The use of ASR-CAI tool and its impact on interpreters' performance during simultaneous interpretation

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An Independent Study Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Arts in Translation and Interpretation
Field of Study of Translation and Interpretation
FACULTY OF ARTS
Chulalongkorn University
Academic Year 2021

การใช้โปรแกรมแปลภาษาแบบประยุกต์เทคโนโลยีรู้จำเสียงพูด (ASR-CAI tool) และผลกระทบต่อประสิทธิภาพการทำงานในการล่ามพูดพร้อม

น.ส.พรรณพัทธ ธรรมศรีสวัสดิ์

สารนิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาอักษรศาสตรมหาบัณฑิต
สาขาวิชาการแปลและการล่าม สาขาวิชาการแปลและการล่าม
คณะอักษรศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย
ปีการศึกษา 2564

Independent Study Title	The use of ASR-CAI tool and its impact on interpreters' performance during simultaneous interpretation
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Accepted by the FACULTY OF ARTS, Chulalongkorn University in Partial Fulfillment of the Requirement for the Master of Arts

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พรรณพัทธ ธรรมศรีสวัสดิ์ : การใช้โปรแกรมแปลภาษาแบบประยุกต์เทคโนโลยีรู้จำเสียงพูด (ASR-CAI tool)และผลกระทบต่อประสิทธิภาพการทำงานในการล่ามพูดพร้อม. (The use of ASR-CAI tool and its impact on interpreters' performance during simultaneous interpretation) อ.ที่ปรึกษาหลัก : ผศ. ดร.หนึ่งหทัย แรงผลสัมฤทธิ์

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สาขาวิชา การแปลและการล่าม ลายมือชื่อนิสิต .....

ปีการศึกษา 2564 ลายมือชื่อ อ.ที่ปรึกษาหลัก .....

6388040422 : MAJOR TRANSLATION AND INTERPRETATION

KEYWORD: automatic speech recognition, simultaneous interpreting, computer-assisted interpreting, terminology rendition, cognitive effort, ASR-CAI tools

Pannapat Tammasrisawat : The use of ASR-CAI tool and its impact on interpreters' performance during simultaneous interpretation. Advisor: Asst. Prof. NUNGHATAI RANGPONSUMRIT, Ph.D.

Ever since automatic speech recognition (ASR) was introduced as a means to improve the terminology lookup mechanism and reduce additional cognitive effort in performing a terminology query, many studies have been conducted to investigate the use of ASR-CAI tools in simultaneous interpretation (SI). However, few studies have implemented the process-oriented method in addition to the product-based method in analyzing how the use of ASR-CAI tools may affect the interpreting process. By using both product/process-oriented approaches, this paper set out to investigate the impact of ASR-CAI tool on interpreters' overall performance. The results showed that the support of ASR-CAI tool led to a significant reduction in error rate and omissions as well as improved the quality of terminology rendition. The paper also discussed the impact of ASR-CAI tool on interpreters' processing capacity and cognitive effort during SI. In addition, potential benefits and limitations of ASR-CAI tool were analyzed to provide a better understanding regarding the tool's usability so that such tools can be better integrated into the interpreting process.

Field of Study:	Translation and Interpretation	Student's Signature .....
Academic Year	2021	Advisor's Signature

ACKNOWLEDGEMENTS

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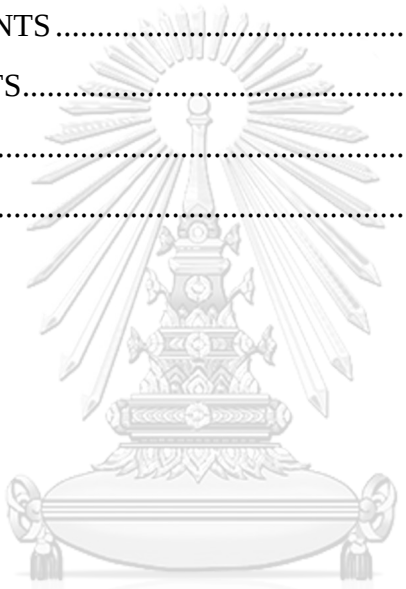

The use of ASR-CAI tool and its impact on interpreters' performance during simultaneous interpretation

Pannapat Tammasrisawat

Abstract

Ever since automatic speech recognition (ASR) was introduced as a means to improve the terminology lookup mechanism and reduce additional cognitive effort in performing a terminology query, many studies have been conducted to investigate the use of ASR-CAI tools in simultaneous interpretation (SI). However, few studies have implemented the process-oriented method in addition to the product-based method in analyzing how the use of ASR-CAI tools may affect the interpreting process. By using both product/process-oriented approaches, this paper set out to investigate the impact of ASR-CAI tool on interpreters' overall performance. The results showed that the support of ASR-CAI tool led to a significant reduction in error rate and omissions as well as improved the quality of terminology rendition. The paper also discussed the impact of ASR-CAI tool on interpreters' processing capacity and cognitive effort during SI. In addition, potential benefits and limitations of ASR-CAI tool were analyzed to provide a better understanding regarding the tool's usability so that such tools can be better integrated into the interpreting process.

Keywords: automatic speech recognition, simultaneous interpreting, computer-assisted interpreting, terminology rendition, cognitive effort, ASR-CAI tools

Introduction

Ever since the introduction of computer-assisted interpreting (CAI) technology, many interpreters have made use of CAI tools to assist them during different phases of their workflow, mainly in organizing terminological data and in accessing glossaries in the booth. First empirical analyses on the use of CAI tools during simultaneous interpretation (SI) suggest an improvement of terminology rendition during the interpreting process, but the main drawback remains in the way that the tools require manual operation in looking up terminology, which can potentially add to interpreters' cognitive load during the process (Pisani and Fantinuoli, 2021, p.7). In recent years, automatic speech recognition (ASR) has been proposed as a means to improve the lookup mechanism for interpreters to reduce additional cognitive effort in performing a glossary search. Since then, several studies have been conducted to investigate the integration of ASR in CAI tools (Fantinuoli, 2016, 2017a,

2017b; Desmet et al., 2018), with InterpretBank being featured in most studies as a prototype of ASR-CAI integration which "transcribes in real-time the speech delivered by a speaker and automatically provides an interpreter with translation of terminology as well as with numerals and their units of measurement." (Pisani and Fantinuoli, 2021).

So far, existing studies (Fantinuoli, 2017b; Defrancq and Fantinuoli, 2020; Pisani and Fantinuoli, 2021) have focused on evaluating the integration of ASR in CAI tools by measuring the precision and recall scores for terminology and number identification, but few studies (Prandi, 2017, 2018) have evaluated the impact of ASR-CAI tools on the interpreting process. Most experiments mainly focused on the product-based analysis of the tools' performance and the extent to which they may improve interpreters' rendition quality, but there is still a limited number of studies on how the use of ASR-CAI tools may impact interpreters' processing capacity as well as their overall performance in SI. Although the studies conducted on ASR-CAI tools suggest that ASR proves effective in providing interpreters support during the interpretation of speeches dense in numbers and terminology, few experiment has implemented the process-oriented method in studying the usability of ASR-CAI tools and how the use of such tools may affect the overall interpreting process.

Considering the research gaps mentioned, this study set out to investigate the usability of ASR-CAI tool and its impact on interpreters' overall performance during simultaneous interpreting process. The aim of this research was three folds: 1) to investigate the differences in rendition quality of SI performed with and without the support of ASR-CAI tool and test the usefulness of the functions provided by the tool, namely the real-time transcriptions and translation suggestions for terminology, 2) to explore interpreters' processing capacity and cognitive effort during SI performed with ASR-CAI tool through the implementation of both product/process-based methods, and 3) to study interpreters' perception towards the usability of ASR-CAI tool to see how the use of such tools affects the interpreting process.

The author hopes that further investigation to evaluate the impact of ASR-CAI tools on interpreters' performance and processing capacity will help bridge existing research gaps and provide useful insights on how ASR-CAI tools can be better integrated into the interpreting process for the most effective outcome.

CAI Tools with ASR Integration: the state of the art

Nowadays, more and more interpreters have opted to use CAI tools to assist them during the preparation stage and to facilitate the glossary search process in the booth. Although one key feature of CAI tools lies in their ability to support interpreters in accessing

terminology during SI, earlier studies pointed out certain shortcomings of the use of CAI tools, with the main drawback being that the tools' database has to be queried manually. As a result, this can potentially add to interpreters' cognitive effort and interrupt the overall interpreting process.

Fantinuoli (2017) proposed that this disadvantage could be addressed by automating the querying system through the use of ASR. In his paper on speech recognition in interpreters' workstation, Fantinuoli proposed the integration of ASR in CAI tools as a means to improve the lookup mechanism and conducted a pilot study featuring a prototype of an ASR-CAI integration to test its precision and recall of terminology retrieval and numbers identification. The results confirmed that ASR could effectively provide support for users during the interpretation of speeches dense in numbers and terminology, which consequently led to a reduction of error rate and omissions among participants.

Proposed as a means to enhance state-of-the-art computer-assisted interpreting tools, ASR made it possible for machine-learning techniques to be integrated into the workflow of professional interpreters. Following Fantinuoli's proposition regarding the possibility of ASR integration, many scholars have tried to develop theoretical frameworks for empirical studies in the area of ASR-supported CAI tools, with most studies focusing on the tools' performance when dealing with problem triggers such as numbers and terminological data, and exploring the extent to which the tools can improve interpreters' rendition quality.

Defrancq and Fantinuoli (2020) reported on a small-scale experiment with in-booth CAI which tested the usefulness of real-time transcriptions with numbers using InterpretBank ASR. The study proved that the system's precision is high and its latency low enough to fit interpreters' ear–voice span (EVS). The results of the study showed that 96% of the numbers were displayed correctly and that the tool's precision was higher than interpreters' accuracy levels reported in experimental and corpus-based research. Defrancq and Fantinuoli concluded that ASR, therefore, had the potential to improve interpreters' accuracy in number rendition.

Another similar research conducted by Pisani and Fantinuoli (2021) adds on the findings of Defrancq and Fantinuoli by measuring the impact of ASR on number rendition in SI. In their experiment, Pisani and Fantinuoli used a real-life ASR-enhanced CAI tool in which typical issues of ASR such as latency and mistranscriptions were not eliminated. This allowed them to draw conclusions on the potential and limits of ASR technology. The experiment confirmed that ASR proved effective in providing interpreters support during interpretation of speeches dense in numbers. The support of ASR was also reported to help reduce omissions and approximations, as well as help interpreters avoid phonetic perception errors.

The results of both studies confirmed the usefulness of ASR and allowed for a more complete picture of user-machine interaction in the context of real-time CAI support. However, both experiments focused on the product-based analysis of ASR-CAI tools and the quality of number rendition. Both studies mainly assessed participants' performance in terms of accuracy without further exploring how the use of ASR-CAI tool may affect interpreters' cognitive capacity or how the results may vary if the tool is presented with other kind of information.

First attempts at analyzing the allocation of cognitive resources while working with CAI tools during SI can be identified in exploratory research by Prandi (2018). In her research, Prandi aimed to develop a research methodology through an exploratory study which implemented both product/process-based measures to investigate the local variations in cognitive load while interpreters performed a glossary query using CAI tool in comparison to electronic glossaries. Prandi proposed that, when working with CAI tools, interpreters were expected to perform fewer manual-spatial and visual-spatial sub-tasks since they only had to type in and visually locate the term needed. In comparison, electronic glossaries such as Word or Excel table would require interpreters to position the cursor in the search field, type and press the enter button, scroll up and down or press the "forward" button to locate the term needed, and delete the term before starting a new search (Prandi, 2017).

The results from Prandi's research showed that CAI tool did perform better compared to electronic glossaries. However, the analysis remained focused at terminological level, and it was deemed necessary to expand the analysis to the sentence level. In addition, in Prandi's previous work (2017) on the use of InterpretBank in the booth, she also proposed that the integration of ASR in CAI tools such as InterpretBank would lower additional cognitive load as no manual-spatial response would be needed.

In regards to existing studies and findings on the use of ASR-CAI tools during SI, it remains unclear how the support of CAI tools with ASR integration may affect interpreters' processing capacity and the interpreting process. This paper hopes to bridge the gap regarding the use of ASR-CAI tools by implementing both product/process-oriented approaches to assess participants' overall performance and their cognitive effort during SI of speeches dense in terminology. By using combined analysis methods to evaluate participants' renditions of SI performed with the support of ASR-CAI tool, the study set out to explore the potential benefits and limitations of such tools as well as their usability during simultaneous interpreting process.

Research methodology

In order to investigate the influence of ASR-CAI tool on interpreters' performance and its impact on the interpreting process, a small-scale experiment was conducted to obtain data

of SI performed with and without the support of ASR-CAI tool. At the end of the experiment, an in-depth interview was conducted to get participants' feedback on their perception and experience in using ASR-CAI tool. Both product/process-based methods were then implemented to analyze the data obtained from the experiment and interview.

Equipment

For the ASR-CAI tool of choice, this experiment used InterpretBank, a web-based ASR-supported CAI tool which transcribes in real-time the speech delivered by a speaker and automatically provides interpreters with numerals and translation options for terminology drawn from the tool's terminology database. For this experiment, a glossary was prepared beforehand on the tool's database by the author to support the tool's terminology lookup function.

Figure 1 shows a screenshot of InterpretBank's user interface. Real-time transcriptions of the source text are displayed at the top of the screen. On the left is the terminology section where translation suggestions for terminology are presented. Lastly, numerals are displayed on the right together with their units of measurements, with the newest information being displayed on top and highlighted in red.

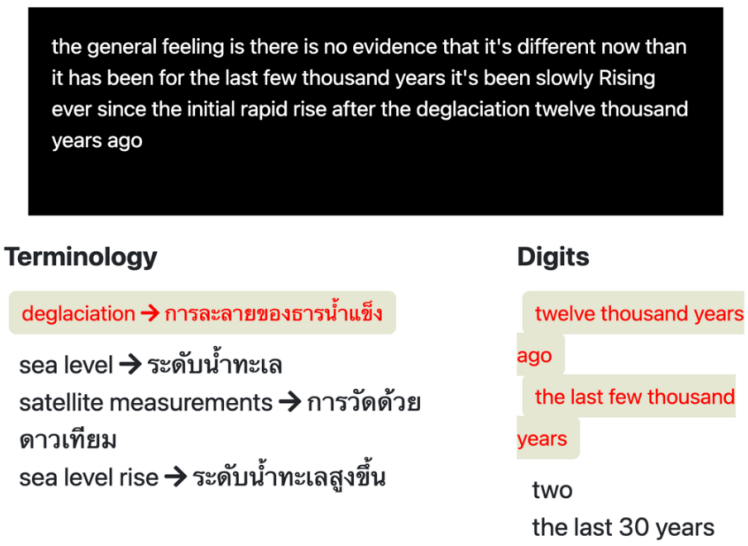

Figure 1: InterpretBank's user interface

Population sample

The experiment involved four students enrolled in Master of Arts Program in Interpretation at Chulalongkorn University. Prior to the experiment, all participants have completed four

semesters of practice in both simultaneous and consecutive interpreting. All are native speakers of Thai with English as their B language in the working language combination. In addition, all participants have no prior experience in using ASR-CAI tools during SI and have not received training on how to use InterpretBank prior to this experiment.

Speeches

The experiment used two selected speeches which were dense in terminology. Both speeches were comparable in terms of topics, information density, and the delivery style. The speeches were on the topics of (1) assisted reproductive technologies and (2) the condition of endometriosis. Both speeches were chosen based on the assumption that participants were likely to have minimal familiarity with the selected topics. Each speech lasted about ten minutes with an average delivery rate of 160 words per minute. The first speech contained 61 specialized terms while the second speech contained 56 specialized terms.

Procedure

The experiment was conducted remotely via Zoom meeting in which the performance of each participant was recorded separately for analysis. In addition, the entire experiment was also video-recorded.

Participants were given instructions about the structure of the experiment and were informed that they would be interpreting two speeches which were dense in terminology from English to Thai. They were then given a basic training on how to use InterpretBank. A short video was played to demonstrate how the tool operated and to show the types of information that the tool provided. This was also done so that participants could gain familiarity with how the information would be displayed on the user interface.

Participants were informed about the topics of the two speeches right before the experiment started and were given a briefing on the topic of each speech. Since the selected speeches were highly technical, participants were given materials containing background information and glossary documents for both speeches to study 15 minutes before each session started. However, they weren't given time to prepare their own glossary or do any further research on each topic beforehand.

The materials for background information included two pages of information in Thai which covered all the main points being presented in the speeches. In addition, the materials also gave explanations and clarifications for the specialized terms that were found in both speeches. The glossary documents were given to participants in a form of Excel files,

featuring all the terminology presented in the speeches together with their translation equivalents (Appendix A).

The experiment was divided into two sessions, one for each speech.

a) The first session was carried out with the support of InterpretBank, in which participants were provided with real-time transcriptions of the speech as well as suggestions for numerals and terminology translations. Providing that the participants had the support of InterpretBank in this session, they were asked not to consult the glossary document given to them during the interpreting process. In terms of the setup, the screen was divided into two areas as shown in Figure 2. The video of the speaker was positioned on the left-hand side while the user interface of InterpretBank was displayed on the right-hand side where participants could see the information provided by the tool.

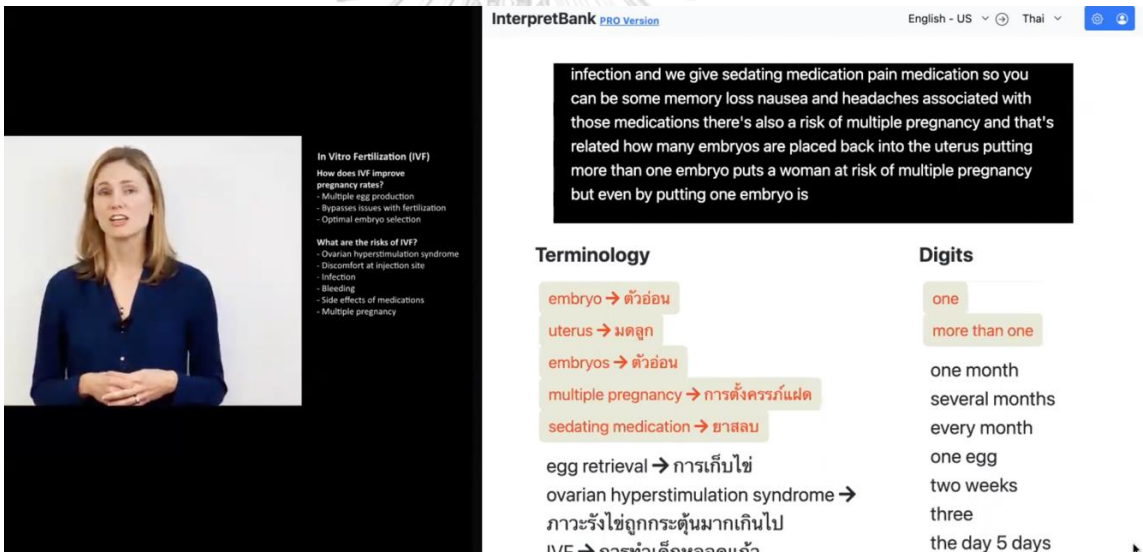

Figure 2: Screen setup for the experiment

b) For the second session, participants were asked to perform SI without the support of InterpretBank. Instead, they were allowed to consult the glossary document given to them throughout the entire session.

At the end of the experiment, participants were asked to participate in an in-depth interview to give feedback on the tool's usability (Appendix B). The study aimed to investigate participants' perception on the use of InterpretBank in the following aspects:

- The extent to which InterpretBank helps improve overall performance.
- Issues or difficulties that occurred during SI performed with the support of InterpretBank.
- The usefulness of visual suggestions provided by the tool.
- Participants' perception regarding the tool's usability.
- Reports of any increased cognitive effort when working with ASR-CAI tool.

Results and discussion

Performance analysis

The transcripts of participants' renditions were analyzed in terms of terminology quality and translation accuracy to determine whether the support of InterpretBank helped improve terminological precision and the quality of overall performance.

Terminology quality

In assessing the terminology quality, the study analyzed participants' renditions in search of mistranslations and use of English word, which means the terms were left untranslated and repeated as they were said in the source text. In this case, the English words that are widely used or borrowed into Thai would not be counted as errors if participants reported them as in the source language (Appendix C). Table 1 shows examples of the terms featured in the speech about assisted reproductive technologies, demonstrating which terms were considered as acceptable to be used in English and which terms required translation.

Translations not required	Translations required
Blastocyst stage	Cervix
Cystic fibrosis	Egg retrieval
Endometriosis	Fertility treatment
IUI – Intrauterine Insemination	Ovulation
IVF – In Vitro Fertilization	Unexplained infertility
LH surge	Uterus
Sperm wash	Vagina

Table 1: Terminology from Speech 1 categorized by their requirements for translation

The study found that, in terms of terminology quality, participants committed fewer mistranslations of specialized terms and used fewer English words in their renditions when they had the support of InterpretBank. For example, the terms "uterus" and "cervix" were presented in both speeches. When participants performed SI with the support of InterpretBank, all of them were able to provide correct translations for both terms.

However, during SI performed without the tool's support, the study found that several participants either reported the two terms in English or gave incorrect translations for them.

The graphs in Figures 3 and 4 show that the use of InterpretBank helped improve the terminology quality in all participants' renditions. On average, participants committed 48% fewer mistranslations and used 72% fewer English word during SI performed with InterpretBank's support. The results indicated that the support of ASR-CAI tools such as InterpretBank led to a significant reduction of mistranslations in terminology rendition as well as reduced the use of English word as a coping strategy among all participants, resulting in a higher level of precision in terminology quality.

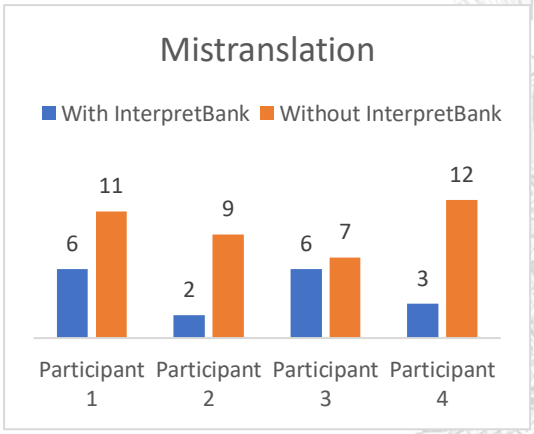

Figure 3: Data on mistranslations

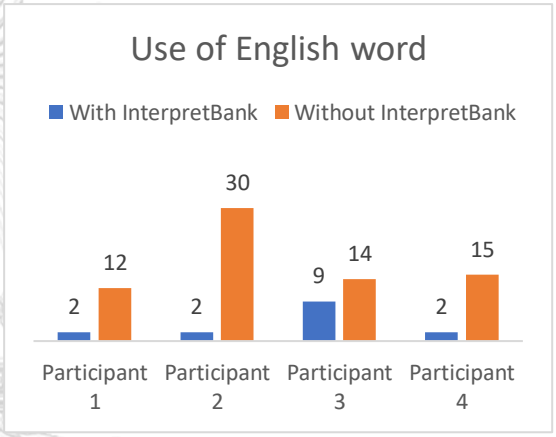

Figure 4: Data on use of English word

Translation accuracy

For the assessment of translation accuracy, the analysis was expanded to the sentence level to examine whether the support of InterpretBank would lead to an improvement of participants' overall performance. In analyzing translation accuracy, the participants' renditions were annotated following Barik's (1971) classification of errors encountered in SI, which are generally classified as omissions, additions, and substitutions.

Omissions

Omissions were counted as errors when ideas in the source text were completely missing in the rendition, resulting in loss of information in the target text. The following paragraph shows an example of segments from the source text in which participants were found to commit omissions in their renditions.

> *"IUI is also known as sperm wash. It's done in cases of male factor infertility or in cases where woman couples, single woman, or same-sex couples are using donor sperm, and it's also done in cases of unexplained infertility as well."*

The study found that three out of four participants committed omissions in their renditions of these segments, in which they only mentioned that sperm wash was done in cases of unexplained infertility and omitted information about other cases where sperm wash could be performed.

Additions

When information was presented in the target text where no reference to it could be found in the source text, such errors were considered as additions.

For example, in one segment which said, "The useful thing about doing this surgery is that if you find an endometrial tissue, it's possible to put some treatments in place such as cauterizing that tissue or excising it out," one participant correctly conveyed the key message in their rendition. However, they also added information about how endometrial tissue could cause damage to the body. In such cases when information was presented in the target text with no reference to the ideas presented in the source text, the error was considered as addition.

Substitutions

Errors that were considered as substitutions were when ideas in the source text were altered, resulting in contradictions, ambiguity, or misinterpretations in the target text.

For example, during SI of the speech about endometriosis, one segment in the source text originally said, "There's no particular endometriosis gene that's been found, but we do find that it does have a tendency to run in families." However, one participant misinterpreted the segment by saying that endometriosis had no tendency to run in families. In cases when such errors occurred, those errors would be counted as substitutions.

Upon investigation, the study found that participants committed fewer omissions, additions, and substitutions during SI performed with the support of InterpretBank. Figures 5, 6, and 7 show the data collected from the experiment, illustrating the differences in error rate of SI performed with and without the support of ASR-CAI tool.

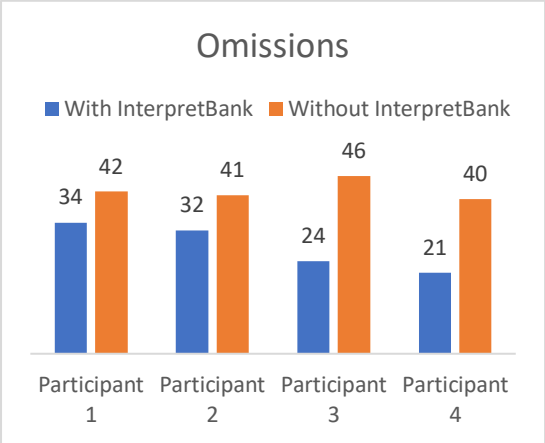

Figure 5: Data on omissions

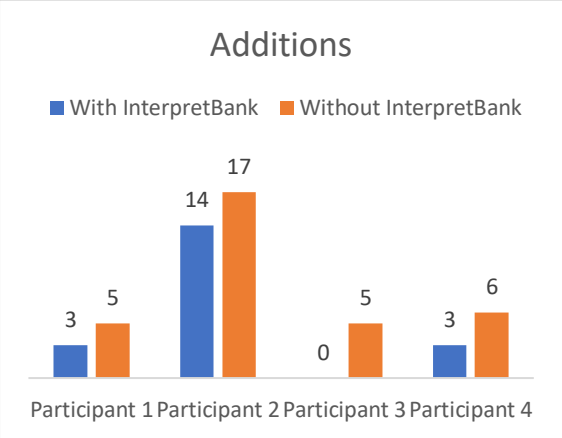

Figure 6: Data on additions

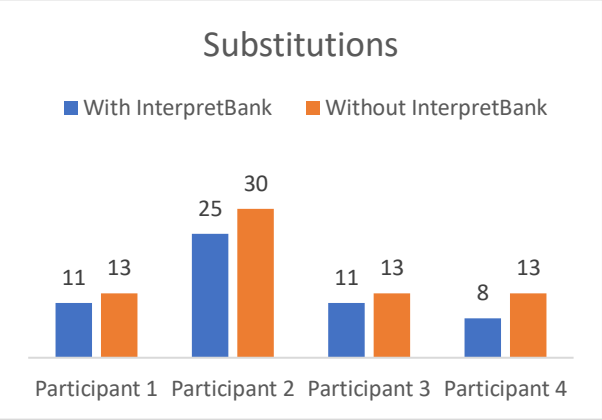

Figure 7: Data on substitutions

According to the data presented, participants were found to commit fewer errors when they had the support of InterpretBank during SI. On average, InterpretBank was found to help reduce omissions by 33%, reduce additions by 51.9%, and reduce substitutions in participants' renditions by 21%. In this regard, the study concluded that the use of ASR-CAI tool proved to help reduce errors in all participants' renditions with the reduction of additions being most evident.

The usefulness of InterpretBank's support during SI was further confirmed as the features of the two speeches used in the experiment were taken into account. As already mentioned, the two speeches were comparable in terms of topics with the first speech containing 61 specialized terms and the second containing 56 specialized terms. In addition, some of the terminology featured in the first speech was also found in the second speech. Considering that several terms were presented in both speeches with the second speech containing less specialized terms overall, participants were expected to have gained some familiarity with

both the topic and the terminology after the first session of SI which should lead them to perform better during SI of the second speech. However, the data showed that participants actually committed more mistranslations and errors and used more English words in their renditions of the second speech when they had no support from ASR-CAI tool.

Despite their lack of experience in dealing with the topic and the terminology being featured in the speech, participants evidently performed better during SI of the first speech when they had the support of InterpretBank, resulting in a lower error rate in all participants' renditions.

This proved that ASR-CAI tools such as InterpretBank had the potential to serve as effective support for interpreters during SI of specialized texts which are dense in terminology, and further confirmed that such tools could really help improve interpreters' overall performance and the quality of their terminology rendition.

Process-based analysis

In this section, the functions provided by InterpretBank will be discussed in relation to how they affected participants' performance and the interpreting process.

Regarding the use of InterpretBank during SI, data visualization was found to have significant impact on participants' rendition quality. For example, in cases where the software failed to provide any translation suggestions for the terminology featured in the source text, the study found that participants often struggled to come up with their own translations for the terminology presented. An example could be found in the segments which said, "IUI is also known as sperm wash. It's done in cases of male factor infertility or in cases where woman couples, single woman, or same-sex couples are using donor sperm." During these segments, InterpretBank failed to retrieve the translation for the term "male factor infertility" from the terminology database. As a result, no translation suggestion for the term was provided for participants. This caused two participants to pause for several seconds and ended up omitting the term in their renditions. In addition, the delay also affected their renditions of the subsequent segments, resulting in omissions of information in the target text.

Furthermore, data visualization was also found to play a role in cases when multiple suggestions were displayed at the same time on the user interface as shown in Figure 8.

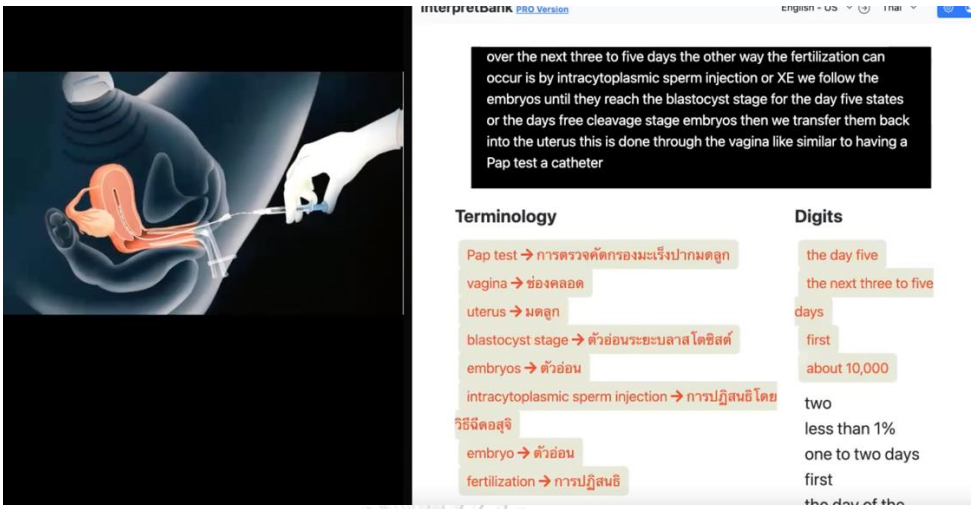

Figure 8: InterpretBank's interface with multiple suggestions displayed

The segments displayed in the transcription section contained eight specialized terms, and all of them were displayed at the same time on the interface together with the suggestions for their translations. In such segments where multiple translation suggestions were shown, most participants reported of having difficulty identifying the translations they needed. As a result, they were found to commit omissions and other types of errors such as additions and substitutions in their renditions.

According to this finding, the study concluded that data visualization could significantly impact the interpreting process as well as interpreters' rendition quality. In cases when ASR-CAI tool failed to provided any translation suggestions or when multiple suggestions were displayed at the same time on the interface, the interpreting process could potentially get interrupted, causing interpreters to commit errors in their renditions.

Real-time transcriptions

An assessment regarding the usefulness of real-time transcriptions revealed that the ASR system still had limitations relating to its precision. In analyzing the quality of real-time transcriptions, the study assessed the transcriptions provided by InterpretBank in search of errors in each segment. In this study, minor mistranscriptions which did not affect the overall meaning of the source text were overlooked. In this regard, only mistranscriptions

which potentially resulted in contradictions, ambiguity, or misinterpretations were taken into account.

The study found that, in terms of terminology, the ASR system was able to correctly transcribe and identify 80% of the terminology featured in the glossary. However, when the transcriptions were assessed at the segment level, mistranscriptions were found in 50% of the segments. In these instances, the software was found to provide participants with inaccurate transcriptions, which consequently led participants who relied on them to commit mistranslations in their renditions.

For example, when one participant was performing SI with the support of InterpretBank, the software mistranscribed one segment which said "IVF can be performed for a number of different reasons" as "I have to be performed for a number of different reasons." This caused confusion for the participant and consequently led them to commit errors in the target text. Furthermore, the transcriptions were often found to shift back and forth before they became stabilized due to the real-time correction function of the ASR system.

Considering the issues associating with the ASR system which had been identified in this study, it seemed that real-time transcriptions still need improvement to be of effective support for interpreters. Admittedly, real-time transcriptions provided by ASR-CAI tools such as InterpretBank could provide certain level of support for interpreters during the interpreting process. However, interpreters should still make sure not to rely completely on the transcriptions provided to them by the tool. Instead, they should keep in mind to use ASR-CAI tools as merely supportive tools rather than letting the tools' support replace their skills entirely.

Translation suggestions

Upon investigation, translation suggestions proved effective in providing support for participants during SI of speeches dense in terminology, resulting in a higher level of precision in terminology rendition. The study found that participants were able to integrate most of the suggested translations into their renditions in a correct context during segments that didn't feature a high number of specialized terms, which led to an accurate rendition of the whole segments. On the other hand, suggested translations were often improperly integrated during segments that were particularly dense in terminology, resulting in errors such as additions or substitutions in the target text.

In this study, when a segment contained over five specialized terms which appeared close to one another, such segments were considered as dense in terminology (Appendix D). Figure 9 shows a screenshot of InterpretBank's interface, featuring the transcriptions for

two segments that were considered to be dense in terminology. Both segments contained six specialized terms, all appearing in close range of one another.

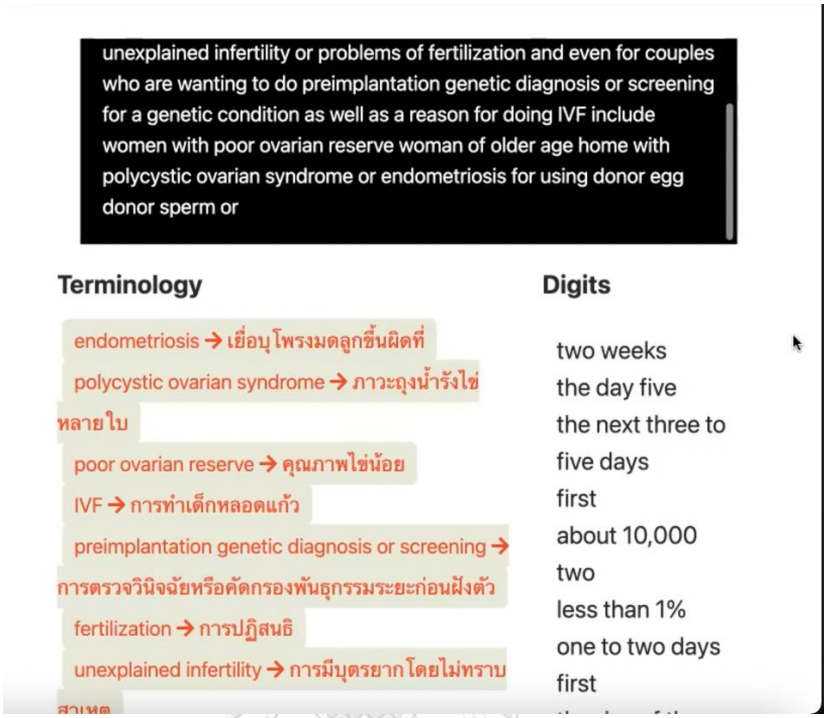

Figure 9: Screenshot of segments dense in terminology

The following paragraph shows the full transcriptions of the two segments mentioned. The highlighted terms were included in the glossary and were displayed on the interface together with their translations.

> *"IVF can be performed for a number of different reasons, which include male factor infertility, tubal factor infertility, for women and couples with unexplained infertility or problems with fertilization, and even for couples who are wanting to do pre-implantation genetic diagnosis or screening for genetic condition as well."*

> *"Additional reasons for doing IVF would include women with poor ovarian reserve, women of older age, women with polycystic ovarian syndrome or endometriosis or using donor egg or donor sperm or even embryo donation."*

During such segments, the study found that participants were able to integrate the translation suggestions for terminology into their renditions, but they also committed additions and substitutions in the process, resulting in an inaccurate rendition of the whole segments.

Based on this finding, the study concluded that translation suggestions had the potential to improve participants' rendition quality in terms of terminology. However, they didn't always lead to an accurate rendition of the segment in which the terminology was embedded in.

Partly, the density of information provided by InterpretBank might have added to participants' processing load. This additional task of input processing consequently required participants to put additional effort into managing their processing capacity. This could potentially lead to processing capacity mismanagement considering that all participants had no prior experience in using ASR-CAI tools such as InterpretBank during SI. Thus, they lacked the familiarity and expertise in how to best handle the additional information provided to them, which caused them to commit errors in their renditions.

In addition, the occurrence of errors may also be ascribed to participants' over-reliance on the support of ASR-CAI tool during SI. When participants could not keep up with the speaker, they might resort to using the suggested translations for terminology as pointers for the content they missed. This led participants to integrate translation suggestions into their renditions with no clear idea of the exact context that those terms appeared in, causing them to commit errors in their renditions at the sentence level while precision was still maintained at the terminological level.

Perception-based analysis

In general, participants described the support of InterpretBank as helpful when dealing with speeches dense in terminology. Participants reported that they benefitted the most from the translation suggestions for terminology, whereas real-time transcriptions offered the least benefit as they were reported to pose more of a distraction for most participants during the interpreting process. Participants who relied on the transcriptions for support reported of having difficulty correcting their renditions in a prompt manner when the software provided them with incorrect transcriptions of the source text, which consequently led them to commit mistranslations in their renditions.

In terms of the user interface, participants stated that the sections for each type of information were well-divided and that they had no difficulty identifying the information they needed from each section. However, two participants expressed that they sometimes

struggled with how the data was presented, specifically when multiple translation suggestions appeared at the same time on the interface during segments rich in terminology. In these instances when several suggestions were displayed in the terminology section, almost all participants reported of experiencing an increase in cognitive load, which consequently led them to commit omissions and other types of errors in their renditions.

Interestingly, one participant pointed out that the support of ASR-CAI tools such as InterpretBank had the potential to offer psychological benefits to interpreters through the availability of visual suggestions provided by the tool. The participant expressed that, by having the translation suggestions available when needed, it helped reduce the cognitive task of having to manually perform a glossary search. Moreover, this also helped reduce their cognitive pressure while performing SI of speeches dense in terminology.

In conclusion, the suggested translations for terminology were used most often by participants which evidently led to an improvement of terminology quality in their renditions. Real-time transcriptions appeared to offer the least benefit and oftentimes posed as a source of distraction for participants, leading them to commit mistranslations in the target text. In addition, most participants reported of experiencing increased cognitive effort when multiple translation suggestions were displayed at the same time on the interface. However, all participants emphasized that they might've been able to make use of the tool's functions more effectively had they had more familiarity with how the tool operated as well as more practice in how to use the tool.

Analysis of cognitive effort

In analyzing the cognitive effort experienced by participants during SI performed with the support of ASR-CAI tool, the study drew on similar research conducted by Gumul (2019) in which she aimed to measure the level of correspondence between the problems related to increased cognitive effort reported by interpreters and problem indicators identified in the target texts. In this study, the target text segments in which participants reported of experiencing increased cognitive load were analyzed in search of the following problem indicators which have been proposed to reflect increased cognitive effort during SI.

- Pauses exceeding two seconds
- Omissions leading to the loss of information
- Mispronunciations
- Hesitation markers

Upon investigation, the study found that the majority of participants' reports regarding increased cognitive effort coincided with the problem indicators found in their renditions. In these instances, pauses, mispronunciations, and hesitation markers were identified in the target text segments which participants reported of experiencing an increase in cognitive load.

Most problem indicators were found in segments that were particularly dense in terminology, which consequently caused InterpretBank to display multiple translation suggestions for the terminology presented in those segments. This correlated with participants' feedback in which they reported of experiencing increased cognitive effort when the tool displayed multiple translation suggestions on the interface during segments dense in terminology, causing them to commit errors and omissions in their renditions.

The study concluded that the problem indicators found in the target text could indicate an increase in cognitive effort and processing problems experienced by participants during the interpreting process. The increased cognitive effort experienced by participants could partly be ascribed to the use of ASR-CAI tool during SI. The additional information provided by InterpretBank together with the density of information in the source text could potentially add to participants' processing load and make them more susceptible to experiencing cognitive overload, causing them to commit errors such as additions, substitutions, and omissions in their renditions of subsequent segments.

Conclusion

The study confirmed that InterpretBank proved effective in providing interpreters support during SI of speeches dense in terminology. The tool's support evidently led to an improvement of terminology quality and a reduction of errors in all participants' renditions.

The paper discussed potential benefits and limitations of the functions provided by InterpretBank, namely the real-time transcriptions and translation suggestions for terminology. It was found that while participants significantly benefitted from the translation suggestions, real-time transcriptions seemed to pose as a distraction due to issues associated with the ASR system such as latency and imprecision of the transcriptions, which led participants who relied on them to commit errors in their renditions. In addition, the paper also investigated the influence of ASR-CAI tool on participants' processing capacity and cognitive effort during SI, in which data visualization was discussed in relation to increased cognitive load and participants' rendition quality.

The findings presented above can help shed light on the usability of ASR-CAI tools and their impact on interpreters' performance and cognitive effort during SI. Nevertheless, further research should be conducted to study the impact of ASR-CAI tools on interpreters' cognitive load with new methods tested to provide a clearer picture of how such tools can impact interpreters' processing capacity during the interpreting process. In addition, it would be beneficial if similar studies could be conducted with different population samples such as professional interpreters or interpreters with prior experience in using ASR-CAI tools to see how the use of such tools may impact their performance during SI.

Despite the limitations that InterpretBank presents, it is evident that the support of such tools can help improve interpreters' rendition quality and overall performance. Although the information provided by the tool appears to add to interpreters' cognitive load in certain circumstances, the study proposes that this issue can be minimized if interpreters are given opportunities to gain more familiarity with the tool's functions, after which they can devise their own strategies to better manage the additional information provided to them by ASR-CAI tools.

As technology makes its way into the field of interpretation, the implementation of CAI technologies has also become more prevalent. An integration of ASR in CAI tools presents interpreters with new possibilities in how interpretation can be performed and improved. Given that there's still a lack of research in this area, this paper hopes that the findings which have been discussed above can provide a better understanding regarding the usability of ASR-CAI tools so that interpreters can make better use of the functions provided and better integrate them into the interpreting process for the most effective outcome.

Appendix A: Complete glossary lists for the two speeches used in the experiment

Terminology glossary for the speech on assisted reproductive technologies

English	Thai
Assisted hatching	การช่วยฟักตัวอ่อน
Balanced translocation	ความผิดปกติของโครงสร้างโครโมโซม
Biopsy	การเจาะชิ้นเนื้อ
Bladder	กระเพาะปัสสาวะ
Blastocyst stage	ตัวอ่อนระยะบลาสโตซิสต์
Blood clots	ลิ่มเลือด
Blood vessels	หลอดเลือด
Bloodwork	การตรวจเลือด
BRCA	ยีนที่ทำหน้าที่ควบคุมการเจริญของเซลล์
Catheter	หลอดสวน
Cervical mucus	เมือกปากมดลูก
Cervix	ปากมดลูก
Chromosomal abnormalities	ความผิดปกติของโครโมโซม
Chromosomal testing	การตรวจหาความผิดปกติของโครโมโซม
Cleavage stage embryos	ตัวอ่อนระยะแบ่งตัว
Congenital abnormalities	ความผิดปกติแต่กำเนิดของทารก
Congenital anomalies	ความผิดปกติแต่กำเนิดของทารก
Cystic fibrosis	โรคซิสติกไฟโบรซิส
Donor sperm	อสุจิจากการบริจาค
Egg retrieval	การเก็บไข่
Embryo	ตัวอ่อน
Embryo donation	การบริจาคตัวอ่อน
Endometriosis	เยื่อบุโพรงมดลูกขึ้นผิดที่
Fertility treatment	การรักษาภาวะเจริญพันธุ์
Fertilization	การปฏิสนธิ
Fertilization failure	การผิดปกติของการปฏิสนธิ

Fertilized egg	ไข่ที่ได้รับการผสมแล้ว
Follicles	ถุงไข่
Frozen embryo transfer	การย้ายตัวอ่อนแช่แข็ง
IVF - In Vitro Fertilization	การปฏิสนธินอกร่างกาย
ICSI - Intracytoplasmic Sperm Injection	การปฏิสนธิโดยวิธีฉีดอสุจิ
IUI - Intrauterine Insemination	การฉีดเชื้อผสมเทียม
LH surge	การผลิตฮอร์โมน LH ในปริมาณมาก
Male factor infertility	ภาวะมีบุตรยากในเพศชาย
Maturation process	กระบวนการสุกของไข่
Menstrual cycle	รอบประจำเดือน
Multiple pregnancy	การตั้งครรภ์แฝด
Muscular dystrophy	โรคกล้ามเนื้อเสื่อม
OHSS - Ovarian Hyperstimulation Syndrome	ภาวะรังไข่ถูกกระตุ้นมากเกินไป
Ovarian torsion	โรครังไข่บิดขั้ว
Ovidrel	ยา Ovidrel
Ovulation	การตกไข่
PAP test	การตรวจคัดกรองมะเร็งปากมดลูก
Polycystic ovarian syndrome	ภาวะถุงน้ำรังไข่หลายใบ
Poor ovarian reserve	คุณภาพไข่น้อย
PGD/PGS - Preimplantation Genetic Diagnosis or Screening	การตรวจวินิจฉัยหรือคัดกรองพันธุกรรมระยะก่อนฝังตัว
Recurrent implantation failure	ภาวะตัวอ่อนไม่ฝังตัวซ้ำซ้อน
Screening for genetic condition	การตรวจคัดกรองหาโรคทางพันธุกรรม
Sedating medication	ยาสลบ
Semen	น้ำเชื้อ
Single gene disorders	โรคที่เกิดจากความผิดปกติของยีนเดี่ยว
Sperm wash	การปั่นล้างอสุจิ
Symptomatic	แสดงอาการ
Transabdominal ultrasound	การตรวจอัลตราซาวด์ทางช่องท้อง

Transvaginal ultrasound	การตรวจอัลตราซาวด์ทางช่องคลอด
Tubal factor infertility	การมีบุตรยากด้วยสาเหตุจากท่อนำไข่
Unexplained infertility	การมีบุตรยากโดยไม่ทราบสาเหตุ
Uterus	มดลูก
Vagina	ช่องคลอด
Zona pellucida	เปลือกชั้นโซนาเพลลูซิดา

Terminology glossary for the speech on endometriosis

English	Thai
Abnormal bleeding	ภาวะเลือดออกผิดปกติ
Adhesion	พังผืด
Adnexal tenderness	การกดเจ็บที่ปีกมดลูก
Analgesia	ยาแก้ปวด
Bilateral salpingo-oophorectomy	การตัดมดลูก ปากมดลูก และรังไข่
Bimanual examination	การตรวจคลำหน้าท้องพร้อมใช้นิ้วสอด
Cauterize	จี้เผา
Cervix	ปากมดลูก
Chronic pelvic pain	ภาวะปวดท้องน้อยเรื้อรัง
Combined oral contraceptive pill	ยาเม็ดคุมกำเนิดชนิดฮอร์โมนรวม
Cyclical pain	อาการปวดรอบประจำเดือน
Deposits of endometriosis	คราบเยื่อบุโพรงมดลูก
Depot injection	ยาฉีดคุมกำเนิด
Endometriosis	เยื่อบุโพรงมดลูกขึ้นผิดที่
Endometrium	เยื่อบุโพรงมดลูก
Fallopian tubes	ท่อนำไข่
Fertility	ภาวะเจริญพันธุ์
Fertilization	การปฏิสนธิ
GnRH analogues	ยา GnRH analogues

Goserelin	ยา Goserelin
Hormone medications	ยารักษาประเภทฮอร์โมน
Hysterectomy	การผ่าตัดมดลูก
Infertility	ภาวะมีบุตรยาก
Inflammation	การอักเสบ
Irritation	การระคายเคือง
Keyhole surgery	การผ่าตัดผ่านรูที่เจาะไว้บนผิวหนัง
Laparoscopic surgery	การผ่าตัดผ่านกล้อง
Lesions	บาดแผล
Lining of the pelvis	ผนังเชิงกราน
Local tissue	เนื้อเยื่อเฉพาะที่
Localized bleeding	ภาวะเลือดออกเฉพาะที่
Lymphatic system	ระบบน้ำเหลือง
Medical menopause	การหมดประจำเดือนโดยการให้ยา
Menopause	วัยหมดประจำเดือน
Menstrual cycle	รอบประจำเดือน
Menstruation	ประจำเดือน
Metaplasia	การเปลี่ยนแปลงรูปร่างของเซลล์
Metastasize	การแพร่กระจาย
Mirena coil	ห่วงคุมกำเนิด
Ovaries	รังไข่
Ovulation	การตกไข่
Pelvic pain	อาการปวดท้องน้อย
Pelvic ultrasound	การตรวจอัลตราซาวด์เชิงกราน
Pelvis	กระดูกเชิงกราน
Peritoneum	เยื่อบุช่องท้อง
Pouch of Douglas	กระเป๋าดักลาส
Progesterone	ฮอร์โมนโปรเจสเตอโรน
Rectum	ลำไส้ตรง

Reduced fertility	ภาวะเจริญพันธุ์ลดลง
Retrograde menstruation	ภาวะประจำเดือนไหลย้อนกลับไปในรังไข่
Scar tissues	เนื้อเยื่อแผลเป็น
Speculum examination	การตรวจภายใน
Uterus	มดลูก
Vagina	ช่องคลอด
Zoladex injection	การฉีดยา Zoladex

Appendix B: List of questions for the in-depth interview

1. How would you describe your experience in using InterpretBank as the support tool of choice while performing SI?

2. In your opinion, how does the support of ASR-CAI tool affect the rendition quality and your overall performance?

3. Are there any issues or difficulties that you encountered while performing SI with the support of ASR-CAI tool provided?

4. Did you have any difficulties identifying the information needed from the way the data has been presented on the user interface?

5. Did the additional information provided by the tool cause you any visual or cognitive overload during SI?

6. Would you prefer to use ASR-CAI tools for support during SI in the future if given an opportunity?

Appendix C: Terminology from speech 1 and 2 in which translations are not required and are considered as acceptable to be used in English

Speech 1
Blastocyst stage
BRCA
Cleavage stage embryos
Cystic fibrosis
Endometriosis
IVF - In Vitro Fertilization
ICSI - Intracytoplasmic Sperm Injection
IUI - Intrauterine Insemination
LH surge
Ovidrel
PGD/PGS - Preimplantation Genetic Diagnosis or Screening
Sperm wash
Zona pellucida

Speech 2
GnRH analogues
Goserelin
Mirena coil
Pouch of Douglas
Progesterone
Zoladex injection

Appendix D: List of the segments from speech 1 which are considered as dense in terminology with the terminology highlighted in yellow

1. IVF can be performed for a number of different reasons, which include male factor infertility, tubal factor infertility, for women and couples with unexplained infertility or problems with fertilization, and even for couples who are wanting to do pre-implantation genetic diagnosis or screening for genetic condition as well.

2. Additional reasons for doing IVF would include women with poor ovarian reserve, women of older age, women with polycystic ovarian syndrome or endometriosis or using donor egg or donor sperm or even embryo donation.

3. Pre-implantation genetic diagnosis or screening, PGD or PGS, refers to the biopsy of an embryo that is a fertilized egg that has developed.

4. It's done for conditions such as single gene disorders like cystic fibrosis, BRCA, muscular dystrophy, or in couples where someone is known to have a chromosomal abnormality like a balanced translocation.

5. IVF has been associated with an increased risk of congenital anomalies. It is unclear whether that's due to the fertility treatment itself or whether couples with infertility are at higher risk for having a child with a congenital abnormality.

6. It can also be used for donor sperm situations, and in couples who've gone through an IVF treatment and have failed or have not had any fertilization during that IVF treatment. It also is used in situations when couples want to do pre-implantation genetic diagnosis or screening.

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