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Working memory and simultaneous interpreting – Linking different levels of cognitive load to different levels of source text difficulty

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Abstract

Working memory holds information in an immediately accessible state for ongoing cognition. It is thought to play an important role in successful simultaneous interpreting. This study investigated the relationships between, on the one hand, variations in cognitive load (high vs. low) in a working memory task and, on the other hand, the accuracy of rendition of a source text of predefined difficulty (easy vs. difficult) in a simultaneous interpreting task. The results show that more information was retained in the working memory task when the cognitive load was low than when it was high. Correlations with accuracy scores in the simultaneous interpreting task revealed that working memory performance in both high and low cognitive load conditions was related to difficult source text passages, but not to easy ones. The results of this study provide a more nuanced picture of the relationship between working memory and simultaneous interpreting than heretofore.

Keywords

Working memory, simultaneous interpreting, cognitive load, source text difficulty.

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According to the Tightrope Hypothesis, "interpreters work close to saturation" most of the time in simultaneous interpreting (SI) (Gile 2009: 182; cf. also Mizuno 2005). During SI, interpreters work under a high cognitive load as they have to simultaneously understand the incoming speech, retain the relevant information and interpret it into another language. Working memory (WM), defined as a cognitive system that holds information available for ongoing cognitive processes (Oberauer/Hein 2012; Martini *et al*. 2015), is thought to play a critical role in this process (Timarová 2008). WM capacity refers to the individual difference construct that reflects the limited capacity of a person's WM (Wilhelm *et al*., 2013), e.g., the number of items that can be temporarily retained in WM while other information is processed simultaneously. WM capacity has been linked to a wide range of cognitive abilities, including language comprehension (Just/Carpenter 1992), fluid intelligence (Conway *et al*. 2002), and the integration of pre-existing domain knowledge (Hambrick/Engle 2002). Thus, WM is also a core cognitive construct for explaining SI performance (Timarová 2012).

Experimental research into the cognitive processes involved in conference interpreting began in the 1970s (cf. Daró 1997). Today, it can be broadly divided into three areas: a) research focusing on the executive functions (cf. Nour *et a*l. 2020: 164; Timarová 2008: 21), b) attempts to prove the Interpreter Advantage Hypothesis (García 2014; cf. Chmiel 2018), and c) research on the relationship between working memory and interpreting in general. This relationship, which is the subject of this study, was analysed in the meta-study carried out by Mellinger/Hanson (2019). In line with Timarová (2008), they divided the studies analysed into two groups: a) studies comparing professional interpreters with one or more control groups (e.g. students), and b) studies relating interpreting performance to interpreters' WM capacity. To the best of our knowledge, so far there have been ten studies which can be assigned to the latter group: Christoffels *et al.* 2003; Liu *et al.* 2004; Tzou *et al*. 2012; Timarová *et al*. 2014, Timarovà *et al*. 2015; Injoque-Ricle *et al*. 2015; Macnamara/Conway 2015; Dong *et al*. 2018; Anssari-Naim 2021 and Bae/Jeong 2021). Three of these studies focus on the correlation between WM and SI performance, i.e. accuracy, in the spoken language, by testing either interpreting students or experts. Tzou *et al*. (2011) compared interpreting students with a control group of untrained bilingual persons. They found that a reading span task was positively correlated with SI performance. Injoque-Ricle *et al*. (2015) tested professional interpreters and found that a listening span task with articulatory suppression predicted SI performance, whereas listening span without articulatory suppression did not. Bae/Jeong (2021) tested interpreting students and found a positive correlation between an operation span task and SI performance. The three studies used different approaches to measure SI performance. Tzou *et al*. (2011) asked two experienced interpreters to rate on a five-point scale the overall quality, i.e. accuracy, voice and interpreter's confidence, and on a scale from 0 to 3, the interpretation of ten sentences equally distributed in the speech. In the study conducted by Injoque-Ricle *et al*. (2015), two bilingual raters assessed fluency, delay and accuracy on a scale from 1 to 10. Bae/Jeong (2021) had two interpreting teachers rating the SI performance by giving a maximum of 100 points for accuracy (40%), fluency (40%) and delivery (20%). None of the three studies provides information on the level of difficulty of the source text (ST).

1. The study

The present study contrasted the effects of WM load (high vs. low) with ST difficulty in SI (easy vs. difficult). The aim was to examine experimental variations in the specific WM process of retention and experimental variations of ST difficulty in SI, and to investigate how these relate to each other. Such manipulation of both WM and SI tasks would provide a deeper understanding of the relationships between WM and SI and the conditions under which WM is related to SI.

The WM task in the present study focused on the retention interval between encoding and retrieval. Retaining information in an immediately accessible state so that it can be retrieved at the moment it is needed is a core function of WM and probably essential for successful SI. Therefore, the WM task was manipulated and administered under low and high cognitive load conditions. Cognitive load in this context refers to the attentional demands of a concurrent processing task while relevant information has to be held in WM. Accordingly, cognitive load can be operationalised as the ratio of the time that the processing task occupies attention to the duration of memory retention. The longer attention is occupied by a secondary task, the less time is left to refresh the to-be-retained information, resulting in a decrease in WM performance (Barrouillet *et al.* 2011). According to the time-based resource-sharing model (Barrouillet *et al.* 2004), memory traces decay over time. However, decaying memory traces can be maintained in WM by attentional refreshing, i.e. by bringing the to-be-remembered items back into the focus of attention (Camos *et al*. 2018). Refreshing is thought to occur in the brief moments between two processing tasks (for alternative explanations, see Langerock *et al*. 2024). Reducing the time available between two processing tasks, e.g. by presenting more items to be remembered in the same amount of time, increases cognitive load and decreases WM performance. As a result, fewer items can be maintained in WM. Conversely, increasing the time between two processing tasks, e.g. by reducing the number of items to be processed in the same amount of time, decreases cognitive load and increases WM performance. This means more items to be remembered can be maintained in WM because more time is available to refresh the items. This cognitive load effect has been replicated many times (e.g., Barrouillet *et al*. 2004; Langerock *et al*. 2014; Vergauwe *et al*. 2010) and has been proposed as a Priority-A benchmark that any model of WM should be able to explain (Oberauer *et al*. 2018).

In the WM task, participants had to memorise six digits, followed by a sentence-verification task. The cognitive load manipulation related to the number of sentences they had to judge before recalling the digits in the correct order. In the low WM load condition, four sentences had to be judged; in the high load condition, as many sentences as possible had to be judged. This methodological approach made it possible to directly measure the effect of the discrete WM function of temporarily maintaining information under different interference conditions, while holding information load (number of encoded items) and retention interval (20 seconds) constant.

The SI task focused on a variation in the difficulty of the ST. Experimental studies on the role of WM for SI do not always provide exhaustive information (and reflection) on the characteristics of the ST. Tzou *et al.* (2011) specify that the speech they used was read by an American native speaker at 130 words per minute. Injoque-Ricle *et al*. (2015) state that their speech was pre-recorded and that it was about WM and

dyslexia. Bae/Jeong (2021) used final exam speeches from English into Korean, read by a native speaker at 110-120 words per minute. The aim of the present study was not to use authentic live speeches for the sake of ecological validity but to manipulate the ST for the specific purposes of the study. Accordingly, the ST contained easy sections that should not be challenging, even for beginners, alternating with 'difficult' sections that were expected to lead to errors because of the high cognitive load they should represent for the interpreters, unless strategic decisions allow them to deal with the difficulties successfully.

Assuming that interpreting competence – i.e. among others, the successful use of interpreting strategies – is only visible above a certain level of ST difficulty, the differentiation of ST difficulty should help to test whether experimental results differ according to the difficulty of the ST. The scoring system to measure the interpreting performance was not based on general marks for the overall interpretation, but by assessing propositional accuracy, thus allowing high local granularity.

For the WM task, participants were expected to retain more items in the low cognitive load condition than in the high cognitive load condition (Barrouillet *et al*. 2004, 2007, 2011; Oberauer *et a*l. 2018; Vergauwe *et al*. 2010). For the SI task, participants were expected to show higher propositional accuracy for easy text paragraphs than for difficult text paragraphs. For the relationship between WM performance and SI performance, it was predicted that the higher both WM cognitive load and ST difficulty of SI, the greater the positive correlation.

2. Method

2.1 Participants

Twenty-eight students on a master's degree programme in conference interpreting from seven different universities in Germany (Mainz/Germersheim, Heidelberg and Cologne) and Austria (Innsbruck, Vienna and Graz) took part in the online experiment[1]. Due to problems with the WM task, such as task interruptions and repeated starts during the experiment, five participants had to be excluded from the analysis. Three participants did not complete the interpretation task, so no file was recorded for them. The analysed data set consisted of twenty participants (20 female, mean age = 23.5 years, standard deviation (SD) = 2.07 years, age range = 21-30 years). The experiment was approved by the ethics committee of the University of Innsbruck. All participants gave their explicit consent before the experiment.

All 20 participants had German as their A language and English as their B language (45%) or C language (55%). They were in their first year of study in the master's programme (85% in the first semester, 15% in the 2nd semester). Nine of them had taken a one-semester introduction to SI from English into German for 45 minutes per week while studying for their bachelor's degree.

1 After being contacted personally by us, interpreter trainers at the seven institutes presented the study in class. Students who wished to take part were offered the prospect of being informed of their test results and could register by e-mail. The response rate was low, with 28 participants from a total of seven institutes.

2.2 Procedure

The study was conducted entirely online.[2] After registration, all participants received a link to the study website, which contained information in the following tabs: *Welcome and general information*, *Consent form*, *Instructions* (general procedure, standard browsers (Chrome and Firefox) and download links, Deactivation of AdBlocks), *Task 1* (the WM task under two conditions), *Task 2* (the SI task from English into German), *Prize draw* (all participants were entered into a prize draw for 8 x 70 euros) and *Contact details* of the study managers. All information on the website was presented in German, the participants' L1.

The tabs for *Task 1* and *Task 2* contained information about the nature and procedure of the task, as well as a link to start the task. At the end of Task 2, participants completed a general questionnaire on socio-demographic and related information. Participants were asked to complete all parts of the study within two weeks. The website was created in Google Sites, and the tasks were programmed and hosted using PsychoPy and Pavlovia (Pierce et al. 2019, 2022). All data were automatically recorded under a subject code.

2.3 Working memory task and cognitive load manipulation

To measure cognitive load effects in WM, participants performed a WM task under two cognitive load manipulation conditions: part 1 in the low WM load condition and part 2 in the high WM load condition. Each part consisted of a block of ten trials. Part 1 had to be completed first. The time between part 1 and part 2 could be chosen freely. Participants were encouraged to complete each part in a quiet, undisturbed environment and in a rested state.

At the beginning of the task, participants were informed that they would need headphones. They were given the opportunity to test the volume. Each part started with two test runs in the respective condition. During the task, the background colour of the screen was black and the font colour was white. The entire experiment was conducted in German.

An example of an experimental trial is shown in Figure 1. In each condition, the task started with a written instruction: "In the following, you will hear 6 digits between 1 and 9. Remember the digits in the heard order". Digits were generated with speech-to-voice software (https://speechelo.com/). The voice was female. Each audio file lasted ~4.5 seconds (~450ms/digit and an inter-stimulus interval of ~300ms). For the whole duration of the presentation of the digits, participants saw a red "+" in the middle of the screen. After an auditory presentation of six digits, participants were

2 Conducting studies online can help save time and money as well as increase the number of participants by removing time and geographical constraints. Implementing the different tasks so that they can be completed online is time-consuming but has proved to be a reliable way of obtaining the data needed for this type of study, so the same experiment was carried out with professional interpreters in October/November 2024. However, the sound quality of the online recordings made by students may not be sufficient for analysing prosodic characteristics of the interpretations.

presented with simple sentences for 20 seconds (retention interval). The instructions were: "Directly after the series of numbers, you will be presented with simple sentences. Your task is to check whether the sentence is correct. If it is (e.g. "Apples are good for your health"), press the right arrow key for 'the sentence is correct'. If the sentence is incorrect (e.g. All people eat apples) press the left arrow key for 'the sentence is incorrect'. These instructions were followed by a picture of the position of the fingers and the request to position the fingers as shown in the picture for the duration of the task. A pool of 344 German sentences was generated. These sentences were randomly assigned to the participants.

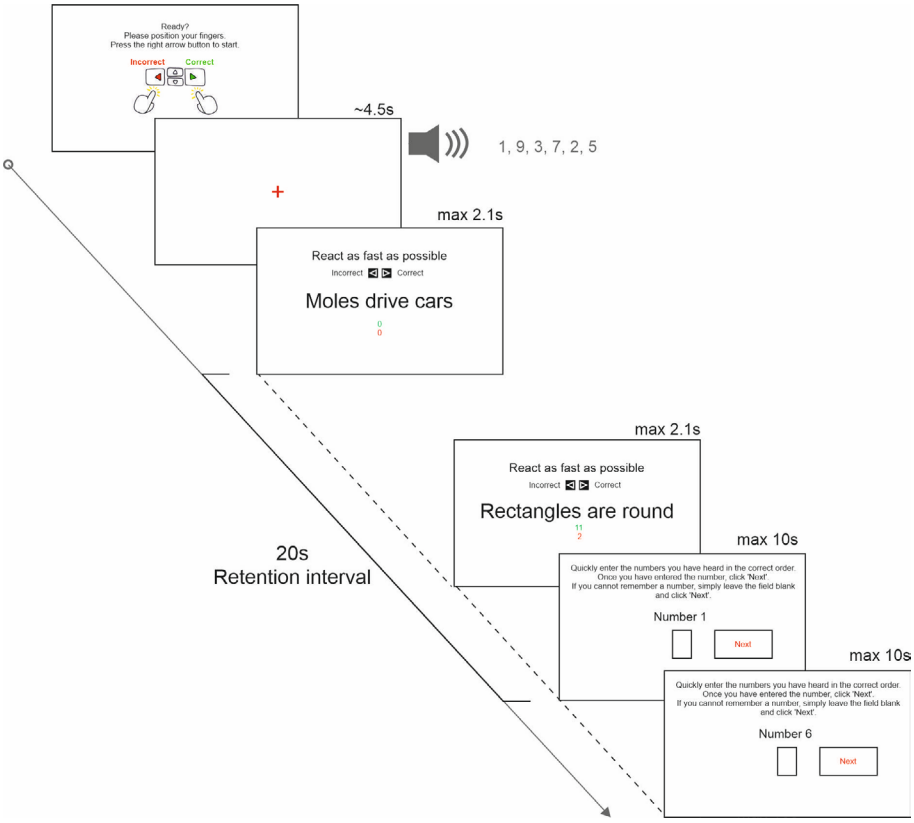

Figure 1. Example of a single experimental trial of the working memory task.
Participants encoded six auditorily presented digits followed by a 20-second retention interval. During the retention interval, participants verified sentences as correct or incorrect. In the low WM load condition, four sentences were presented during the retention interval; in the high WM load condition, participants were instructed to verify as many sentences as possible. The retention interval was followed by a recall phase in which participants were asked to enter, in the order of presentation, the previously heard digits in the fields provided. Background and font colours were changed for presentation purposes; for details, see text.

In the low load condition, four sentences were presented and had to be rated during the 20-second retention interval. In the high load condition, the retention interval was the same, but participants were asked to rate as many sentences as possible during these 20 seconds (in this condition, the test persons rated an average of 14 sentences: M = 14.10, SD = 1.11). Each sentence was presented for a maximum of 2.1s. If no rating of the sentence (correct/incorrect) was given within this time, the sentence was counted as incorrect. The response time began 800ms after a sentence appeared on the screen (maximum response time was 1.3s). The latency between responding and the next sentence was 3.9s in the low load condition and 0ms in the high load condition. As shown in Figure 1, above the sentence presentation, participants constantly saw the cues "Please react as fast as possible" and that the left arrow key referred to 'incorrect' and the right arrow key to 'correct'. Continuous feedback on how many sentences were answered correctly (number coloured green) and how many were answered incorrectly (number coloured red) was displayed below the sentence to increase the participants' motivation to give correct answers. Immediately after rating the sentences, participants were asked to recall the digits in the order in which they had heard them. They were given the following instructions: "Quickly enter the digits you heard in the correct order. Once you have entered a digit, click 'Next'. If you cannot remember a digit, just leave the field blank and click 'Next'". Participants recalled the digits at their own pace, within a maximum of 10 seconds per digit.

To measure whether participants had rehearsed the digits during the processing task, they were asked at the end of both parts of the WM task whether and when they had rehearsed the digits using a three-point scale (1 = "not at all", 2 = "parallel to the sentences", 3 = "in between sentences").

2.4 Interpreting task

The interpreting task was to simultaneously interpret a four-minute general speech from English into German.

2.4.1 Source text

The written speech (duration of speech: 4:10 min., length: 439 words, 676 syllables, 33 sentences, speech rate: 107 words per minute, 164 syllables per minute) was read and recorded by a native speaker of British English. It was a speech on the topic of the Red Cross in the fight against HIV/AIDS.

The ST was manipulated by defining two levels of difficulty: easy and difficult. Easy text paragraphs consisted of simple syntax, frequent words and expected sequences (cf. Kalina 2011: 169), obvious idiomatic equivalents in the target language (cf. Mankauskienė 2016: 146f.) and a maximum of one adjective accompanying a noun (cf. Gile 2009: 193; Wang 2015: 69f.; e.g.: "Many countries don't have enough doctors and nurses. Other countries don't have enough money to pay for hospitals. Our volunteers are trying to fill these gaps. But this is not enough."). Difficult paragraphs contained higher demands on the cognitive level due to hypotaxis, less frequent words, terms with less obvious equivalents in the target language and syntactic challenges, i.e. segments specifically placed at the beginning or in the middle of a

sentence which would need to be placed later in the sentence in the German rendition (e.g. "As your experience is an asset allowing us to learn more about the issues that are closest to you, the conference's open format will create an energizing and inspiring context for the day.").

There was a total of 13 paragraphs (on average 2.6 sentences with an average of 31 words). The seven easy paragraphs contained an average of 3.6 sentences with an average of 31.7 words and the difficult paragraphs contained an average of 1.5 sentences with an average of 30.1 words. The speech started with two short sentences that were classified as very easy to make it easier to start interpreting and were not counted. The text then alternated between easy and difficult paragraphs, starting with an easy paragraph. The two levels of difficulty of the ST can be seen in Table 1.

	whole text	difficult paragraphs	easy paragraphs
words	439	206	231
Flesch Reading Ease[3]	58 fairly difficult	42.1 difficult	70.1 fairly easy
LIX[4]	37.33 low complexity	53.48 medium complexity	29.52 very low complexity

Table 1. Levels of difficulty of the source text

2.4.2 Procedure

On the study's website, the participants were informed that this task involved interpreting a text simultaneously from English into German, that they would need headphones and a microphone, and that the computer would have access to the microphone. The details of the speech included information on the length of the speech and the topic. The task was preceded by a rehearsal with a 3-minute test speech (on the topic 'The coexistence of generations in our society'). After a recommended break of five minutes, the main speech was to be interpreted.

The participants were asked to find a place where they could concentrate on the task undisturbed. After checking the volume, the test task and the main task could be started by clicking on a link. The participants had the option of contacting one of the experimenters in case of technical difficulties, but none of the 20 participants made use of this option.

2.4.3 Scoring system

The accuracy of the interpretations was assessed using propositional analysis. The evaluation grid was created from a combination of automatic and manual counting of the propositions (drawing upon CPDIR, based on Turner/Green 1977, and following the approach proposed by Bovair/Kieras (1985) (cf. Brown *et al*. 2008)). Each

3 Readability score from 0 to 100 (100 = extremely easy to read)
4 Björnsson (1968)

proposition was assigned a value of 1, resulting in a total score of 234 points (119 in total for the easy paragraphs and 115 in total for the difficult paragraphs). The units to be assessed were therefore the propositions, i.e. no units of meaning were formed, nor could such units have been weighted in terms of their relevance (cf. Gieshoff/ Albl-Mikasa 2022). Although in case of very fast speeches, the omission of less important segments can occur and is a rather good strategic choice by the interpreter, the term accuracy not only refers to correctness and precision of the interpretation but also to completeness, i.e., everything the speaker says has to be transferred into the target language.

The evaluation using a stable scoring system was limited to propositional accuracy to obtain a reliable numeric value to compare to the WM performance. Other criteria generally used to assess an interpreting performance – e.g. prosodic features, situation and audience orientation (cf. Behr 2015), or omissions for strategic reasons – were not taken into account. In the event of a significant error such as a *contre-sens*, i.e. a misinterpretation, where the interpreter says the opposite of what the speaker said in the original, raters could mark the deduction of one point in the scoring scheme. The evaluation grid was used by three raters, all of whom have a degree in conference interpreting, German as A language and English as B or C language; two raters have had extensive professional and teaching experience. The inter-rater reliability was high (.953).

Transcripts were created with Whisper AI for all automatically recorded interpretations and corrected manually, where necessary. The raters used these transcripts to assess accuracy.

3. Results

Data were analysed using JASP (JASP Team, 2024).

3.1 Working memory performance

Performance on the sentence validation task was on average over 70% in both the low load condition (M = 73.88%, SD = 13.99%) and high load condition (M = 79.29%, SD = 9.23%) and did not differ across conditions based on a paired samples t-test, t(20) = -1.85.08, p = .080.

Mean memory performance is shown in Figure 2. Participants retained significantly more digits in the low load condition (M = 67.75%, SD = 21.03%) than in the high load condition (M = 58.92%, SD = 21.02%), t(19) = 3.13, p = .003 (one-tailed), d = .699. Memory performance in the high and low load WM conditions were positively correlated, r(20) = .819, p < .001.

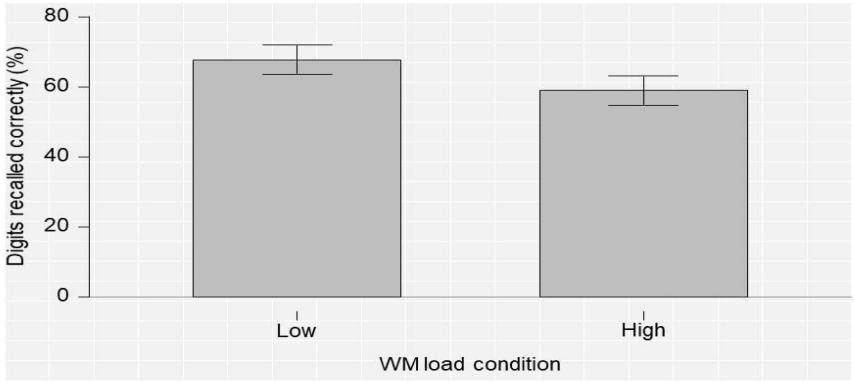

Figure 2. Memory performance in the working memory task conditions
Note: Mean number of digits correctly recalled in the low (left) and high (right) load working memory conditions. Error bars represent 95% confidence intervals.

3.2 Rehearsal strategy in the WM task conditions

In the low WM load condition, 13 participants (65%) reported that they rehearsed the digits simultaneously with reading and judging the sentences in the sentence-verification task, and 6 participants (30%) reported that they rehearsed the digits between sentences. In the high WM load condition, 14 participants (70%) reported that they rehearsed the digits simultaneously with the sentences, 2 participants (10%) rehearsed them between the sentences, and 4 participants (20%) reported that they did not rehearse the words during sentence-verification. 14 participants (70%) reported that they did not change their rehearsal strategy, and 5 participants (25%) reported that they changed their rehearsal strategy from the low WM load to the high WM load condition. A binomial test revealed that the proportion of participants who reported changing their rehearsal strategy from the low WM load to the high WM load condition was not significantly different from the expected test value of .55, $p = .112$.

3.3 Interpreting task

The distribution of accuracy scores in percentages is shown in Figure 3 and descriptive statistics are shown in Table 2. The overall accuracy scores were around 60%. A Shapiro-Wilk test indicated that the overall accuracy scores were normally distributed, $W = .94$, $p = .193$.

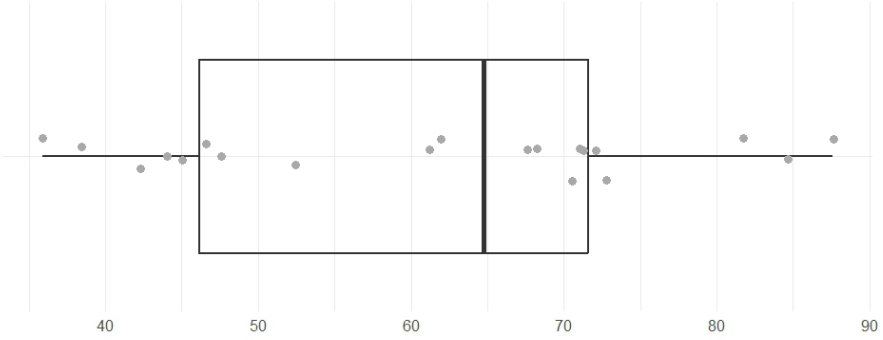

Figure 3. Percentage of accuracy in the SI task
Note: Boxplot for the accuracy scores in percentages. The accuracy scores in percentages (x-axis) were calculated by dividing the individual accuracy score by the maximum accuracy score and multiplying the quotient by 100. The dots represent participants' accuracy scores.

Accuracy	Mean	SD	Minimum	Maximum
Overall	61.13	15.97	35.9	87.61
Easy text paragraphs	73.03	16.38	35.29	96.64
Difficult text paragraphs	48.83	18.07	18.26	78.26

Table 2. Descriptive statistics for the overall accuracy, as well as the easy and difficult paragraphs of the SI text, SD = Standard deviation

Accuracy scores for the easy paragraphs show that 73% were correctly reproduced, compared to 48% for the difficult paragraphs (Table 2). Shapiro-Wilk tests showed that the scores for the easy paragraphs, $W = .94$, $p = .260$, and the difficult paragraphs, $W = .97$, $p = .659$, were normally distributed. Accuracy scores were significantly higher for the easy paragraphs than for the difficult paragraphs, $t(19) = 8.38$, $p < .001$, $d = 1.873$.

3.4 Relation between working memory performance and interpreting accuracy

As shown in Table 3, Pearson correlations revealed a significant correlation between memory performance in both WM load conditions and overall SI accuracy (easy + difficult ST). Furthermore, memory performance in the low WM load condition was significantly correlated with SI accuracy on the difficult ST passages but not with easy ST passages. Memory performance in the high WM load condition was significantly correlated with SI accuracy on the difficult ST passages but not with easy ST passages.[5]

5 Additional statistical analyses: High and low load WM tasks were strongly correlated, $r(20) = .819$, $p < .001$. Although the sample size was small, two linear regression models were applied. The first model included accuracy scores for easy text passages in the SI task as the

WM load condition	ST difficulty	$r_{Pearson}$ (p)
low	easy + difficult	r(20) = .51 (p = .011)*[1]
high	easy + difficult	r(20) = .38 (p = .046)*[1]
low	easy	r(20) = .31 (p = .184)
low	difficult	r(20) = .63 (p = .003)**
high	easy	r(20) = .10 (p = .692)
high	difficult	r(20) = .61 (p = .005)**

* p < .05; ** p < .01; [1] = one-tailed; WM = working memory; ST = source text

Table 3. Correlations between WM load conditions and ST difficulty

4. Discussion

The present study aimed to further investigate the relationship between WM and SI by varying cognitive load in WM and ST difficulty in the SI task. The results show that (i) in line with our hypothesis, memory performance in the low WM load condition was higher than in the high WM load condition, and (ii) memory performance in both the low and high WM load conditions correlated with SI accuracy for difficult ST passages but not for easy ST passages.

The results showing that increasing cognitive load in WM decreases memory performance are consistent with existing findings (Barrouillet *et al*. 2004; Langerock *et al*. 2014; Vergauwe *et al*. 2010, but also Ricker/Vergauwe 2020). The general finding that task performance in WM is related to SI performance supports theories suggesting that temporary active maintenance of information (in WM) plays an important role in interpreting (Darò/Fabbro 1994; Gerver 1975; Moser 1978) and also supports studies that have found a relationship between WM performance and SI performance (Tzou et al. 2011; Injoque-Ricle *et al*. 2015; Bae/Jeong 2021; see also Mellinger/Hanson 2019). The present study complements previous studies by experimentally varying the parameters of both the WM and the SI tasks.

dependent variable and the two WM tasks (low load vs. high load) as covariates. The results for the first model showed that the ANOVA model was non-significant, F(2,19)=1.78, p = .199, adjusted R^2 = .076. The second model included accuracy scores on difficult text passages in the SI task as the dependent variable and the two WM tasks (low vs. high load) as covariates. The results for the second model showed a significant ANOVA model, F(2,19) = 6.12, p = .010, adjusted R^2 = .350, but both the low load WM task, β = .397, t = 1.30, p = .236, and the high load WM task, β = .280, t = .87, p = .398, were non-significant. Together with the high standard errors (SE) for the regression coefficients (SE low load WM task = .462; SE high load WM task = .462), these results tend to indicate a multicollinearity problem. One way to reduce the problem of multicollinearity is to exclude one of the correlated variables. In the case of the present study with only two predictor variables, excluding one predictor variable would lead to the results of the correlational analyses (see Results section). Accordingly, the low load WM task shared most of the variance with the accuracy score for the difficult source text passages in the SI task.

Memory performance in both the low and high WM load conditions were significantly related to difficult ST passages. A central assumption of the study was that increasing the time between two sentence-verification items would increase the possibility of refreshing the items to be maintained (low WM load condition), and decreasing that time would decrease the possibility of refreshing the items to be maintained (high WM load condition; e.g. Barrouillet *et al*. 2004). Accordingly, it was assumed that participants who are better at maintaining information, in our case digits, while simultaneously processing other information, in our case sentence-verification, should also show higher SI accuracy. The results of the study support this assumption. We expected a stronger relationship with SI accuracy under the high WM load condition than under the low load condition, as it might be an advantage for interpreters to maintain relevant information in a highly accessible state for a longer temporal interval while simultaneously processing other relevant information. Therefore, the low WM load condition was specifically designed to allow participants to refresh the digits in the 20s-retention interval where distraction through the sentence verification task was low, as there were only four sentences to verify. In contrast, the high WM load condition was designed to maximally minimise participants' possibilities to refresh the digits through a continuous, high frequency engagement in the sentence verification task in the 20s-retention interval. However, the result that in both the high and low WM load conditions WM performance correlated with difficult ST passages may indicate that the two WM load conditions measured different abilities relevant to SI. It can be speculated that in the low WM load condition, the refreshing of information over a prolonged period was measured, whereas, in the high WM load condition, where the focus of attention is bound to process new relevant information, it was the maintaining of information outside the focus of attention in a highly accessible state over a prolonged period. However, it should be noted that performance on the sentence-verification task was below 80% in both WM task conditions. This may indicate that the maximum time allowed for sentence-verification was too short to make a correct decision, or that participants were preoccupied with refreshing the digits to be remembered. While this may have less of an effect in the low WM load condition, where participants had enough time to refresh the digits, it may have a more substantial impact on the measured memory performance in the high WM load condition, where the intention was to maximise attention to the sentence-verification task and, thus, minimise the opportunities to refresh the digits. This is a possible reason why the measures of the two tasks were highly correlated and shared a similar amount of variance with SI accuracy for the difficult ST passages.

Contrary to our expectations, the results of the present study show that the two WM load conditions were not correlated with accuracy in the case of easy ST passages. Easy compared to difficult ST passages were characterised, for example, by simple syntax, frequent words and expected sequences (see Methods section). WM is a construct that keeps relational representations in a directly accessible state and interacts strongly with long-term memory. Reducing the number of relational bindings formed in interaction with long-term knowledge helps WM to divert information away from the focus of attention, making WM more flexible, i.e. more WM capacity is available for processing new incoming information (Rhodes/Cowan 2018). Accordingly, it is conceivable that no relationship between the low WM load condition and easy ST passages was found because the WM load manipulations measured WM-related process-

es, whereas interpreting easy ST passages measured more long-term memory-related processes. The interpretation of easy ST passages may require less WM involvement due to existing language chunks in long-term memory, which can be directly accessed during SI, helping to free WM capacity (Thalmann *et al.* 2019). This view is supported by studies showing that WM capacity is increased when information can be related to long-term knowledge. For example, Fincher-Kiefer et al. (1988) found that participants with high baseball knowledge outperformed participants with low baseball knowledge on a reading span task when sentences were baseball-related, whereas no differences were found when sentences were free of domain-specific knowledge. The efficient use of long-term knowledge is a characteristic of expertise resulting from intensive training. Studies have shown that deliberate practice (training) can improve performance in various domains, such as chess, music or sports (Ericsson *et al.* 2006). Accordingly, practice improves the accuracy, efficiency and ease of the cognitive processes involved and, thus, the execution of actions. Training is said to increase the number and connectivity of information units in long-term memory, which can lead to more effective information processing despite the limitations of WM (Hambrick/Engle 2002; Ericsson/Kintsch 1995). This finding is in line with the assumption that interpreters use their WM more efficiently by reverting to knowledge and strategies specific to SI (Liu *et al*. 2004: 36; for experiential knowledge, see also Wen/Dong 2019: 779; Ghiselli 2022: 73). Several studies have shown that experienced interpreters recur more often to certain strategies than student interpreters (Köpke/Signorelli 2011; Kohn/Kalina 1996; Riccardi 1996; Jörg 1997), and the relevance of the strategic use of anticipation was expressed by Chernov as early as the 1970s: "Our hypothesis is that the basic mechanism that makes SI possible is probability anticipation of the development of the message" (Chernov 2004: 91; see also Mizuno 2005: 749). Up to now, little is known about a possible relationship between cognitive load and specific interpreting strategies (cf. Dong/Li 2020), although these strategies allow cognitive resources to be saved due to automation (cf. Ericsson *et al*. 2006; for automation by and in interpreting training, see Balakhonov 2023).

Higher accuracy scores for the easy paragraphs than for the difficult ones demonstrate the relevance of ST difficulty for interpreting accuracy as one of the central quality criteria and for experimental design. This result confirms that paragraphs with hypotaxis, less frequent words, terms with less obvious equivalents in the target language and syntactic challenges are more difficult than paragraphs without such characteristics. Thus, when analysing what happens when difficult sections are interpreted, easy sections can be useful as reference values. At the same time, this result suggests that differences in performance are not visible below a certain threshold of difficulty. Therefore, it is reasonable to conduct studies where interpreting scores do not refer to a whole text but only to selected passages in the interpretations, e.g. critical sentences (Liu *et al*. 2004), pre-selected and manipulated variables (Timarová *et al*. 2015) or selected sentences (Tzou *et al*. 2011) – provided they are sufficiently difficult. Furthermore, defining the level of difficulty of the whole ST makes it possible to control this variable, which is particularly useful when considering other aspects of interpretation, such as stamina, types of errors, use of strategies.

The present study has several limitations. Firstly, the results are limited to interpreting students at the master's level. The average performance level of 75% is relatively low and should be higher for professional interpreters who have developed the

necessary interpreting skills. Although in the present study, memory performance in the low WM load and accuracy in the difficult ST passages shared almost 40% of their variance, several other factors relevant to SI performance were not measured. One such factor is the level of expertise, i.e. the amount of SI practice. The meta-studies by Wen/Dong (2019) and Ghiselli (2022) provide evidence that the level of expertise is one possible predictor of SI performance. A relevant cognitive ability within expert performance seems to be a better selection of relevant information (Liu *et al*. 2004: 19; 36) – a process that can also be related to WM (Unsworth/Engle 2007; Unsworth et al. 2012; but see also Meinz/Hambrick 2010, who show that WM capacity is a central predictor of sight-reading piano playing independent of practice level). Second, interpreting quality was assessed solely based on propositional accuracy. Accuracy is considered one of the most essential quality criteria, but a thorough evaluation of an interpreting performance must also include aspects such as prosody, communication skills and register (cf. Bühler 1986; Riccardi 2002; Collados Aís *et al.* 2011).

In conclusion, the present study shows a positive relationship between WM and SI, but only under certain conditions. Our results indicate that maintenance of information in the face of distraction is significantly related to SI accuracy for difficult text passages. This finding is a further step toward a better understanding of the relationship between WM and SI, as it highlights that specific WM processes are related to specific processes in SI. Our findings, therefore, suggest that it is important to break up WM and SI processes to get a better understanding of the conditions when WM is related to SI – which is masked when sub-processes on both sites are neglected.

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