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Cognitive processes in sight interpreting/ translation: a systematic literature review

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Abstract

This systematic literature review examines the cognitive processes involved in sight interpreting/translation (SIT). Following the PRISMA approach, we review the findings of 49 publications identified through a comprehensive search strategy. The analysis shows that the comprehension processes involved in SIT appear to differ from those in reading for other purposes. It also highlights that three specific cognitive features may increase the processing demands of the task: resisting visual interference, dealing with memory requirements, and managing coordination between the processes at hand. The review then addresses the effects of training and professional experience. Drawing on these results, we critically discuss three key gaps in our current understanding of cognitive processing in SIT. They relate to the precise nature of the underlying comprehension processes, the cognitive constraints, and the development of competence. On this basis, we propose directions for future research.

Keywords

Sight interpreting/translation, sight translation, cognitive processes, translation and interpreting process research, systematic literature review.

Sight interpreting/translation is defined as the oral or signed rendition in one language of a text written in a different language (Čeňková 2015). It is a particularly significant form of multilingual mediated communication for trainers and practitioners alike. It has also received growing interest in translation and interpreting (T&I) research in recent years. In this systematic review, we aim to identify and examine the literature on the cognitive processes underlying this task of cross-modal transfer, as well as provide suggestions for future research.

Because sight interpreting/translation (hereafter, SIT) involves the processing of both visual and oral information (Lambert 2004), it has traditionally been considered a 'hybrid' between translation and interpreting (e.g. Agrifoglio 2004). While *sight translation* remains the most commonly employed term, the task has widely been characterised as a mode of interpreting, both because of its oral nature and its "real-time processing demands" (Čeňková 2015: 374), which has led some authors to favour the term *sight interpreting* (e.g. Su 2023). In this article, *sight interpreting/translation* (SIT) will be preferred, following Ho (2022) who recommends its use as the overarching term that encompasses all the contexts in which it may occur. SIT is clearly a "multi-purpose" task (Chen 2015: 145) whose practical relevance has been recognised in a wide range of professional and pedagogical settings. Accordingly, SIT can be categorised along two functional dimensions: communicative and instrumental (Jiménez Ivars/Hurtado Albir 2003).

In its communicative function, SIT aims to provide an immediate reformulation of a written text for a real audience (*Ibid.*). As one of the core tasks of dialogue interpreting (Vargas-Urpi 2019), SIT is often used in many contexts, including courtroom, healthcare, and asylum settings (Čeňková 2015). SIT is also frequently used in conference interpreting (Chen 2015). Specifically, *simultaneous interpreting with text* has become increasingly common in international organizations, where speakers, constrained by strict time limits, may decide to rapidly read out loud a pre-written speech (Seeber 2017a). The rise in slide-supported presentations has also contributed to making interpreting from visual information more prevalent (Seeber 2017b).

In its instrumental function, SIT serves as a means to an end, beyond immediate communication (Jiménez Ivars/Hurtado Albir 2003). For instance, it can become an important preparation tool for interpreters, e.g. to prepare terminology before an assignment (Weber 1990). The instrumental relevance of SIT has equally been acknowledged in foreign language teaching (van Dyk 2007), in admission testing for T&I training programs (Shang/Xie 2023), and in the certification process of interpreters in a number of countries (Paez 2013). Importantly, SIT has been included in many curricula around the world, because it is "regarded by many experts on T&I pedagogy as a valuable training tool" (Mikkelson 1994: 382). It can facilitate the development of skills that are essential in T&I, e.g. swift source-text analysis, deverbalisation, and speaking skills (Falbo 1995; Viaggio 1995; Angelone 2010).

SIT has attracted increasing research interest in recent years, as reflected in the two scoping reviews published to date, which provide an overview of the main research trends (Li 2014; Ho 2022). However, the growing literature on the cognitive underpinnings of SIT has yet to be systematically examined. This is particularly relevant,

because obtaining a clearer picture of cognitive processing in SIT – a task that presents unique cognitive challenges (Shreve *et al.* 2010) – can not only inform further research, but also pedagogical and professional practices, given its highly multi-functional nature as outlined above. In an attempt to address this need, this article presents a systematic review based on the PRISMA approach (Page *et al.* 2021). SIT will be defined here as a task involving one input channel (visual) and one output channel (oral), therefore excluding variants such as simultaneous interpreting with text, based on the assumption that they involve different comprehension and production processes. This review aims to answer the following research questions:

1. As SIT relies on processing written input, how can reading in SIT be described from a cognitive perspective? In particular, are there SIT-specific comprehension processes?
2. What are the task-specific cognitive features of SIT? Specifically, how does it compare to other tasks in terms of its cognitive constraints?
3. Are these aspects modulated by training and professional experience?[1] If so, how?

After outlining the methodology used (Section 1), the results of the review will be presented (Section 2). Then, they will be critically discussed, and areas for future methodological improvements will be suggested (Section 3). Lastly, conclusions will be offered (Section 4).

1. Methods

This review follows the widely established PRISMA framework (Page *et al.* 2021), which offers comprehensive guidelines to ensure transparency, rigour, and reproducibility in systematic reviews by providing a structured approach to identifying, selecting, and synthetizing studies. The following subsections outline the search strategy that ultimately led to the inclusion of 49 publications relevant to addressing the research questions, as summarised in Figure 1.

1.1 Identification and selection procedures

The identification and selection of relevant publications involved multiple steps. Firstly, a keyword-based search was performed in the three leading databases in T&I studies: Translation Studies Bibliography (TSB), Bibliography of Interpreting and Translation (BITRA), and Conference Interpreting Research Information Network (CIRIN).[2] The keywords used were the most common synonyms for SIT in English

1 In this paper, the term professional *experience* will be preferred over *expertise* (used by some authors in the publications reviewed), because it is more easily quantifiable. For a discussion of the differences between the two terms, see Tiselius/Jenset (2011).

2 Unlike TSB and BITRA, CIRIN is not an online database with a search interface. Instead, the data were downloaded as spreadsheets and keyword searches were performed in Microsoft Excel 365.

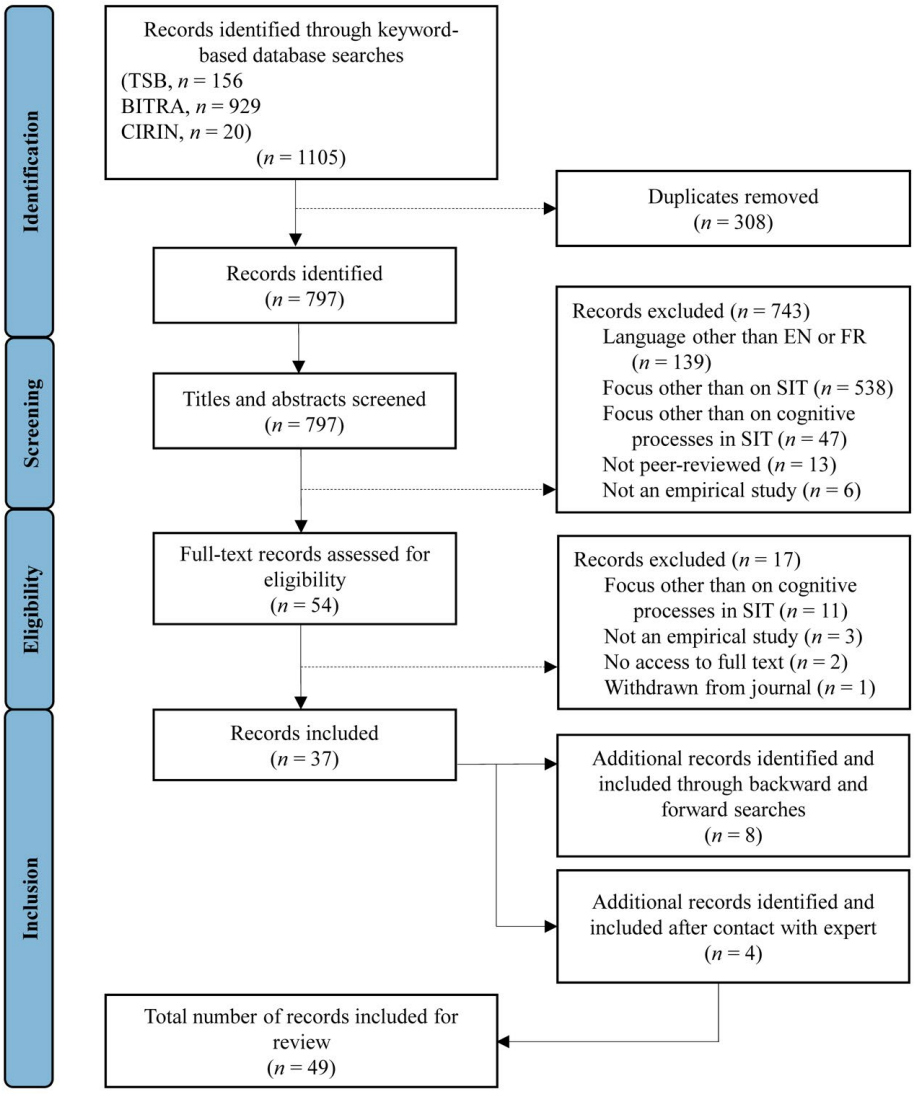

Figure 1: Identification and selection of publications for review.

and French, two languages spoken by the researchers, i.e. *sight translation*, *sight interpreting*, *sight interpreting/translation*, *sight interpretation*, *prima vista* in English, and *traduction à vue*, *interprétation à vue* in French. No filters were used in the databases, nor were restrictions on publication dates applied. The searches were conducted in October 2023. This step led to the initial identification of 797 publications, excluding duplicates.

Secondly, the titles and abstracts of the identified publications were manually screened against 5 inclusion criteria. Publications needed (1) to be peer-reviewed, to

ensure their quality;[3] (2) to focus on the cognitive processes involved in SIT, to guarantee that they fit the research objectives; (3) to be empirical, to ensure that the review is grounded in data-driven findings; (4) to cover all language pairs and directions, to guarantee breadth of coverage; (5) to be written in French or English. As a result, 54 publications were eligible for inclusion.

Thirdly, the full texts of the eligible publications were read to determine final inclusion based on the 5 inclusion criteria, which brought the total to 37 articles.

Lastly, 3 additional steps were taken to identify any overlooked publications. Backward searches were conducted by manually screening the reference lists of eligible publications. Forward searches were also performed by using Google Scholar to find articles that have cited the eligible publications. This resulted in the identification of 8 relevant publications. Then, the pre-final list was sent to 3 established scholars in SIT research, who are not the authors of this review. They were asked to assist in identifying any missed publications. One agreed, which helped include 4 additional articles. The complete list of the 49 publications included can be found in Appendix 1.

1.2 Data collection and analysis

Information related to cognitive processing in SIT was manually extracted and organised into overarching categories following the framework-based synthesis method (Dixon-Woods 2011). Initially, a deductive approach guided the development of a scheme based on the research objectives. As the review progressed, an inductive approach was used to include new categories relevant to answering the research questions. By combining predefined and emergent categories, this approach ensured both a comprehensive and flexible analysis of the data (*Ibid*.).

1.3 Description of the publications reviewed

The three most common language pairs in the publications reviewed were English-Chinese (47%), English-Spanish (18%), and English-Polish (14%). In terms of directionality, 69.5% examined direct (L2-L1) SIT, 20.5% focused on inverse (L1-L2) SIT, and 10% investigated both directions. 58% involved only students and/or untrained bilinguals, 12.5% involved only professionals, and 28.5% included both groups, with an average number of participants of 21.7 per study. The most frequent methods for investigating cognitive processing were performance analyses (65%), followed by eye tracking (63%) and retrospective methods such as post-task interviews and questionnaires (24.5%). Less frequent methods included the self-paced reading paradigm (8%) and physiological measures (2%). The most common design used one method only (47%), while others combined two methods (43%), three (8%), and four (2%).

3 Dissertations and conference proceedings were therefore excluded.

2. Results

2.1 Reading in SIT: The underlying comprehension processes

SIT involves concurrent reading and speaking processes during the production of the target text. This production stage is sometimes preceded by a preparation stage, which consists in prior reading of the source text. This section will first review the evidence related to reading in unprepared SIT, before addressing reading in preparation for SIT.

When it comes to reading in unprepared SIT, a seminal eye-tracking study (McDonald/Carpenter 1981) modelled its phases by analysing how participants processed ambiguous sentences in English-German SIT. Three distinct phases were identified: (1) an initial comprehension phase, characterised by left-to-right eye fixations and a reading rate similar to that of reading for the purpose of understanding; (2) a translation phase, involving the rendition of the target sentence, and marked by regressions to previously read segments and a longer reading rate; (3) an error recovery phase, defined by additional re-reading and, if necessary, a correction of the rendition of the ambiguous sentence. On this basis, the authors propose that the SIT reading process involves at least two distinct stages. The first is not specific to SIT, but rather typical of bilingual reading for regular comprehension. During the second, SIT-specific comprehension and production processes co-occur. However, subsequent empirical research has presented contrasting results on whether SIT builds on such a model, and specifically on whether its first phase is non-SIT-specific.

On the one hand, some studies do report an early activation of the target language during the initial comprehension phase, in contrast to McDonald/Carpenter's model. It was found that comprehension was slower in reading for SIT than in reading for comprehension (Macizo/Bajo 2004), and that both lexical ambiguity (Macizo/Bajo 2006) and lexical frequency (Ruiz *et al.* 2008) had a significant impact on reading times in SIT, but not in reading for repetition. Similarly, an eye-tracking study (Ma 2021) reported a significant effect of syntactic complexity on first fixation durations[4] in SIT, unlike in reading for comprehension. These results seem to suggest that the initial processing stage may already involve SIT-specific processes that differ from those underlying normal reading for comprehension.

On the other hand, findings from recent eye-tracking studies lend support to McDonald/Carpenter's model by demonstrating both a lexical frequency and an experience effect, two factors that are well known to influence processes in reading for comprehension. Consistent with this account, high-frequency words were processed faster than low-frequency words during the initial reading stage in SIT (as shown by shorter first fixation durations), although no statistical significance was reached, in Lijewska *et al.* (2022). Additionally, the same study reported that nearly all low-frequency words were re-read after the initial reading pass, which may imply that inter-

4 In eye-tracking research, first fixation duration is the duration, in milliseconds, of the very first eye fixation on an area of interest, before the gaze moves elsewhere. It is an early measure, assumed to reveal initial, automatic comprehension processes, such as word recognition and lexical access. In contrast, late measures are considered to reflect conscious, strategic processes, such as information integration. Late measures include, for example, regressions to earlier parts of the text (Conklin *et al.* 2018).

preting/translation processes occurred during this second phase. Likewise, an effect of experience could be expected if SIT-specific processes were involved during the first reading phase. Yet, no significant difference in first-pass eye-tracking measures was found between untrained bilinguals and students (Ho *et al.* 2020), nor between students and professionals (Ho 2021; Lijewska *et al.* 2022), whereas an effect of experience was indeed noted during the re-readings of low-frequency words (Lijewska *et al.* 2022). These findings seem to suggest that comprehension in SIT builds on an initial processing stage that is not task-specific.

As for reading in preparation for SIT, research has mostly focused on the allocation of time and effort. Su/Li (2020) found that compared to the production stage, interpreting students invested significantly less cognitive effort (as indexed by eye fixation durations) but more time to preparatory reading, which was self-paced (i.e. not time-constrained by the researchers), in both directions in Chinese-English SIT. These results are largely consistent with those reported in Su (2020) in inverse SIT for the same language pair. Conversely, results in Ho (2021) indicate that professionals spent slightly more time on self-paced preparatory reading than students in direct English-Chinese SIT, though this difference was not statistically significant, nor was there a significant difference in fixation counts between the groups. It could intuitively be expected that greater effort and time spent in the preparation stage would result in less effortful processing during the production stage. In her analysis of other eye-tracking measures indicative of cognitive effort (spatial saccades and pupil dilations), Płużyczka (2020) indeed showed that preparatory reading led to a reduction in cognitive effort during production for students in inverse Polish-English SIT. Yet, Su (2020) presented findings suggesting the opposite, as a positive correlation in two common indicators of cognitive effort (fixation durations and pupil dilations) was observed between the two stages for both professionals and students in inverse Chinese-English SIT.

2.2 Cognitive constraints in SIT: Managing visual interference, memory, and coordination

SIT is a cognitively demanding task. This has been demonstrated in research comparing it to other reading and speech production tasks. Eye-tracking studies have consistently found SIT to involve higher task time and fixation counts than reading for comprehension (Jakobsen/Jensen 2008; Shreve *et al.* 2010; Wang/He 2018; Ho *et al.* 2020), reading in preparation for written translation (henceforth, WT; Jakobsen/Jensen 2008; Wang/He 2018), and reading aloud (Ho *et al.* 2020; Zhou *et al.* 2021). Similarly, a study comparing students' performances in spontaneous speech, prepared speech, consecutive interpreting (hereafter, CI), and prepared SIT (Bóna/Bakti 2020) found that SIT required the highest level of cognitive effort, as indicated by various measures related to temporal characteristics and disfluency markers. Another performance analysis of problems and strategies in WT and SIT (Jiménez Ivars 2008) reached similar conclusions, with SIT inducing nearly twice as many self-identified problems by students, the top causes of which were related to cognitive aspects (i.e. difficulty in understanding the source text, finding an equivalent, and reading ahead).

These findings also align with students' higher levels of physiological and self-reported stress in SIT than in WT (Baghi/Khoshsaligheh 2019).

Taken together, these studies provide empirical support for the substantial cognitive demands inherent to SIT. Importantly, they have also contributed to shedding light on some of its task-specific constraints. Three of them appear particularly salient: resisting visual interference, dealing with memory requirements, and managing coordination between the processes involved.

2.2.1 Resisting visual interference from the source text

SIT may pose a high risk of source-language interference, because of the constant presence of the source text. A landmark study in SIT research (Agrifoglio 2004) conducted a comparison of errors in the performances of professionals in simultaneous interpreting (hereafter, SI), CI, and SIT. According to the author, the high rate of expression errors in SIT (e.g. lack of subject-verb agreement), contrary to SI and CI which mostly contained meaning failures, may have mostly been caused by the perpetual presence of the source text. This seemed to be "the greatest obstacle for the sight translator", who had to "devote more effort to resisting this influence in [SIT]" than resisting auditory interference in SI (*Ibid.*: 61).

Subsequent studies have provided support for Agrifoglio's (2004: 49) hypothesis that SIT presents "an extreme risk of interference". For instance, students in Su (2023) often fixated on source-text difficulties multiple times before initiating their renditions, and they produced more errors than professionals. This was interpreted as an indication of increased cognitive effort likely resulting from an attempt to resist visual interference. Comparably, another eye-tracking study (Chmiel/Lijewska 2019) found that students diverted their gaze from the source text more frequently than professionals when processing syntactic complexities, suggesting a similar effort to suppress source-text interference by looking away from the text. Lastly, several studies on the impact of word-order asymmetry (Ma 2021; Ma *et al*. 2021; Ma/Li 2021) revealed that presenting the input in context (as opposed to single sentences) did not lead to less effortful processing. According to the authors, context could have been expected to facilitate the processing of asymmetrical structures by supporting a deverbalisation approach. This might similarly point towards the negative influence of visual interference in context.

In contrast, Chmiel *et al*.'s (2020) comprehensive investigation of source-language interference in SIT and SI provides a more nuanced answer. The authors found that greater visual interference in SIT was only confirmed for false cognates, which could not be rendered by similar equivalents in the target language, unlike cognates. In light of these findings, they warn that more research is needed on the mechanisms involved in resisting visual interference in SIT.

2.2.2 Dealing with memory requirements

A key issue in research on the cognitive challenges of SIT has been to determine whether the continuous availability of textual information reduces, or even eliminates, the need to store information in memory. In an early experiment, Viezzi (1989) proposed that the lower rates of information retention after SIT, compared to SI, could be due to the constant presence of the source text, which would reduce the need for immediate processing and temporary storage of information. Following this line of thought, Shreve *et al.* (2010: 65) formulated the "shallow-scan hypothesis", which posits that "because the written source text remains available to sight translators, they are not 'forced', as interpreters are, to process the information in the text at deeper levels."

However, further empirical evidence has demonstrated the significant involvement of memory in SIT. For instance, Pedersen/Dam (2014) showed, on the basis of performance analyses and retrospective interviews, that memory was not only required, but also extensively used. Interestingly, such evidence may have also been found in eye-tracking data. Płużyczka (2020) observed that many participants displayed spatial saccadic movements, i.e. saccades that extend beyond the source text (e.g. the margins). Participants' tendency to look away from the stimuli was taken as indication that they were searching for information or translation equivalents in their long-term memory.

2.2.3 Managing coordination between the processes involved

SIT is a task of divided attention, as it involves several sets of processes that are carried out simultaneously. These do not only include reading, cross-language transfer, speech production, and memory processes, but also coordination between these different subtasks (Su 2020). Particularly, coordinating reading and speaking seems crucial. Although the rhythm of production is self-paced in SIT, achieving smooth delivery requires initiating reformulation while still reading (Agrifoglio 2004). Such coordination has been operationalised as eye-voice span (hereafter, EyeVS),[5] which refers to the time lag between the viewing of the source-language word and its target-language rendition (Su 2020).

Three types of reading-speaking coordination behaviours have been identified so far: (1) a diffuse approach, in which the rendition is not immediately initiated after reading, but rather stored in memory and uttered later, resulting in longer EyeVS (Su/Li 2020); (2) a first-in first-out approach, in which production begins swiftly after reading, as reflected in shorter EyeVS (Su/Li 2020); (3) a delayed approach, in which production is initiated, but then paused and/or corrected, typically when difficulties arise (Su 2020).

5 To avoid confusion with *ear*-voice span in SI, commonly abbreviated as EVS, we suggest using EyeVS in line with Su (2023), which appears more intuitive than IVS proposed in Chmiel/Lijewska (2023).

These coordination patterns could be modulated by three factors in particular: directionality, professional experience, and source-text complexity. In terms of directionality, Su/Li (2020) found that a first-in first-out approach was typical of direct English-Chinese SIT, while a diffuse approach was prominent in inverse Chinese-English SIT. The authors argue that in inverse SIT, longer EyeVS may be due to the structural differences between the languages and the subsequent need to retain certain elements in memory before starting production. Regarding the impact of professional experience, Chmiel/Lijewska (2023) found no significant relation between professionals' EyeVS length and performance quality in direct English-Polish SIT. However, Su (2023) observed that longer EyeVS correlated with higher error rates for students, but not for professionals, and with increased disfluencies for both groups in inverse Chinese-English SIT. As for source-text complexity, it has been suggested that it lengthens EyeVS (Chmiel/Lijewska 2019; Su 2020; Su/Li 2020). Yet, findings in Chmiel/Lijewska (2023) indicate that coordination patterns may not be influenced by syntactic complexity *per se*, but rather by whether syntactic restructuring is required in the target language.

2.3 Modulation of cognitive processing in SIT: The impact of training and professional experience

The impact of training has mainly been explored on students' performance quality, strategic behaviours, and processing patterns. Overall, a positive effect of training has been found in reducing task time (Ho *et al.* 2020; Su/Li 2021; Lai/Chang 2023), improving fluency (Ho *et al.* 2020; Fang/Zhang 2021; Fang *et al.* 2023; Lai/Chang 2023), and fostering the development of strategic behaviours, such as chunking (Ho *et al.* 2020; Lai/Chang 2023) and omitting (Fang/Wang 2022). The impact on students' reading behaviours appears to be more limited. For instance, a longitudinal study conducted over 9 months of training (Fang *et al.* 2023) found no significant differences in eye-tracking reading measures, the only exception being a decrease in the number of regressions to syntactically complex segments.

Much like training, professional experience has a substantial impact on task time, with professionals completing tasks significantly faster than students (Jakobsen/Jensen 2008; Alves *et al.* 2011; Lee 2012; Wang/He 2018; Chmiel/Lijewska 2019; Su 2020). Professionals' performances have also been found to be marked by greater accuracy (McDonald/Carpenter 1981; Lee 2012; Ho 2021; Lijewska *et al.* 2022) and fewer disfluencies (Su 2020; Ho 2021) than students', which may stem from a more effective use of strategies (He/Wang 2021). In terms of processing patterns, one of the most comprehensive investigations to date of the behavioural differences between students and professionals in inverse SIT (Su 2020) found that global reading behaviours only differed significantly between groups during prior reading, but not during the production. Another eye-tracking study (Ho 2021) showed that in direct SIT, students and professionals displayed quite similar reading behaviours in both the preparation and production stages. One significant exception relates to regressions, similarly to what is observed in training. Professionals seem to regress less to previously read segments, especially complex ones (McDonald/Carpenter 1981; He/

Wang 2021; Lijewska *et al.* 2022). This could be attributed to a greater confidence in their rendition choices (He/Wang 2021), their ability to rely on information stored in memory (Su 2020), or to more effective coordination between reading and speaking (Chmiel/Lijewska 2019; Su 2020, 2023).

3. Discussion

In this systematic review, we have examined the findings of 49 publications on cognitive processing in SIT. In order to address the research questions (see Introduction), the analysis has integrated the empirical evidence regarding the comprehension processes, the cognitive features, and the influence of training and professional experience in SIT. In this section, these results will be considered further and critically discussed, with a particular focus on future research directions.

3.1 Does SIT rely on specific comprehension processes?

The precise nature of the comprehension processes underlying SIT deserves more empirical investigation. Two contrasting lines have emerged. On the one hand, some studies indicate that SIT builds on a first phase of comprehension similar to normal bilingual reading (e.g. McDonald/Carpenter 1981; Lijewska *et al.* 2022). On the other, some studies show that the initial comprehension phase is SIT-specific, as it involves an early activation of the target language (e.g. Macizo/Bajo 2004; Ma 2021). These diverging conclusions can be partially explained by methodological differences.

Some studies adopted the self-paced, word-by-word reading paradigm, in which participants pressed a key to reveal the next word in order to index comprehension through reading times (e.g. Macizo/Bajo 2004). This may not only constrain participants to focus on individual words, but also force them to adopt a potentially artificial linear reading approach. Importantly, this method does not allow to distinguish between first and second reading passes, unlike eye-tracking experiments.

Other studies, which indeed used eye tracking, favoured single-sentence stimuli, which can ensure tight variable control (e.g. McDonald/Carpenter 1981), but may similarly fail to account for the real demands of text processing in SIT. Accordingly, the ecological validity of such designs can be questioned, as they may not reflect authentic comprehension processes.

In contrast, some eye-tracked experiments did employ authentic texts. Yet, the fact that no effect of training (Ho *et al.* 2020) or professional experience (Ho 2021) was found on first-pass reading measures could be explained by an insufficient level of source-text complexity. In these two studies, the texts were rated an average difficulty score of 3/7 by 4 assessors. It can be argued that differences may only become visible in more challenging conditions. For example, Dillinger (1989) found no differences in comprehension processes between students and professionals during SI, but he highlighted the lack of source-text complexity in explaining his results. In fact, it could be suggested that in unchallenging conditions, participants would resort to their default, normal comprehension behaviours – which would, however, not suffice in more

difficult comprehension conditions. Some evidence for this has been provided in an investigation of the differences in the comprehension of complex syntactic structures between students and professional interpreters in SI (Hild 2011: 265), which argued that when facing difficulty, "text processing in expert SI is qualitatively different from normal text comprehension, while the unskilled SI still continued to rely on general-purpose strategies and skills characteristic of text comprehension". Although there is currently little evidence to support a similar claim in SIT, it seems reasonable to hypothesise that comprehension in SIT may also hinge on the deployment of purpose-driven comprehension behaviours when they are recognised as necessary. This would point towards the need to explore reading behaviours from a strategic perspective, including, for example, goal-oriented text processing in challenged conditions.

Building on this, we suggest that in order to obtain a higher-resolution picture of the nature of the comprehension processes involved in the different phases of SIT, future research should focus on using (1) a research method that allows for a precise distinction between the different reading passes; (2) stimuli that can account for the authentic demands of text processing; (3) source-text complexity levels that are appropriately calibrated to potentially elicit the use of purpose-driven comprehension behaviours.

3.2 How can the cognitive constraints of SIT be characterised?

The different constraints that contribute to the processing demands of the task have been reviewed. Firstly, the persistent presence of the written source text has been found to lead to increased visual interference, which, in turn, may result in more errors and disfluencies. Yet, the analysis has shown that a better understanding of the mechanisms involved in resisting visual interference is needed. To achieve this, it would be helpful to adopt a consistent measure of interference avoidance. One relevant possibility, suggested by Chmiel/Lijewska (2019), is the percentage of dwell time, i.e. the proportion of time participants spend looking away from the text.

Secondly, early accounts of SIT assumed that it imposed no significant memory demands. Accordingly, Gile's original Effort Model (1995) for SIT included two components only: Reading Effort and Production Effort. Because the source material remains constantly available, Gile (1995) argued that memory could always be refreshed by looking at the text, unlike in CI and SI. However, in the revised model (Gile 2009), a Memory Effort was subsequently added, along with a Coordination Effort. This reflects the growing empirical evidence indicating that SIT does, indeed, involve extensive memory requirements.

Thirdly, further research is needed on the factors influencing reading-speaking coordination and the impact of different coordination patterns on the SIT process and product. Additionally, the use of EyeVS may require reconsideration, as longer EyeVS could not only reflect coordination behaviours (e.g. a diffuse approach as in Su/Li 2020) but also processing difficulty (e.g. suppressing source-language visual interference). Future studies could benefit from using separate measures to distinguish between the depth of cognitive processing and reading-speaking coordination. For example, Zhou *et al.* (2021) propose using eye fixations as macro-level indications

of how deeply information is being processed, while EyeVS could be used as a micro-level measure of coordination patterns.

3.3 How does SIT competence develop?

Overall, the analysis has found that professional experience was mostly reflected in decreased task time and better performance quality, which largely aligns with the characteristics of expert performance in SI (Liu 2008). In future studies, it could be worth exploring in greater depth the mechanisms through which professionals achieve this. For instance, is their shorter and better performance due to more efficient coordination? Are they deploying specific problem-solving behaviours to optimise it? So far, such questions have largely remained underexplored in SIT.

As for the effects of training, this review shows that two particular aspects call for more investigation. Firstly, how does training modulate reading behaviours? Fang *et al.*'s (2023) eye-tracked longitudinal study found that after 9 months of training, the only significant change observed in reading measures was a decrease in regressions to syntactic complexities. This led to the suggestion that training had a limited impact on reading behaviours. However, it may be possible that students had acquired a better awareness of their own comprehension processes, particularly in instances of challenged comprehension (i.e. complex syntax). This, in turn, could have been reflected in them re-fixating less on earlier text. Monitoring one's comprehension is arguably a key determinant of successful comprehension processes in SIT, as suggested in the context of SI in Kalina (2000). Therefore, it can be argued that a decrease in regressions to complex syntactic segments does, indeed, point towards the positive impact of training on reading behaviours, as it may underlie the development of metacognitive skills. Alternatively, Fang *et al.* (2023) indicate that students may have acquired more efficient chunking strategies. If reading in SIT is seen from a strategic, goal-oriented perspective (see Section 3.1), developing a better understanding of where to chunk units may similarly highlight the positive impact of training on strategic reading behaviours. Yet, these two explanations require further validation, as such processes cannot be fully observed in eye-tracking data alone. In themselves, eye-tracking measures therefore appear insufficient to account for a phenomenon as complex as the development of reading behaviours in SIT.

This naturally leads to the second aspect: how does training impact strategy acquisition? Despite findings showing that training fosters the development of some problem-solving strategies (e.g. Fang/Wang 2022), research remains quite scarce, and it is currently limited to two language pairs, i.e. English-Chinese and English-Polish. Additionally, existing research has almost exclusively focused on between-subject comparisons, which may raise issues related to pre-experimental differences between participants (Chmiel/Mazur 2013).

Drawing on these gaps in knowledge, we argue that in order to gain a more precise understanding of how SIT competence develops, future research should consider (1) the use of multiple data elicitation methods including retrospective process tracing, in order to complement quantitative measures, such as eye tracking, with qualitative data that can provide more nuanced insights into participants' cognitive processing; (2) the investigation of a wider range of language pairs, given the potential language-pair specificity of

many aspects of competence development, such as strategy acquisition; (3) the adoption of longitudinal designs, as they can not only offer better control over individual differences compared to between-subject, cross-sectional studies (Bernardini 2001), but they could also provide a more detailed and reliable understanding of how competence develops.

4. Conclusions

This systematic literature review has identified and analysed the existing research on cognitive processing in SIT. It has contributed to providing a clearer understanding of the processes that underpin this complex task. As the first systematic review on this topic, it has also identified key gaps in the literature to date, and it has proposed areas for methodological improvements. In particular, the analysis has highlighted that the comprehension processes involved in SIT are not completely akin to those in reading for other purposes, but that further investigation is required to determine their exact nature. This would allow researchers to obtain a finer-grained model of the different phases that underlie reading in SIT. The review has also revealed that dealing with visual interference resistance, extensive memory requirements, and coordination processes are three specific features that may add extra burden on processing capacity. The SIT process has been found to be modulated by training and professional experience, though further studies are needed to clarify how SIT competence develops.

One limitation to this paper must be acknowledged. The language scope was limited to publications in English and French, which potentially excluded relevant studies in other languages.

Nonetheless, this systematic review has shown that the insights gained so far provide a strong foundation to inform future empirical research on cognitive processing in SIT, which is still in its early stages. As such, improving our understanding of the cognitive mechanisms of SIT is essential, as it can have meaningful implications to enhance both teaching and professional practice.

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Publications included for review and cited in this article are marked with an asterisk. The complete list of the 49 publications reviewed is provided in Appendix 1.

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Appendix 1

Publications included in the systematic literature review

Author	Year	Title	Publication	Pages
Agrifoglio M.	2004	Sight translation and interpreting: A comparative analysis of constraints and failures	*Interpreting*, 6/1	43-67
Alan C.	2020	Processing garden-path sentences in sight translation: An experimental study	*Çeviribilim ve Uygulamaları Dergisi*, 29	1-16
Alves F., Pagano A., & Da Silva I.	2011	Towards an investigation of reading modalities in/for translation: An exploratory study using eye-tracking data	In O. Brien (ed.), *Cognitive Explorations of Translation*	175-196
Baghi H. & Khoshsaligheh M.	2019	Stress in written and sight translation in training setting	*Hikma*, 18/2	235-253
Bóna J. & Bakti M.	2020	The effect of cognitive load on temporal and disfluency patterns of speech: Evidence from consecutive interpreting and sight translation	*Target*, 32/3	482-506
Chmiel A., Janikowski P. & Cieślewicz A.	2020	The eye or the ear?: Source language interference in sight translation and simultaneous interpreting	*Interpreting*, 22/2	187-210
Chmiel A. & Lijewska A.	2019	Syntactic processing in sight translation by professional and trainee interpreters: Professionals are more time-efficient while trainees view the source text less	*Target*, 31/3	378-397
Chmiel A. & Lijewska A.	2023	Reading patterns, reformulation and eye-voice span (IVS) in sight translation	*Translation and Interpreting Studies*, 18/2	213-234
Chmiel A. & Mazur I.	2013	Eye tracking sight translation performed by trainee interpreters	In C. Way *et al.* (eds), *Tracks and Treks in Translation Studies: Selected papers from the EST Congress, Leuven 2010*	189-205
Dragsted B. & Hansen I.G.	2009	Exploring translation and interpreting hybrids. The case of sight translation	*Meta*, 54/3	588-604
Fang J. & Wang J.	2022	Student interpreters' strategies in dealing with unfamiliar words in sight translation	*Translation & Interpreting*, 14/1	42-65
Fang J. & Zhang X.	2021	Pause in sight translation: A longitudinal study focusing on training effect	In R. Moratto & M. Woesler (eds.), *Diverse Voices in Chinese Translation and Interpreting*	157-189

Fang J., Zhang X. & Kotze H.	2023	The effects of training on reading behaviour and performance in sight translation: A longitudinal study using eye-tracking	*Perspectives*, 31/4	655-671
He Y. & Wang J.	2021	Eye tracking uncertainty management in sight translation: Differences between professional and novice interpreters	In R. Muñoz Martín *et al.* (eds.), *Advances in Cognitive Translation Studies*	181-200
Ho C.-E.	2021	What does professional experience have to offer?: An eyetracking study of sight interpreting/translation behaviour	*Translation, Cognition & Behavior*, 4/1	47-73
Ho C.-E., Chen T.-W. & Tsai J.-L.	2020	How does training shape English-Chinese sight translation behaviour?: An eyetracking study	*Translation, Cognition & Behavior*, 3/1	1-24
Jakobsen A. L. & Jensen K. T. H.	2008	Eye movement behaviour across four different types of reading task	In S. Göpferich *et al.* (eds.), *Looking at Eyes: Eye-Tracking Studies of Reading and Translation Processing*	103-124
Jiang X. & Jiang Y.	2020	Effect of dependency distance of source text on disfluencies in interpreting	*Lingua*, 243	1-18
Jiménez Ivars A.	2008	Sight translation and written translation. A comparative analysis of causes of problems, strategies and translation errors within the PACTE translation competence model	*FORUM*, 6/2	79-104
Lai C.-J. & Chang L.-Y.	2023	The effects of students' employment of translation principles and techniques on English-Chinese sight translation performance: An eye-tracking and interview study	*Social Sciences & Humanities Open*, 8/1	100542
Lambert S.	2004	Shared attention during sight translation, sight interpretation and simultaneous interpretation	*Meta*, 49/2	294-306
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Lijewska A., Chmiel A. & Inhoff A. W.	2022	Stages of sight translation: Evidence from eye movements	*Applied Psycholinguistics*, 43/5	997-1018
Ma X.	2021	Coping with syntactic complexity in English-Chinese sight translation by translation and interpreting students: An eye-tracking investigation	*Across Languages and Cultures*, 22/2	192-213
Ma X. & Li D.	2021	A cognitive investigation of 'chunking' and 'reordering' for coping with word-order asymmetry in English-to-Chinese sight translation: Evidence from an eye-tracking study	*Interpreting*, 23/2	192-221

Ma X, Li D. & Hsu Y.-Y.	2021	Exploring the impact of word order asymmetry on cognitive load during Chinese-English sight translation: Evidence from eye-movement data	*Target*, 33/1	103-131
Ma X., Li D., Tsai J.-L. & Hsu Y.-Y.	2022	An eye-tracking based investigation into reading behavior during Chinese-English sight translation: The effect of word order asymmetry	*Translation & Interpreting*, 14/1	66-83
Macizo P. & Bajo M. T.	2004	When translation makes the difference: Sentence processing in reading and translation	*Psicológica*, 25	181-205
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Ruiz C., Paredes N., Macizo P. & Bajo M. T.	2008	Activation of lexical and syntactic target language properties in translation	*Acta Psychologica*, 128	490-500
Shreve G. M., Lacruz I. & Angelone E.	2010	Cognitive effort, syntactic disruption, and visual interference in a sight translation task	In G. M. Shreve & E. Angelone (eds.), *Translation and Cognition*	63-84
Shreve G. M., Lacruz I. & Angelone E.	2011	Sight translation and speech disfluency: Performance analysis as a window to cognitive translation processes	In C. Alvstad *et al.* (eds.), *Methods and Strategies of Process Research: Integrative approaches in Translation Studies*	93-120
Su W.	2020	Eye-tracking processes and styles in sight translation		
Su W.	2023	Eye-voice span in sight interpreting: An eye-tracking investigation	*Perspectives*, 31/5	969-985
Su W. & Li D.	2019	Identifying translation problems in English-Chinese sight translation: An eye-tracking experiment	*Translation and Interpreting Studies*, 14/1	110-134

Su W. & Li D.	2020	Exploring processing patterns of Chinese-English sight translation: An eye-tracking study	*Babel*, 66/6	999-1024
Su W. & Li D.	2021	Exploring the effect of interpreting training: Eye-tracking English-Chinese sight interpreting	*Lingua*, 256	103094
Viezzi M.	1989	Information retention as a parameter for the comparison of sight translation and simultaneous interpretation: An experimental study	*The Interpreters' Newsletter*, 2	65-69
Wang J.-Y. & He Y.	2018	How effortful are interpreters in translation related reading tasks?: An eye-tracking study	*Journal of Literature and Art Studies*, 8/10	1497-1508
Wu Z.	2019	Text characteristics, perceived difficulty and task performance in sight translation: An exploratory study of university-level students	*Interpreting*, 21/2	196-219
Zheng B. & Xiang X.	2014	The impact of cultural background knowledge in the processing of metaphorical expressions: An empirical study of English-Chinese sight translation	*Translation and Interpreting Studies,* 9/1	5-24
Zheng B. & Hao Z.	2018	Revisiting processing time for metaphorical expressions: An eye-tracking study on eye-voice span during sight translation	*Foreign Language Teaching and Research*, 50/5	744-759
Zheng B. & Xiang X.	2013	Processing metaphorical expressions in sight translation: An empirical-experimental research	*Babel*, 59/2	160-183
Zhou H., Weng Y. & Zheng B.	2021	Temporal eye-voice span as a dynamic indicator for cognitive effort during speech processing: A comparative study of reading aloud and sight translation	In R. Muñoz Martín *et al.* (eds.), *Advances in Cognitive Translation Studies*	161-179