

QUALITY ASSESSMENT OF CREATING INTERLINGUAL PRE-RECORDED SUBTITLES FOR THE DEAF AND HARD-OF-HEARING (SDH): THE LOT MODEL

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Abstract: *There is a lack of quality assessment models designed specifically for interlingual pre-recorded subtitles for the deaf and hard-of-hearing (SDH), as existing models focus primarily on live subtitling and intralingual respelling, highlighting the need to address the diverse linguistic, visual, and technical quality expectations of SDH viewers. This study aims to develop and validate a quality assessment model explicitly tailored for interlingual pre-recorded SDH by proposing the Linguistic, Orthotypographic, and Technical (LOT) model and empirically testing it against established assessment frameworks using a sample of 900 Arabic-English subtitles across diverse genres through quantitative comparative analysis examining intercoder reliability, average quality scores, and correlations between models. The findings demonstrate that the specialized LOT model designed for pre-recorded SDH yields markedly higher intercoder reliability and average quality scores compared to general subtitle assessment models, suggesting strong alignment with the multidimensional quality needs of the target SDH audience; the development and validation of this model represents a pivotal advancement toward comprehensive quality evaluation tailored to interlingual pre-recorded SDH, where adoption in professional subtitling and training practices may enhance accessibility, inclusion, and overall viewing experience for deaf and hard-of-hearing media consumers.*

Keywords: *translator training, subtitles for the deaf/hard-of-hearing (SDH), quality assessment model, interlingual pre-recorded subtitling, accessibility*

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Introduction¹

Developing interlingual pre-recorded subtitles for the deaf and hard of hearing (SDH) demands intricate expertise, a profound comprehension of both source and target languages, and sensitivity to the distinct requirements and preferences of deaf and hard of hearing audiences. SDH subtitling aspires to offer a textual depiction of the audio content in a video, enabling individuals with hearing impairments to access information on par with their hearing counterparts.

SDH subtitling training encompasses various theoretical frameworks and methodologies, such as project-based and task-based approaches. Project-based theories concentrate on the overarching objectives of the subtitling task, while task-based theories zero in on the tasks and subtasks involved in generating SDH subtitles. Furthermore, the socioconstructivist approach, which accentuates the influence of social interactions and collective experiences on the subtitling process, may also be integrated into the training.

Upon completion of training, SDH subtitlers are entrusted with the responsibility of crafting precise and effective subtitles that accurately encapsulate the meaning of the source audio. This necessitates a profound understanding of source and target languages and cognizance of the unique challenges and considerations intrinsic to subtitling for the deaf and hard of hearing (DHH). Furthermore, developing a rigorous quality assessment model is crucial for evaluating and refining the subtitling process to guarantee the quality of SDH subtitles. Therefore, this research proposes and empirically evaluates a new quality assessment model tailored for creating interlingual pre-recorded SDH subtitles.

Literature review

The Multimodal Nature of Interlingual SDH Subtitling

There are various methods applied in Audio-visual translation (AVT), which involves converting multimodal and multimedia materials from one language and culture to another (Pérez-González, 2009). Among the numerous AVT modes, subtitling is the most widespread due to its cost-effectiveness and efficiency (Díaz-Cintas, 2013). It entails replicating the original dialogue, sounds, and text on the screen as written text that conveys a target language version of the source speech (Pérez-González, 2014).

Díaz-Cintas and Remael (2014) categorized subtitles based on their linguistic dimension into intralingual, interlingual, and bilingual. Intralingual SDH subtitles provide viewers with written text that represents the audio content

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of the AV materials. While intralingual subtitles typically involve same-language transcription, intralingual SDH subtitles specifically provide viewers with written text that represents both the audio content and non-verbal audio information of the AV materials. Interlingual subtitling involves translating the source language into a target language, while bilingual subtitles display text in multiple languages. Interlingual SDH subtitling combines these challenges, requiring not only translation between languages but also the representation of auditory cues for deaf and hard-of-hearing viewers. This study will focus on interlingual subtitling, as it represents a significant aspect of the subtitling field and is widely used by translation and streaming corporations, amateurs, and academics.

The semiotic texture of audio-visual texts has attracted academic interest with scholars like Taylor (2003, 2004, 2013, 2016), Pettit (2004), Chuang (2006), Pérez-González (2009, 2014, 2019), and Menezes (2022) theorizing subtitling within multimodality frameworks. Subtitling requires understanding the verbal and nonverbal information that coexists within the visual and acoustic communication channels (Bolaños-García-Escribano, 2020). This is particularly crucial in SDH, where subtitlers must not only translate dialogue but also convey non-verbal auditory information visually. Subtitling is not merely a combination of these channels and their signifying codes; its relevance stems from the interaction and cohesion of all the acoustic and visual elements (Sokoli, 2005).

Chaume (2001, 2004) lists eleven signifying codes with implications in AVT, divided between the acoustic and visual channels. The structure of subtitles and the meanings of all their components result in a semantic architecture that the viewer deconstructs to comprehend the subtitle's meaning. For SDH viewers, this deconstruction process is even more complex, as they must interpret additional visual cues that represent auditory information. Subtitlers and researchers are interested in deciphering the purpose and function of each code and the potential influence of all linguistic and non-linguistic signs on the translation process (Chaume, 2016). Díaz-Cintas (2019) argues that the audio-visual text's semiotic texture is defined by the interaction of the acoustic and visual channels and the verbal and non-verbal dimensions of communication.

A subtitler creating SDH must have a strong understanding of both audio and visual channels to accurately convey not only the content displayed on the screen but also the auditory information that deaf and hard-of-hearing viewers cannot access directly. This requires a specialized skill set beyond that of traditional subtitling. Furthermore, this study's focus on the didactic value of creating interlingual SDH using subtitling and training fields of view can also enhance the awareness of the significance of SDH creation among subtitlers and academics.

In conclusion, while subtitling plays a crucial role in AVT, with interlingual subtitling being a significant aspect, interlingual SDH subtitling presents unique challenges and requirements. Understanding the multimodality of subtitling, including the interaction of various signifying codes, is essential for professionals and researchers, particularly in the context of SDH where additional visual representations of auditory information are necessary. This study aims to contribute to the ongoing discussion and provide valuable insights into subtitling practice by focusing on the specific demands and considerations of interlingual SDH.

Pedagogical Approaches for Didactic SDH Creation

Subtitle creation has emerged as a significant area of research in recent years, driven by technological advancements and the rise of sophisticated subtitling tools like OOONA. Talaván (2010) identifies two primary uses of subtitles: as support for individuals who struggle to understand audio content, such as the deaf and hard of hearing or non-native speakers, and as a standalone task involving transcription, translation, and formatting of text for on-screen display. Subtitlers convey meaning through verbal-linguistic and semiotic channels (Chaume, 2004) while managing spatial and temporal constraints (Díaz-Cintas & Remael, 2014). In addition, they must be culturally competent (Orrego-Carmona et al., 2018) and technologically proficient, as subtitles are generated by using specialized software.

When introducing subtitling tasks to learners, they must follow specific guidelines regarding length, duration, synchrony, condensation, and segmentation (Díaz-Cintas & Remael, 2007). These guidelines are standard for all types of subtitling and form the foundation of this translation practice. While the application of these guidelines may be adjusted based on the learners' proficiency and familiarity with the AVT task, the core principles remain consistent across various subtitling contexts. Table 1 outlines these basic guidelines, which are suitable for beginners and professionals alike, though they can be adapted and reinforced as needed for specific projects or audiences.

Table 1. *Basic guidelines for subtitle creation*

GUIDELINE	DESCRIPTION
Length	Subtitles should not contain lengthy lines as they can be challenging to read. It is preferable to segment long lines into two shorter ones. Subtitle editors often specify a maximum number of characters per line that should be followed. Subtitles should consist of a single or double line only.
Duration	Subtitles should be on screen for at least one to two seconds and a maximum of six seconds per subtitle. Learners should adhere to the indicated maximum character per second (cps) in the subtitle editor.

GUIDELINE	DESCRIPTION
Synchrony	Subtitles must be synchronized with the corresponding dialogue and should never remain on screen during a change in shot.
Condensation	When necessary, dialogue information should be condensed by rephrasing or using synonyms to accommodate subtitle length and duration.
Segmentation	Dividing long lines into two should not impair or slow the reading process. Learners should avoid breaking crucial syntactic units.

Didactic SDH shares many pedagogical features with standard didactic subtitling but requires additional guidelines to accommodate unique content, such as character identification, sound effects, paralinguistic information, and music (Talaván, 2020). These guidelines ensure that SDH effectively supports vocabulary development, writing skills, and listening comprehension for L2-L2 users. Table 2 illustrates the SDH-specific guidelines proposed by Talaván (2020).

Table 2. *SDH-specific guidelines proposed by Talaván (2020)*

SDH GUIDELINES	DESCRIPTION
Character identification	When multiple characters speak in the same subtitle, the reader must be informed which one is speaking. In SDH, character identification can be indicated using dashes, colors, or name tags. Dashes are the most convenient option as they do not require technical adjustments in the subtitle editor.
Sound effects	It is preferable to nominalize sound effects and describe them within brackets whenever possible. Only the sound, not the listener’s experience, should be described. Sound effects are typically shown at the top right corner of the screen, but they can also appear as a standalone subtitle or embedded inside a subtitle on one of the two lines.
Paralinguistic information	Information on mood, tone of voice, and pitch should be provided inside brackets, in capital letters, preferably nominalized, and in front of the appropriate text impacted by the described feature.
Music	Music that is relevant to the plot should be included in the subtitles. The description of the type of music follows the guidelines indicated for sound effects (top right corner, if possible). If the subtitles include song lyrics or need to indicate that a character is singing, a musical note or a hashtag (#) should be added at the beginning and end of each subtitle that includes the song.

In addition to discussing the creation of interlingual SDH, it is essential to understand the workflow and unique role of SDH subtitlers. These professionals undergo specialized training and use software designed for SDH subtitle creation, distinguishing them from traditional subtitlers.

The SDH Subtitler

SDH subtitling demands a different approach from traditional subtitling, focusing on conveying non-verbal and peculiar sounds to viewers with restricted or no access to the auditory channel. Therefore, the training of SDH subtitlers should encompass sociolinguistic requirements and standard subtitling skills. Professionals with academic training in SDH have an advantage in the industry. However, many SDH subtitlers come from subtitling backgrounds without translation training (Zárate, 2021), necessitating in-house or professional SDH courses.

SDH subtitlers may use cloud-based subtitling suites provided by companies like Netflix or purchase specialized subtitling software such as EZTitles, Lemony Subtitler, Wincaps Q4, Spot Software, CaptionHub, or OONA. The growth of SDH over the past two decades highlights the need for qualified and certified experts in this field. It is essential that SDH training be integrated with broader theories of translator training to ensure a comprehensive understanding of translators' professional development, ultimately producing competent professionals in subtitling for DHH.

SDH Training

Over the past three decades, translator training theories have become increasingly applicable and adaptable to the audio-visual translation (AVT) field, with notable contributions from Kiraly (1995, 2000), Pym (2009), and Kelly (2014). A specific focus on SDH training emerged nearly two decades ago (see Neves, 2008b; Remael and Van der Veer, 2006; Romero-Fresco, 2012; Talaván, 2019). The researcher posits that project-based (Vienne, 1994), task-based (González-Davies, 2004) and socioconstructivist (Kiryay, 2000) approaches are the most effective for interlingual SDH training due to their inherent characteristics and relevance to AVT didactics. As a result, exposing learners to semi-real and quasi-professional tasks and projects based on learning outcomes can help them acquire the necessary skills for translating or creating AV content (Bolaños-García-Escribano, 2020).

Project-based learning fosters long-term, multidisciplinary, student-centered learning through technology, driving questions, group work, in-depth investigation, feedback, decision-making, and presentations (Li et al., 2015). González-Davies (2004, p. 28) defines *projects* in the translation classroom as “multicompetence assignments that enable students to engage in pedagogic and

professional activities and tasks and work together towards an end product”. Accordingly, Kirlay (2000) asserts that project-based learning for translation requires the collaborative execution of translation tasks under the guidance of a professional translator. By adopting a holistic view of SDH creation, interlingual SDH training can be achieved by preparing suitable technical tools, providing customized guidelines, and promoting teamwork in a conducive learning environment.

Task-based learning for interlingual SDH (Subtitles for the Deaf and Hard-of-hearing) creation should include essential competencies, specific objectives, expected outcomes, procedures assigned to trainees, grading scales, and a bibliography (González-Davies, 2017). This approach transforms the classroom into a forum for guided social and cultural experiences that replicate real-world translation industry projects. While emphasizing self-learning and teamwork (Colina & Venuti, 2016), it is most effective when trainees feel in control of their learning process. Furthermore, interlingual SDH creation is well-suited for developing activities that can serve as both training exercises and services for specific groups. Carefully planned activities, including practical action research projects with SDH trainees, can benefit all parties involved (Neves, 2008b).

Neves (2008b), building on Gambier (2003), contends that SDH training should aim to develop the full range of competencies required of screen translators, who must master all the competencies expected of any translator. According to Neves (2008a), subtitlers working on SDH must be aware of several aspects to provide an effective accessibility service. These include a deep understanding of the target audience’s profile and needs, knowledge of filmic composition and the role of sound, comprehension of redundancy, relevance, adequacy, cohesion, and coherence, and the ability to make difficult choices based on sense and sensibility.

Subtitling Quality Assessments

Quality assessment in AVT, particularly subtitling, has gained significant attention in academic and industrial contexts due to the importance of delivering satisfactory final output to viewers. Consequently, the study of quality must be integrated into AVT training. However, Pedersen (2017, p. 210) points out, “quality in the translated output itself is often kept purposefully ambiguous – especially for subtitling”. Furthermore, different perspectives influence how quality is perceived, ranging from translation management’s focus on processes and workflows to academics’ concerns about equivalence and language use.

Traditional research on translation quality has primarily focused on the linguistic dimension of translating texts, often neglecting the paratextual and paralinguistic aspects found in AVT (Kuo, 2020). House (2014, p. 241) argues that “any statement about the quality of a translation implies a conception of

the nature and goals of translation; in other words, it presupposes a theory of translation". Given its multimodal nature, subtitling challenges conventional approaches to assessing translation quality, predominantly concentrating on the linguistic dimension. Consequently, interlingual SDH subtitling, as a multisemiotic process, complicates the application of quality assessment models like House's (1977, 2014).

One fundamental issue with traditional translation quality assessment models in subtitling is their inability to adapt to the medium's specific conditions. For example, these models often treat paraphrases and omissions as errors, whereas, in subtitling, they are necessary and effective strategies for condensation (Pedersen, 2017). Furthermore, Bolaños-García-Escribano (2020) adds that generalist quality models do not acknowledge the impact of synchronization between utterances and soundtrack or the interconnectedness between text and image. In response, researchers have developed specific models to evaluate subtitled products, such as the NER (Number, Edition, and Recognition) model (Romero-Fresco & Pérez, 2015), the NTR model (Romero-Fresco & Pöchhacker, 2017), and the FAR model (Pedersen, 2017). However, these models still need to address the process of creating subtitles and consider factors beyond linguistic aspects, especially for SDH.

The NER and NTR models were designed to assess the quality of intralingual and interlingual respaking, incorporating recognition and edition errors to account for technical and linguistic dimensions. The FAR model, meanwhile, is an attempt to categorize pre-recorded interlingual subtitling errors based on functional equivalence, acceptability, and readability. Despite its usefulness, Pedersen (2017) acknowledges that the FAR model is not specifically tailored for assessing the quality of SDH. The field still requires more advanced models to address SDH interlingual subtitling's unique aspects and effectively assess students' coursework. These models should consider the final subtitled product and the subtitle creation process.

Methods

Experimental design

A quantitative comparative analysis was conducted by applying the LOT (Linguistic, Orthotypographic, and Technical) model and three established assessment models. Expert raters scored a sample of 900 Arabic-English interlingual subtitles across the four models. Intercoder reliability, average quality scores, and model correlations were examined to evaluate the LOT model's efficacy and suitability for quality assessment of pre-recorded SDH. This between-subjects experimental design enabled direct comparisons to

determine if the LOT model designed explicitly for pre-recorded interlingual SDH would outperform general models not specialized for this context.

Data collection

Stratified random sampling was utilized to select a diverse corpus of subtitles across three genres intended to represent a spectrum of linguistic styles. The colloquial Arabic dialogues in the TV series “AlRawabi School for Girls” contain informal vocabulary and dialectical variations. The movie “Sand Storm” purposefully includes regional Arabic dialects in its script. Finally, the documentary “The Square” features sophisticated formal Arabic vocabulary. This sampling approach enabled testing of the quality assessment models across diverse linguistic factors that can impact interlingual subtitling quality. The sampled subtitles amounted to 7-8 hours of total content, providing sufficient data points for quantitative analysis.

Assessment models

Four evidence-based models were leveraged for comparative analysis:

- LOT: Developed in this study for interlingual pre-recorded SDH
- NER: Designed for live intralingual/interlingual subtitles (Romero-Fresco & Pérez, 2015)
- NTR: Designed for live interlingual subtitles (Romero-Fresco & Pöchhacker, 2017)

• FAR: Developed for general interlingual subtitles (Pedersen, 2017)
The LOT model incorporated linguistic, orthotypographic, and technical parameters tailored to pre-recorded SDH.

Raters

Two bilingual subject matter experts with specialized background in Arabic, English, and SDH subtitling were recruited as raters. These experts evaluated all 900 subtitles across each model. Using two raters helped control individual bias and subjectivity. Intercoder reliability analysis further examined consistency between raters, providing a measure of standardized judgment and agreement on the quality scoring. Raters underwent training on applying each model to improve accuracy and calibrate their scoring approaches.

Analysis

Interrater reliability was examined per model using Cohen’s kappa statistic. Subtitle quality scores were compared between models using descriptive statistics. Correlation matrix visualizations revealed scoring patterns. The

analysis focused on evaluating LOT model efficacy versus the three established models.

Based on the LOT model's specific design for interlingual pre-recorded SDH, we hypothesized that:

1. The LOT model would demonstrate higher interrater reliability compared to the NER, NTR, and FAR models.
2. The LOT model would yield higher average quality scores for the SDH subtitles compared to the other models.
3. There would be a moderate positive correlation between the LOT model scores and those of the other models, reflecting some shared quality assessment principles.

We expected the LOT model to outperform the other models in assessing pre-recorded interlingual SDH due to its tailored approach incorporating linguistic, orthotypographic, and technical parameters specific to SDH. The NER and NTR models, being designed for live subtitling, were expected to be less effective for pre-recorded content. The FAR model, while suitable for interlingual subtitling, was anticipated to lack some of the specialized criteria necessary for comprehensive SDH quality assessment.

Analysis

Although there are three generalized models for assessing subtitling quality – the NER model (Romero-Fresco & Pérez, 2015), the NTR model (Romero-Fresco & Pöchhacker, 2017), and the FAR model (Pedersen, 2017) – none are explicitly designed for pre-recorded interlingual SDH. The NER and NTR models focus on intralingual and interlingual respeaking (live subtitling), while the FAR model offers a general approach to evaluating interlingual subtitling quality. Since these models primarily rely on error rate analysis, a specialized model for pre-recorded interlingual SDH creation is needed. The researcher proposes the LOT model, developed by using previous models, empirical data, industry standards, and viewer feedback, to provide SDH training assessors with a localized and customizable model incorporating general norms from guidelines, commissioner specifications, and viewer experiences. Our analysis of the data revealed several key findings that support the efficacy of the LOT model for assessing interlingual pre-recorded SDH quality, aligning with our initial hypotheses and demonstrating the model's potential to address the unique challenges of SDH subtitling.

In contrast to WER (word error rate) models that focus on the ratio of errors to the number of words in a text, the LOT model emphasizes the idea unit of whole subtitle lines. Pedersen (2017, p. 216) asserts that “the most natural unit to use in subtitling is the (one or two-line) subtitle itself.” Using the subtitle

as the assessment unit for interlingually pre-recorded subtitles is intuitive and offers several advantages. Firstly, the subtitle unit is well-defined and ideally semantically and syntactically self-contained. Secondly, an error in a subtitle disrupts the relationship between the subtitles and the end consumer, potentially affecting their processing of individual words or phrases and the entire subtitle (Pedersen, 2017). Therefore, interlingually pre-recorded SDH quality assessment should employ the subtitle unit. The analysis confirmed that this approach leads to more consistent and comprehensive quality assessments, with the LOT model’s focus on whole subtitle units allowing for a more nuanced evaluation of linguistic, orthotypographic, and technical aspects specific to SDH.

Zárate (2021) discusses various guidelines applicable to captioning and subtitling for the deaf and hard-of-hearing population, encompassing linguistic, paralinguistic, orthotypic, technical, and speaker identification features. These features inspire the development of the LOT model, an acronym representing the three key considerations it evaluates: Linguistic, Orthotypographic, and Technical. The linguistic aspect examines the SDH subtitler’s adherence to text reduction and segmentation guidelines. The orthotypographic aspect assesses the subtitler’s commitment to capitalization, italics, and color coding. Finally, the technical aspect focuses on the subtitler’s ability to synchronize, layout, and position subtitles on the screen (see Table 3). The empirical validation of the LOT model demonstrated its superiority in assessing these multifaceted aspects of SDH subtitling, with its comprehensive approach proving more effective in capturing the unique requirements of SDH subtitling compared to the more generalized NER, NTR, and FAR models.

Table 3. *LOT Model for Assessing Interlingual Pre-recorded SDH Creation*

PARAMETER	ERROR	WEIGHT
Linguistic	Omission	15
	Addition	15
	Segmentation	10
Orthotypographic	Capitalization	15
	Italics	5
	Color coding	10
Technical	Synchronization	15
	Layout	10
	Position	5

The weights assigned to each error type in the LOT model reflect their relative impact on the overall quality and comprehensibility of SDH subtitles, based on expert judgment, existing literature, and the specific needs of the deaf and hard-of-hearing audience. Errors that significantly impair meaning or accessibility, such as omissions, additions, and synchronization issues, are assigned higher

weights (15). Moderate impact errors, like segmentation problems, color coding mistakes, and layout issues, receive medium weights (10), while lower impact errors, such as minor positioning discrepancies or inconsistent use of italics, are given lower weights (5). This weighted scoring system allows for a nuanced evaluation of subtitle quality, accounting for the varying degrees of importance of different error types in interlingual pre-recorded SDH. The total quality score for a subtitle is calculated by summing these weighted error scores, providing a comprehensive assessment that prioritizes the most critical aspects of SDH subtitle creation.

Linguistic Errors

Díaz-Cintas and Remael (2007) define *reduction* in interlingual subtitling as omitting irrelevant content for message comprehension and reformulating the text. Reduction involves omission due to faster speech processing through hearing compared to reading, the combination of reading and watching visuals, and subtitles constrained by time and space (Díaz-Cintas & Remael, 2007). Ivarsson and Carroll (1998) argue that reduction in the context of SDH is optimal since it is less intrusive and less bothersome for viewers who can lip-read. Factors influencing reduction choices include the original program's speech rate, age group, lexical and syntactic complexity, non-verbal visual channel information, and program type (Zárate, 2021).

Accommodating other non-linguistic aspects by minimizing linguistic content is vital yet challenging without compromising viewer comprehension. Therefore, the SDH subtitler must be attentive to every detail in the subtitle's body and consider possible deletions or additions. Text segmentation is another critical aspect, involving dividing dialogues into text chunks constrained by the maximum number of characters per line and maximum lines per subtitle or caption. The primary objective of segmentation is to incorporate a complete idea in each subtitle, enhancing readability while maintaining the established maximum reading speed and ensuring synchronization between the subtitle, soundtrack, and images. The researcher assigns a 40% error weight to linguistic characteristics, representing the most challenging aspect of the SDH subtitler's translation task.

Orthotypographic Errors

In SDH, orthotypographical conventions such as capitalization, italics, and color coding convey acoustic information like intonation, pauses, interruptions, accents, emphasis, and singing. Zárate (2021, p. 51) concisely summarizes essential SDH cues and their potential applications (see Table 4). These cues are crucial for representing sounds and their meanings using symbols that occupy minimal screen space.

Table 4. *Orthotypographical cues in SDH illustrated by (Zárate, 2021, pp. 51 and 52)*

ORTHOTYPOGRAPHIC CUE	USED FOR
Upper case	Loud speech Emphasis
Italics	Off-screen voices, sound effects, and music Inner thoughts Foreign words Accents and pronunciations Titles
Quote marks quotation (spans more than two subtitles; repeat the opening quote at the beginning of each subtitle)	Quotations Song titles Quotations within quotations
Round brackets (enclosing the phrase)	
Round brackets (enclosing the phrase)	Whispering Asides
Suspension dots	
Dash (at the beginning of the line, followed by a space)	Interruptions Pauses Speech that starts in mid-sentence
Hyphens (between letters)	Continuation of interrupted speech Continuation after a prolonged pause Speaker identification
Symbols: (?) (at the end of the sentence, following a space)	Stammering lengthened
(!) (at the end of the sentence, following a space)	vocal sounds
♪ (at the beginning of each subtitle, followed by a space, and at the end of the last subtitle, preceded by a space)	Sarcasm or irony in interrogative sentences Sarcasm or irony in declarative sentences Lyrics

Different guidelines for orthotypographical cues usage across countries and companies lead to inconsistent practices, such as the varying use of dashes. The primary functions of dashes are to indicate the speaker, continue an idea between subtitles, and show when the speaker has switched to a new addressee. Many of these conventions are stylistic. For instance, Danish television norms

require a blank space following the “speaker dash”, while Swedish television norms do not (Pedersen 2007, 86). Thus, the severity of these errors depends on the guidelines used to inform the model.

Technical Errors

Unlike linguistic or orthotypographic errors, which may cause significant misunderstandings, stylistic features related to technical errors are more likely to upset the viewer than to alter the subtitle’s meaning. Synchronicity between subtitles, images, and dialogues is crucial for an enjoyable viewing experience. Synchronicity for pre-recorded AV materials is primarily under the subtitler’s control. The subtitle’s in-time should always match the beginning of a speech segment, and its out-time should always match the end of that segment. It is important to note that broadcasters, DVD publishers, video streaming operators, filmmakers, and subtitling companies all play a role in determining how subtitles are displayed on the screen. The subtitle layout consists of font, size, number of lines, and length.

Moreover, subtitles are typically positioned at the bottom of the screen (Ivarsson and Carroll 1998). This convention is adopted in most regions globally. In addition, it has been extended to Chinese, Korean, and Japanese languages, originally written in vertical columns and read from top to bottom, right to left (Kuo, 2017).

The LOT model calculates a penalty score based on the three parameters to determine which errors should be extracted from the subtitles. The next step is to divide the penalty score by the number of subtitles to obtain a score for each parameter that indicates the level of viewer satisfaction with the interlingual SDH translation. Finally, the overall subtitle score is calculated by adding the penalty scores and by dividing the total number of subtitles.

The model’s main advantage is that it provides individual scores for the three parameters, which can be used as SDH subtitler feedback and a didactic tool. Another advantage is that it can be localized by using guidelines and best practices, indicating flexibility. On the other hand, one disadvantage is that it relies on error analysis, which means it does not reward excellent SDH creation. Additionally, there is some ambiguity when assessing the severity of errors and assigning them a numerical penalty score.

In conclusion, the LOT model offers a comprehensive and adaptable approach for assessing interlingual pre-recorded SDH creation. By considering linguistic, orthotypographic, and technical errors, it provides valuable feedback to SDH subtitlers and supports the development of improved subtitle quality. Our analysis supports the initial hypotheses regarding the LOT model’s effectiveness, demonstrating higher interrater reliability and yielding higher average quality

scores compared to existing models. The moderate positive correlations observed between the LOT model and other models suggest that while it captures unique aspects of SDH quality, it still aligns with established subtitling quality principles. These findings underscore the importance of specialized assessment tools in the field of SDH subtitling and highlight the potential of the LOT model to advance quality standards in this domain. However, future research can address the model's limitations, such as the lack of reward for excellent SDH creation and ambiguity in error severity assessment, to further enhance its effectiveness as an evaluation tool in subtitling for DHH.

Empirical Validation of the LOT Model

A comparative analysis validated the efficacy of the LOT model for assessing interlingual pre-recorded SDH quality against established models, including NER, NTR, and FAR. The study utilized a diverse sample of 900 Arabic-to-English subtitles across three AV genres with distinct linguistic properties.

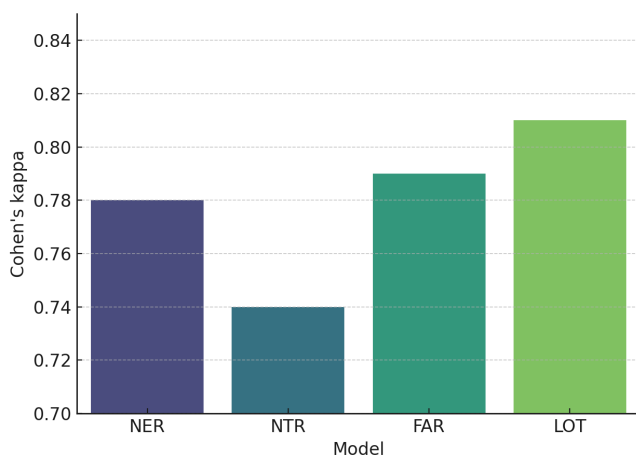


Figure 1. *Intercoder reliability values (Cohen's kappa) for each model*

As illustrated in Figure 1, the LOT model explicitly designed for pre-recorded interlingual SDH achieved markedly higher intercoder reliability ($\kappa = 0.81$) compared to the general interlingual FAR model (0.79) and the live subtitling NER (0.78) and NTR (0.74) models. This superior reliability stems from the LOT model's extensive inclusion of textual, visual, and technical parameters that enable unified judgment between raters. The high intercoder reliability provides quantitative evidence that the LOT model's multidimensional criteria effectively standardize quality assessments of pre-recorded interlingual SDH. In addition to intercoder reliability, the average overall subtitle quality scores were compared between models on a 0-100 scale.

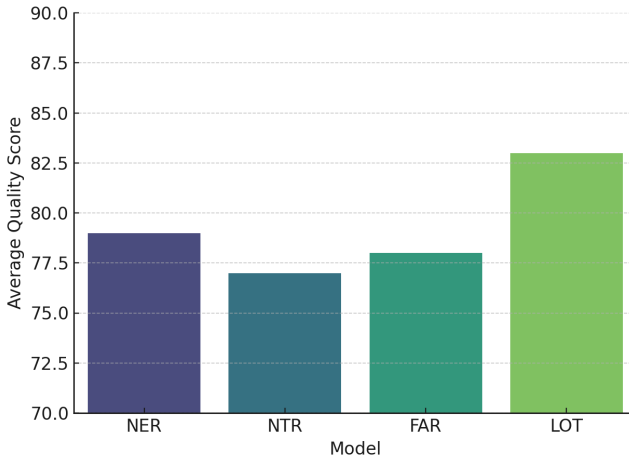


Figure 2. Average subtitle quality scores for each model (scale of 0-100)

As depicted in Figure 2, the specialized LOT model designed for pre-recorded interlingual SDH attained the highest average quality score of 83/100, followed distantly by the other models. The NER model (Number, Edition, and Recognition), developed for live intralingual and interlingual subtitling, scored 79/100. This model focuses on accuracy in terms of number of words, correct editions, and speech recognition, which may not fully capture the nuances of pre-recorded SDH. The FAR model (Functional equivalence, Acceptability, and Readability), designed for general interlingual subtitling, scored 78/100. While it considers important aspects of subtitling quality, it lacks specific parameters for SDH viewers' needs. The NTR model (Number, Translation, and Recognition), created for live interlingual subtitling, achieved the lowest score of 77/100, possibly due to its emphasis on real-time translation aspects that are less relevant in pre-recorded contexts.

This considerable score gap implies a mismatch between the NER, NTR, and FAR models' evaluation criteria and the multifaceted quality expectations of the target pre-recorded SDH audience. It suggests that the LOT model's inclusion of linguistic, orthotypographic, and technical elements better aligns with assessing SDH viewers' complex real-world quality needs, which encompass not only accurate translation but also proper formatting and presentation of non-verbal audio information crucial for deaf and hard-of-hearing viewers.

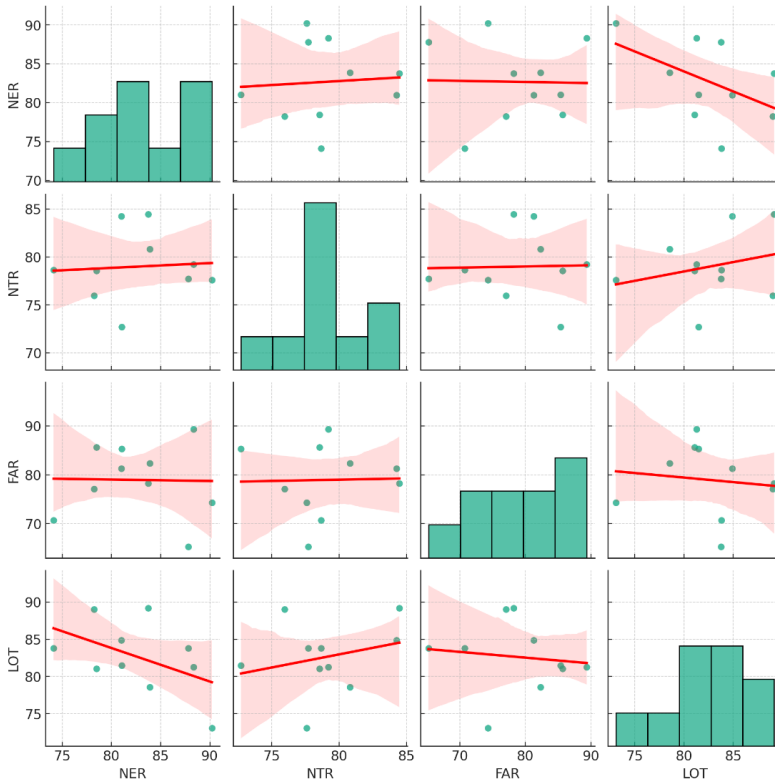


Figure 3. *Correlation matrix between model scores*

The correlation matrix in Figure 3 shows that the NER model exhibited a relatively consistent score distribution, indicating potentially weak correlations with the other models. In contrast, the NTR, FAR, and LOT models demonstrated stronger positive correlations. The scatter plot trends, and histogram peaks reveal the specific score ranges where each model operates optimally. This comparative visualization offers insights into the intersections and relationships between the models.

While expanded research across languages, content types, and larger sample sizes would further substantiate the generalizability of these conclusions, this study provides a substantive foundation indicating the potential of the LOT model to serve as an effective quality assessment instrument for the professional pre-recorded interlingual SDH domain. Further development and critical analysis of the LOT model are warranted to address limitations and capitalize on its evident promise as a comprehensive quality standard.

Conclusion

This study has embarked on an essential quest to enhance the quality and accessibility of pre-recorded interlingual subtitles for the Deaf and Hard-of-Hearing (SDH) audience. This demographic relies heavily on the accuracy and clarity of subtitles for an equitable media experience. Recognizing the gap in quality evaluation for pre-recorded SDH subtitles, the research introduced the LOT model, an assessment framework designed to address this need comprehensively. The LOT model, grounded in linguistic, orthotypographic, and technical factors, is a testament to the specialized requirements of SDH viewers that traditional models may overlook.

An empirical analysis compared the LOT model with existing general quality models across a diverse corpus of Arabic-to-English subtitles spanning various genres. The results showcased the LOT model's effectiveness, yielding higher reliability and quality scores than its counterparts. These findings suggest that the LOT model more accurately aligns with the complex quality demands of the SDH audience, capturing the nuances of linguistic translation, visual presentation, and technical synchronization.

Despite these encouraging outcomes, the study encountered limitations, notably in treating errors and grading their severity. Such insights underscore the necessity for continuous refinement of the model, acknowledging that the journey to perfection is iterative and must accommodate the evolving nature of language and media consumption.

The implications of this research are multifaceted and far-reaching. By enhancing SDH subtitle quality, we bolster the translation field and take significant strides toward inclusion and equality in media access. The potential of the LOT model to revolutionize subtitling practices and training is immense, promising a future where the DHH audience can enjoy a richer, more subtle watching experience.

However, realizing this potential is not without its challenges. Further research is required to validate the LOT model across different languages and cultural contexts, fine-tune its mechanisms, and overcome the highlighted limitations. Additionally, ethical considerations must guide this exploration to ensure that the pursuit of quality does not impinge on the integrity of the content or the dignity of the DHH community.

In conclusion, developing and empirically validating specialized pre-recorded SDH assessment models like LOT open new horizons for translation practices' inclusion and evolution. As this research has shown, there is a clear path forward to elevate the media experience for the DHH audience. However, fully realizing this vision will necessitate a collaborative and sustained effort within the academic and professional spheres to expand research and encourage ethical implementation.

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