures 1 and 2, respectively, we can state that there were not many 'slide changes'. As a result, the risk that subtitles related to slide N appeared on slide N+1 was limited. It should be noted, though, that these results are indicative only, since they were verified by one researcher only.

2.3.3 Performance tests

Student performance was measured by means of 16 questions per lecture (4 questions per fragment, thus a maximum score of 16 per lecture). Similarly to the material preparation, we made sure that every question was structured in the same way as others: multiple-choice questions with four options, with only one correct option. We made sure that every question referred to a comparable amount of lecture content. The questions always referred to a couple of sentences describing one general idea, never to one specific word or concept or to an entire paragraph.

The overall results on performance tests per lecture – that is, irrespective of the group (Dutch L1 and L2) and condition (subtitled and unsubtitled) – can be an indication of the comparability of the level of difficulty of the lectures. The scores for lectures 1 and 2 being not normally distributed (tests of normality of Kolmogorov-Smirnov and Shapiro-Wilk both significant, at $p<0.05$), we conducted a non-parametric test of comparison of two related samples (Wilcoxon signed ranks test). The test was not significant ($Z = -1.02$, $p>0.05$), which seems to indicate that the lectures were of comparable levels of difficulty.

2.3.4 Perception questionnaire

As explained above, at the end of each lecture, the students also answered a series of perception-related questions. These questions related to their subtitle reading behaviour, the perceived difficulty of the lecture, the perceived helpfulness of the subtitles, the perceived general benefits of subtitles for all students, the perceived quality of the subtitles in terms of language and delay, and the perceived effect of the delay and overall preference (a subtitled or an unsubtitled lecture). These questions, related to reading behaviour and perception, draw on previous studies, such as those by Di Giovanni (2018), Perego *et al.* (2016), Romero-Fresco (2009, 2011) and Ryba *et al.* (2006).

At the end of each lecture, the students had to assess the perceived difficulty of the lecture using a Likert-scale: from easy (1) to difficult (5). Similarly to the overall performance results reported on in Section 2.3.3, these perception results can also be an indication of the comparability of the level of difficulty of the lectures. The mean score for lecture 1 was 3.16 (*Mdn* = 3.0) versus 3.04 (*Mdn* = 3.0) for lecture 2. We used a non-

parametrical test of two related samples (Wilcoxon signed rank test), since the variable was measured on an ordinal scale. The test was not significant: $Z = -1.63$, $p > 0.05$. In addition to the overall performance results per lecture not being significantly different (see Section 2.3.3), this seems to indicate that the lectures were of a comparable level of difficulty. At the end of lecture 2, we also asked the students how they perceived the difficulty of lecture 2 as compared to that of lecture 1. Again, we used a Likert scale from 1 to 5, with the following labels:

(1) second lecture much easier than first lecture;
(2) second lecture easier than first lecture;
(3) same difficulty;
(4) second lecture more difficult than first lecture;
(5) second lecture much more difficult than first lecture.

The average score was 2.9, which corresponds roughly to 'same difficulty'. The results seem to indicate that the two lectures were of a comparable level of difficulty. Other perception results are reported on in Section 3.2.

3. Results and discussion

Before reporting on the results of the different mixed ANOVA tests – the aim being to determine whether subtitles have an impact on comprehension and memory – it is important to draw attention to the fact that in the design of this study it was not possible to prove that the students looked at and read the subtitles, since we could not draw on online measures such as eye-tracking. We chose an ecologically valid context in which to conduct our experiments, that is, a real lecture. To measure subtitle reading or at least attention location, we should have used eye-tracking glasses. However, this material is expensive and was not part of the financial plan of this pilot study. Consequently, we included a self-report question about the subtitle reading behaviour in the questionnaire. The participants' self-reported subtitle reading during the lecture was measured by means of a Likert-scale question (never = 1, rarely = 2, sometimes = 3, often = 4 and always = 5). Students reported to have looked at subtitles rarely, in both lecture 1 and lecture 2, irrespective of their first language ($M = 2.41$ and $M = 2.10$ for Dutch L1 students in lectures 1 and 2, respectively; and $M = 2.52$ and $M = 2.07$ for Dutch L2 students in lectures 1 and 2, respectively). However, d'Ydewalle and De Bruycker (2007) have observed that "switching attention from the visual image to 'reading' the subtitles happens effortlessly and almost automatically" (2007: 196). In other words, only eye-tracking could confirm the participants' self-perceived behaviour.

3.1 Performance

3.1.1 Lecture 1: 2 × 2 design

We conducted a mixed ANOVA test with one within-group variable (subtitling, with two levels, i.e. unsubtitled and subtitled) and one between-group variable (student language, i.e. Dutch as a mother tongue or not, thus again two levels). The results for the students' performance in lecture 1 are shown in Figure 1. The *y*-axis has a maximum of 8, since for each condition (subtitled versus unsubtitled) 8 questions were asked (1 point per question). However, as Figure 1 shows, the scores are rather low in all the conditions and groups, with only the Dutch L1 group reaching 50% or more (4 out of 8).

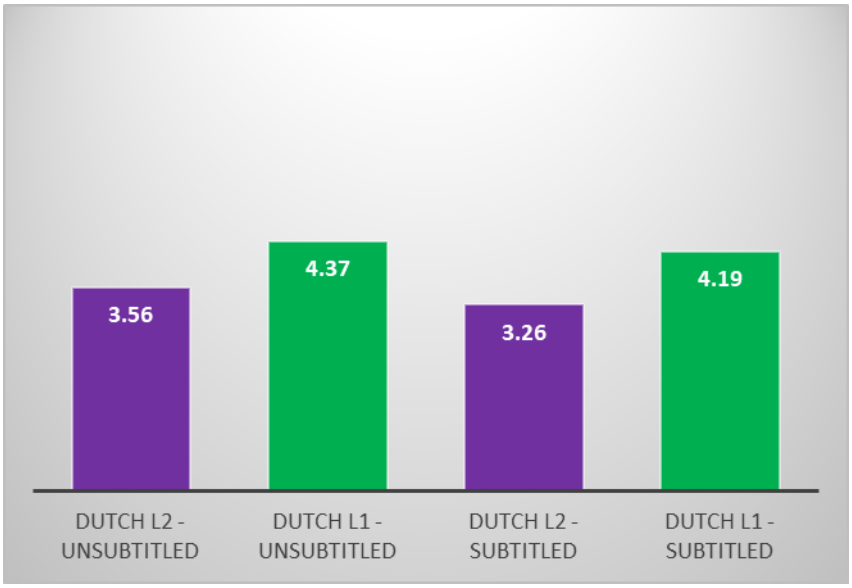

Figure 1. Results for performance of Dutch L1 and L2 students, in lecture 1, with and without subtitles

The results of the test of between-subject effects are shown in Table 3. The test is significant, which means that there is a significant main effect of the between-group variable, whatever the condition. So, Dutch L1 students performed significantly better than Dutch L2 students across both the unsubtitled and the subtitled conditions (M = 4.28 versus M = 3.41; see Table 5).

Source	Type III Sum of Squares	*Df*	Mean Square	*F*	*Sig.*	Partial Eta Squared
Intercept	1301.03	1	1301.03	777.91	.000	.84
Dutch	16.82	1	16.82	10.05	**.002***	.07
Error	240.84	144	1.67			

Table 3. Test of between-subjects effects for lecture 1

The results of the test of within-subjects effects are shown in Table 4. There is no significant main effect of subtitling and no significant interaction effect of subtitling and Dutch as a mother tongue. The students, whatever their mother tongue, did not perform significantly better or worse in the unsubtitled condition in comparison to the subtitled condition (*M* = 3.96 versus *M* = 3.73; see Table 5). There is no significant interaction effect either. Thus, when you take the mother tongue into account and the condition into account, there is no difference between the four scores as they are shown in Figure 1.

Source		Type III Sum of Squares	*Df*	Mean Square	*F*	*Sig*.	Partial Eta Squared
Subtitling	Sphericity Assumed	2.46	1	2.46	1.45	.231	.010
Subtitling * Dutch	Sphericity Assumed	0.19	1	0.16	.093	.761	.001
Error (Subtitling)	Sphericity Assumed	244.46	144	1.70			

Table 4. Test of within-subjects effects for lecture 1

	Unsubtitled	Subtitled	Estimated marginal means
Dutch L1	4.37	4.19	4.28
Dutch L2	3.56	3.26	3.41
Estimated marginal means	3.96	3.73	

Table 5. Lecture 1: 2 × 2 design

3.1.2 Lecture 2: 2 × 2 design

We conducted the same tests for lecture 2. The results are shown in Figure 2 and Tables 6 and 7.

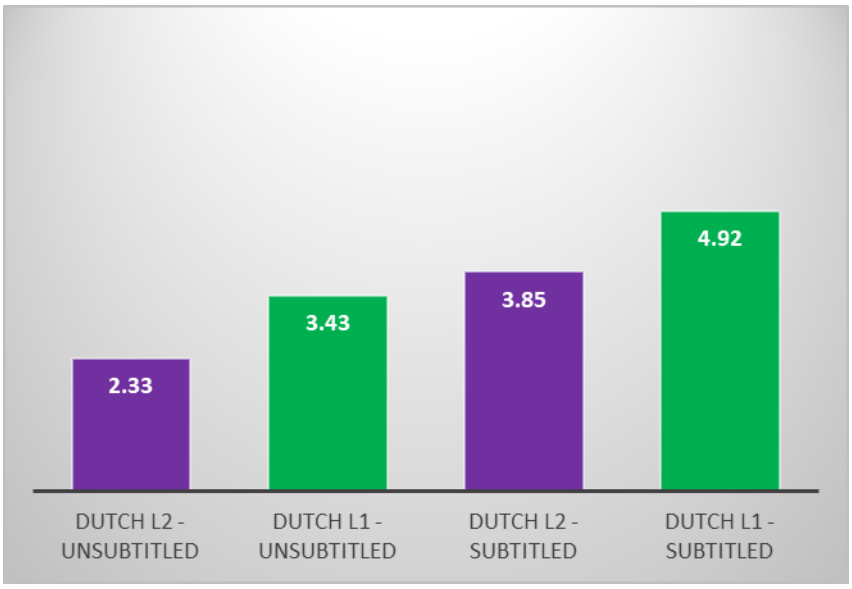

Figure 2. Results for performance of Dutch L1 and L2 students, in lecture 2, with and without subtitles

The results of the test of between-subjects effects are shown in Table 6. The test is significant, which means that there is a significant main effect of the between-group variable, whatever the condition. Dutch L1 students performed significantly better than Dutch L2 students across both conditions (*M* = 4.18 versus *M* = 3.09; see Table 8). These results are in line with those of lecture 1.

Source	Type III Sum of Squares	*Df*	Mean Square	*F*	*Sig.*	Partial Eta Squared
Intercept	1162.83	1	1162.87	442.62	.000	.76
Dutch	25.85	1	25.85	9.84	**.002***	.06
Error	378.31	144	2.63			

Table 6. Test of between-subjects effects for lecture 2

The results of the test of within-subjects effects are shown in Table 7. There is a significant main effect of subtitling, but no significant interaction effect. Students, whatever their mother tongue, performed significantly better in the subtitled condition in comparison to the unsubtitled condition (*M* = 4.39 versus *M* = 3.43; see Table 8). However, there is no significant interaction effect. In other words, the main effect of subtitling was not significantly higher or lower in the Dutch L2 group; this means that students with Dutch L2 did profit from subtitles, but not more or less than students with Dutch L1.

Source		Type III Sum of Squares	*Df*	Mean Square	*F*	*Sig*.	Partial Eta Squared
Subtitling	Sphericity Assumed	99.99	1	99.98	72.62	**.000***	.335
Subtitling * Dutch	Sphericity Assumed	0.01	1	0.01	.004	.949	.000
Error (Subtitling)	Sphericity Assumed	198.24	144	1.38			

Table 7. Test of within-subjects effects for lecture 2

Since, for lecture 2, Dutch L2 students seemed to perform better in the *subtitled* condition than Dutch L1 students in the *unsubtitled* condition, we conducted an additional test: a non-parametric test of two independent samples (Mann-Whitney Test), which was not significant (U = 1421.50, p>0.05). When provided with live subtitles, Dutch L2 students seem to perform as well as Dutch L1 students without live subtitles.

	Unsubtitled	Subtitled	Estimated marginal means
Dutch L2	2.33	3.85	3.09
Dutch L1	3.43	4.92	4.18
Estimated marginal means	3.43	4.39	

Table 8. Lecture 2: 2x2 design

3.1.3 Lectures 1 and 2: 2 × 4 design

Another way of looking at these results is to take both lectures into account and consider that the within-variable has four levels, so that lectures 1 and 2 can be compared. We conducted the same mixed ANOVA test for that scenario. In Figure 3, the scores are presented in the following order: lecture 1 without subtitles, lecture 1 with subtitles, lecture 2 with subtitles and lecture 2 without subtitles. That order is based on the condition of the first fragment of each lecture (without subtitles in lecture 1, with subtitles in lecture 2).

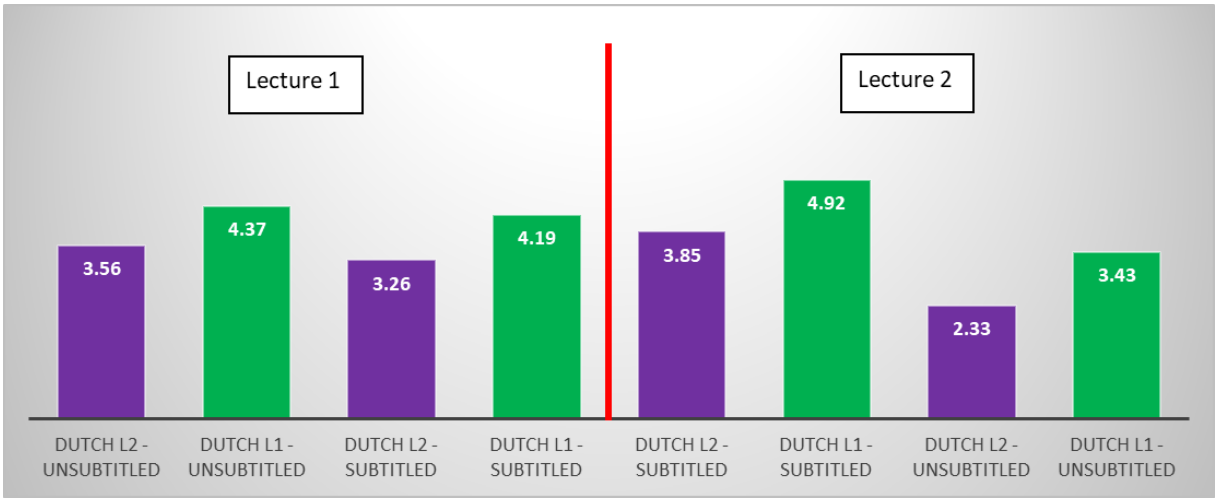

Figure 3. Results for performance of Dutch L1 and L2 students, in lectures 1 and 2 (4 levels), with and without subtitles

The results of the test of between-subjects effects are shown in Table 9. The test is significant, which means that there is a significant main effect of the between-group variable, whatever the condition. Dutch L1 students performed significantly better than Dutch L2 students across all four conditions (M = 4.23 versus M = 3.25; see Table 11). These results are in line with the results for lecture 1 and lecture 2.

Source	Type III Sum of Squares	*df*	Mean Square	*F*	*Sig.*	Partial Eta Squared
Intercept	1230.960	1	1230.960	750.069	.000	.839
Dutch	21.092	1	21.092	12.852	**.000***	.082
Error	236.322	144	1.641			

Table 9. Test of between-subjects effects for lecture 1 and 2

The results of the test of within-subjects effects are shown in Table 10 (Greenhouse-Geisser, since Mauchly's test of sphericity was significant at $p = 0.04$). There is a significant main effect of subtitling, but no significant interaction effect of subtitling and Dutch as a mother tongue. In other words, students, whatever their mother tongue, performed significantly better in the subtitled condition compared to the unsubtitled condition ($M = 4.06$ versus $M = 3.42$; see Table 11). However, there is no significant interaction effect. Thus, the main effect of subtitling was not significantly higher or lower in the Dutch L2 group than in the Dutch L1 students. This means that students with Dutch L2 did profit from subtitles, but not more or less so than students with Dutch L1.

Since we have a within variable with more than two levels, we can look at the contrasts between these levels (Table 12). Two contrasts are significant for the main effect of subtitling, but there is again no interaction effect with Dutch. The contrast is significant between lecture 1 with subtitles (level 2)

and lecture 2 with subtitles (level 3; with a higher score for the latter), and between lecture 2 with subtitles (level 3) and lecture 2 without subtitles (level 4; with a higher score for the former).

Source		Type III Sum of Squares	*Df*	Mean Square	*F*	*Sig.*	Partial Eta Squared
Subtitling	Greenhouse-Geisser	106.317	2.842	37.415	20.809	**.000***	.126
Subtitling * Dutch	Greenhouse-Geisser	1.132	2.842	.398	.222	.872	.002
Error (Subtitling)	Greenhouse-Geisser	735.717	409.180	1.798			

Table 10. Test of within-subjects effects for lecture 1 and 2

	Unsub. L1	Subt. L1	Subt. L2	Unsubt. L2	Estimated marginal means
L2 Dutch	3.56	3.26	3.85	2.33	3.25
L1 Dutch	4.37	4.19	4.92	3.43	4.23
Estimated marginal means	3.96	3.73	4.39	2.88	
Estimated marginal means	3.42 unsubtitled		4.06 subtitled		

Table 11. Lecture 1 and 2: 2x4 design. Results for Dutch L1 and L2 students, in lecture 1 and lecture 2 (4 measures), with and without subtitles

Source		Type III Sum of Squares	*Df*	Mean Square	*F*	*Sig.*	Partial Eta Squared
Subt.	Level 1 vs. Level 2	4.919	1	4.919	1.449	.231	.010
	Level 2 vs. Level 3	38.559	1	38.559	9.477	**.002***	.062
	Level 3 vs. Level 4	199.957	1	199.957	72.622	**.000***	.335
Subt.* Dutch	Level 1 vs. Level 2	.316	1	.316	.093	.761	.001
	Level 2 vs. Level 3	.422	1	.422	.104	.748	.001
	Level 3 vs. Level 4	.011	1	.011	.004	.949	.000
Error (Subt.)	Level 1 vs. Level 2	488.924	144	3.395			
	Level 2 vs. Level 3	585.913	144	4.069			

Table 12. Test of within-subjects contrasts

3.1.4 Performance: discussion

The results from the different analyses reveal a few trends. First, students with Dutch as a mother tongue performed better than students who do not have Dutch as first language or who speak different languages at home – this irrespective of whether the lectures were subtitled or not. Second, there was a significant positive effect of subtitling on performance overall and in lecture 2, but not in lecture 1. When there was an effect, students with Dutch as L2 did not benefit either more or less from subtitles than other

students. The same trend occurred when scores for lectures 1 and 2 were taken together in the analysis (as in Section 3.1.3). However, some students reported that they read the subtitles only rarely. Finally, the results for lecture 1 show a different pattern from those for lecture 2: the students did not perform better or worse either with or without subtitles in lecture 1.

We do not have a clear explanation for this result, but we have discerned a few possible reasons. First, intralingual live subtitles were provided for fragments 1B and 1D (when the students might have been fatigued) and fragments 2A and 2C (when the students were not fatigued). The fatigue effect was compensated for across both lectures, but not within each lecture. Second, the students might have been surprised by the live subtitles appearing on the screen and might have paid too much attention to them, neglecting the content of the lecture (see also Section 3.2.1). Finally, although the lectures had been scripted and the division into fragments was based on the script, the script was not always followed word for word, something that cannot be expected in a real lecture, where students might ask questions, inviting the lecturer to answer and therefore provide more information. We had not fully controlled for that, but we have observed that the duration of each fragment varied between 11 and 18 minutes, although we had planned for 15-minute fragments. In other words, controlling for all variables in the experiments conducted in a natural environment is not without its risks, as is the design of material for a design that includes a within-group variable.

3.2 Perception

3.2.1 Perception of helpfulness

We have already reported on the perception-related questions regarding the perceived difficulty of the lecture in Section 2.3.4; and at the beginning of Section 3 we reported on the behaviour of the students when they were reading the subtitles. Therefore, our focus turns now to other perception-related questions. As indicated before, perception is reported on here only in terms of descriptive statistics, since perception is not the main aim of this study.

Four of the questions (Q) related to the helpfulness of the subtitles. All four were Likert-scale statements (translated from the Dutch below), with five levels of agreement: (1) disagree, (2) slightly disagree, (3) neutral, (4) slightly agree, (5) agree.

- Q19: The live subtitles helped me to understand the lecture better.
- Q20: I feel that I was able to remember more because of the live subtitles.
- Q21: Because of the live subtitles, I was able to take better notes.
- Q22: I think most students would benefit from live subtitled lectures.

Dutch		Lect. 1 Q19	Lect. 2 Q19	Lect. 1 Q20	Lect. 2 Q20	Lect. 1 Q21	Lect. 2 Q21	Lect. 1 Q22	Lect. 2 Q22
No	Mean	2.11	2.22	2.04	1.96	2.26	2.33	2.81	3.19
	Median	2.00	2.00	2.00	2.00	2.00	2.00	3.00	3.00
Yes	Mean	1.97	2.27	1.97	2.08	2.36	2.51	2.73	2.65
	Median	2.00	2.00	2.00	2.00	2.00	2.00	3.00	3.00
Total	Mean	1.99	2.23	1.99	2.05	2.34	2.48	2.77	2.75
	Median	2.00	2.00	2.00	2.00	2.00	2.00	3.00	3.00

Table 13. Mean scores for subtitle helpfulness

As shown in Table 13, the means for questions 19, 20 and 21 fluctuate per group between a minimum of 1.96 and a maximum of 2.51, which means somewhere between 'slightly disagree' and 'neutral'. In general, the students were not very enthusiastic about the helpfulness of the subtitles. They seem to have been slightly more positive about their experience of lecture 2. As far as the last question, which refers to a more general appreciation of helpfulness, is concerned, the pattern is somewhat different: it ranges from 2.65 to 3.19. This means that they were less negative about the general helpfulness of subtitles for most students.

3.2.2 Perception of quality

There were three statements on subtitle quality, evaluated in terms of spelling, formulation and content (Q31, Q33 and Q34), all five-point Likert-scale questions:

- Q31: The spelling of the subtitles was usually ... (Likert scale from 'very bad' to 'very good')
- Q33: The formulation of the subtitles was usually ... (Likert scale from 'very unclear' to 'very clear')
- Q34: The content of the subtitles was usually ... (Likert scale from 'incomplete' to 'complete')

The results in Table 14 show means above 3, and sometimes approaching 4, which indicates that the students' perception of quality ranged between 'neutral' and 'good'.

Dutch		Lect. 1 Q31	Lect. 2 Q31	Lect. 1 Q33	Lect. 2 Q33	Lect. 1 Q34	Lect. 2 Q34
No	Mean	4.04	3.70	3.78	3.41	3.59	3.29
	Median	4.00	4.00	4.00	4.00	4.00	3.00
Yes	Mean	4.04	3.89	3.70	3.64	3.65	3.43
	Median	4.00	4.00	4.00	4.00	4.00	3.00
Total	Mean	4.04	3.86	3.71	3.59	3.64	3.40
	Median	4.00	4.00	4.00	4.00	4.00	3.00

Table 14. Mean scores for subtitle quality

3.2.3 Perception of delay

We asked four questions about the delay in showing the subtitles on screen. These were phrased as statements in the form of either a Likert scale or a multiple-choice format. In addition, an open question gave the students the opportunity to comment on the answer:

- Q35: The subtitles stayed on screen ... (multiple choice with two elements, i.e. 'for too long or not long enough' and 'long enough', with 0 and 1 respectively as values)
- Q74: The subtitles came on the screen ... (five-point Likert scale, from 'much too late' to 'on time')
- Q36: The subtitle delay was ... (five-point Likert scale, from 'inconvenient' to 'convenient'. Why? (= Q37, an open question)
- Q38: The subtitle delay was ... (five-point Likert scale, from 'distracting' to 'not distracting'). Why? (= Q39, an open question)

The students were mildly positive about the duration of the subtitles (Q35) and their view does not seem to have changed between the lectures, either for the Dutch L1 students or for the Dutch L2 students (M = 0.61 and M = 0.70 for lecture 1, and M = 0.61 and M = 0.63 for lecture 2, the maximum being 1).

The results regarding delay are shown in Table 15. All the means are between 2 and 3, which means that the students' perception was between rather negative ('too late', 'rather inconvenient', 'rather distracting') and neutral. Their opinions seem to remain stable between the two lectures.

Dutch		Lect. 1 Q74	Lect. 2 Q74	Lect. 1 Q36	Lect. 2 Q36	Lect. 1 Q38	Lect. 2 Q38
No	Mean	2.59	2.48	2.11	2.22	2.33	2.37
	Median	2.00	2.00	2.00	2.00	3.00	2.00
Yes	Mean	2.55	2.56	2.19	2.41	2.33	2.39
	Median	2.00	2.00	2.00	2.00	2.00	2.00
Total	Mean	2.56	2.58	2.18	2.38	2.33	2.39
	Median	2.00	2.00	2.00	2.00	2.00	2.00

Table 15. Mean scores for delay perception

It is interesting to note that the students who responded that the subtitle delay was 'rather convenient' to 'convenient' (21 students in lecture 1 or 14.4%, and 24 or 16.4% in lecture 2) all had roughly the same argument: the subtitles served as a backup if they did not hear or understand a piece of information explained by the lecturer. However, 99 students (67.81%) in lecture 1 and 87 (59.6%) in lecture 2 thought that the subtitle delay was 'inconvenient' to 'very inconvenient'. They argued that it was difficult to balance reading the subtitles and listening to the lecturer, since the content did not match the subtitles; and that while reading a subtitle, they often

felt that they missed out on what the lecturer was saying. In line with these results, 88 students in lecture 1 (60.27%) and 86 (58.9%) in lecture 2 said that the subtitle delay was 'rather distracting' to 'distracting'.

Finally, almost 80% of the students (78.08% after lecture 1 and 72.60% after lecture 2) expressed a clear preference for attending a Dutch lecture without subtitles. However, when asked after lecture 2 whether they would appreciate the use of intralingual live subtitling in a *foreign language* class, 80.14% of the respondents were in favour of that idea.

4. Conclusion

The aim of this study was to investigate the reception of intralingual live subtitles in the Flemish educational context, mainly regarding performance, but also according to perception. The results show that, overall, when the scores for both lectures are taken into account the students performed significantly better with subtitles than without them. The same applies to lecture 2, but not to lecture 1. The Dutch L2 students benefitted from subtitles, but not more or less so than the students with Dutch as L1. It should be noted, nonetheless, that students with Dutch as L1 performed significantly better than students with Dutch as L2, whatever the condition, subtitled or unsubtitled. Interestingly, the score of Dutch L2 students in lecture 2 in the subtitled condition was as high as the score of Dutch L1 students in the unsubtitled condition.

These results seem to confirm the findings of previous studies on the benefits of pre-recorded subtitles in an educational context. In other words, there seems to be a modality effect, but no redundancy effect. In addition, the delay in the presentation of the subtitles, which goes against the principle of temporal contiguity (see Section 1.2), does not seem to lead to cognitive overload. However, these results should be considered cautiously, since the real reading behaviour of subtitles could not be measured online, but only offline, by means of a post hoc and therefore self-reported questionnaire. Moreover, the students reported having read the subtitles rarely in both lectures.

As far as perception is concerned, the students were generally not very positive towards the intralingual live subtitles of the lectures. All in all, they disagreed about whether live subtitles help them to better understand or remember the content of the lecture, and the same applies to the potential of live subtitles to help them take notes better. They were fairly satisfied with the quality (in terms of spelling, formulation and content), but, again, they were rather negative about the delay in the presentation of the subtitles onscreen. However, those who found the subtitles either 'convenient' or 'very convenient' used them as backup when they had missed something the lecturer had said, which means that they took advantage of the delay.

We hypothesise that there was a learning effect between lecture 1 and lecture 2 as far as the use of the delay was concerned, with students actively selecting and integrating "different sources of redundancy based on their individual and dynamic needs to achieve their learning goal", as observed by Liao *et al.* (2020: 92) in their study. We do not think that there was a learning effect from lecture 1 to lecture 2 as far as content comprehension and retention are concerned, since the performance scores for both lectures, irrespective of the condition and group, show no significant difference (see Section 2.3.3).

Overall, the results of the present study point to potential benefits of intralingual live subtitling in an educational context for all students, including those for whom the language of instruction is not their (only) first language.

As highlighted above, this study also has limitations, such as the imbalance in the student population under study – with Dutch L1 students outnumbering Dutch L2 students by far; the difficulty of compiling comparable material when the design includes at least one within variable, and the absence of online measures of subtitle reading behaviour. On the other hand, this is a pilot study preparatory to a larger study, the design of which should include more lectures over a longer period of time, other production and projection methods for dealing with subtitles, objective measures of proficiency in Dutch, and, finally, online measures of subtitle reading behaviour.

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Notes

[1] According to Romero-Fresco (2018b: 100), "In the US and Canada, live captions are displayed in scrolling mode (and in capitals), whereas in Europe they may be displayed only in blocks (Spain, Switzerland, Belgium), only scrolling (France) or with a combination

of scrolling for the live respoken parts and blocks for the scripted segments (the UK and Italy)." (

[2] Reception is not a clear-cut concept. There does not seem to be a clear consensus about it, as explained by Gambier (2006: 4): "Finally, reception of AV products is a notion on which there is nothing like consensus, since this broad notion might include the 3 Rs, namely reactions on the cognitive level, responses in behavioural terms, and repercussions of a cultural order [...]." In addition, Gambier (2018: 56) later explains that "[p]erception could be defined as what is impressed on the eyes when watching a film and the way in which viewers represent the viewing act: how they think they watch a film, how they believe they apprehend the viewing process. Perception is made of opinions and impressions and varies over time." Consequently, we have chosen to distinguish between *perception* and *performance* and use "reception" as a generic term for both.

[3] Mayer et al. explain that "[i]n two studies, learning a scientific explanation from a narrated animation was hurt by the addition of on-screen text that contained the same words as in the narration. The detrimental effects of redundant on-screen text were found both when the on-screen text was an exact copy of the corresponding narration (i.e. Experiment 2) and when it was a summary with the same words as the corresponding narration (i.e. Experiments 1 and 2)." He refers to this finding as "a redundancy effect: adding redundant on-screen text to a narrated animation detracts from multimedia learning" (2001: 195). In other words, the researchers do not use subtitles as such, but we assume that the "addition of on-screen text that contained the same words as in the narration" (Mayer et al. 2001: 195) can be considered very similar to what subtitles are.

[4] It should be noted that only the final version of the subtitles could be compared to the lecture transcription. The calculation of the accuracy rate does not consider errors that appeared on the screen, even if immediately corrected live by the respeaker.