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The Relationship Between Working Memory, Delivery Rate, and Pauses in Consecutive Interpreting

Mojtaba Amini* — PhD in Translation Studies, Isfahan University, Isfahan, Iran

Mahmood Yenkimaleki — Assistant Professor, Department of English Language, Bu-Ali Sina University, Hamedan, Iran

Abstract

Given the importance of consecutive interpreting as a key mode of communication, various factors influencing its effectiveness must be examined to enhance overall performance. This study explored the relationship between working memory (working memory), interpreting delivery rate, and the number of pauses. To achieve this, two working memory tests and a consecutive interpreting task were administered to 30 MA translation students. The analysis revealed a significant positive correlation between one working memory measure (reading span) and interpreting delivery rate. However, no significant relationship was found between working memory and the number of silent or filled pauses in the interpreting output. Additionally, working memory was identified as a predictor of interpreting delivery rate. These findings suggest that while working memory may be associated with certain variables, such as delivery rate, it may not be linked to others, such as the number of pauses in consecutive interpreting.

Keywords: Consecutive interpreting, interpreting delivery rate, silent and filled pauses, working memory

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*Corresponding author: m.amini257@yahoo.com

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Introduction

Consecutive interpreting (CI) is a widely used mode of communication in settings such as press conferences, police stations, and courtrooms. It involves rendering the source speech segment by segment, allowing the interpreter to take notes during pauses (Pöchhacker, 2004). Various factors influence CI performance, with some playing a more critical role than others. While certain aspects, such as prosody awareness training and note-taking, have been studied, others—such as working memory, pauses, and delivery rate—require further investigation. Additionally, exploring the relationships between different variables in interpreting can provide valuable insights that may enhance interpreter training and performance.

Working memory (WORKING MEMORY) is recognized as a key cognitive ability that plays a crucial role in interpreting (e.g. Amini, et al., 2020, 2022; Bajo, Padilla & Padilla, 2000; Chmiel, 2016; Darò, 1989; Dong, Liu & Cai, 2018; Timarova, 2008; Wen & Dong, 2019). However, its relationship with various aspects of interpreting, such as delivery rate and pauses, has not been systematically examined. Originally introduced by Baddeley and Hitch (1974) as a reconceptualization of short-term memory, WORKING MEMORY was later expanded by Baddeley (2000) into a multi-component model comprising four main components: the central executive, the phonological loop, the visuospatial sketchpad, and the episodic buffer. Each component plays a distinct role in storing, processing, and retrieving information. This model has been widely applied in research on WORKING MEMORY in the context of interpreting.

Assessing interpreting quality is inherently challenging due to its subjective nature, making complete objectivity unattainable. Experts have developed various assessment scales based on their definitions of quality, while audiences may apply their own criteria. Nonetheless, factors such as accuracy, fluency, pauses, delivery rate, and faithfulness play a significant role in quality assessment (e.g., Mahmoodzadeh, 1992; Viezzi, 1996).

Speaking Rate and Interpreting Delivery Rate

People vary in their speaking styles, and multiple factors influence the perception of speech rate. Speech rate, measured in words per minute (WPM), refers to the speed at which one speaks. Laver (1995) notes that speaking rate and articulation rate are often used interchangeably. However, perception of speech speed may be inaccurate when based solely on listening (Roach, 1998). Additionally, languages differ in their use of pauses and hesitations (Ofuka, 1996). Li (2010) suggests that an optimal speech rate for English is between 100 and 120 WPM.

Interpreting is a form of speech; therefore, the same criteria used to measure speech rate can be applied to interpreting delivery rate. Galli (1990) examined the effects of speech rate on three professional English-Italian interpreters and found that a higher speech rate was associated with increased omissions and errors. Shlesinger (2003) conducted an experiment with sixteen professional simultaneous interpreters, who interpreted the same six source texts at two different speeds—120 and 140 WPM. She found that interpreting performance improved at a higher speech rate. However, Chernov (2004) argues that an interpreter's speed does not increase proportionally with that of the speaker.

Regarding the association between speaking rate, interpreting delivery rate, and interpreting quality in the English-Persian language pair, Rostami (2009) examined the relationship between interpreters' speaking speed in their second language (English) and the quality of their consecutive interpreting, reporting a positive and significant correlation. Similarly, Shirinzadeh (2013) found a positive relationship between simultaneous interpreters' speaking speed in Persian (their mother tongue) and their interpreting quality from English into Persian. In contrast, Hoseinzade (2006) found no significant correlation between simultaneous interpreters’ speaking speed in Persian and the quality of their simultaneous interpreting from English into Persian. Additionally, Amini (2015) investigated the relationship between interpreters’ speaking speed in their mother tongue (Persian) and the speed of their CI from English into Persian, reporting a positive and significant association. However, Hasanshahi and Shahrokhi (2016) examined the relationship between simultaneous interpreters’ speaking speed in Persian and their interpreting quality, finding no significant association.

Despite these studies, the relationship between working memory (WORKING MEMORY) and interpreting delivery rate remains unexplored. Therefore, the present study aims to investigate this association in the context of CI.

Silent and Filled Pauses in Speaking and Interpreting

Pauses and fillers in spoken language have been defined and described in various ways by different scholars. According to Hargrove and McGarr (1994), pauses are defined as periods of time during which no acoustic signal is produced, lasting at least 200-270 ms. Additionally, Simone (1990) categorizes pauses as silence, hesitation, or juncture.

Erten (2014) states that fillers are discourse markers speakers use when they think, or hesitate during their speech. According to Bygate (1987), fillers are expressions used in speech to fill in pauses. Furthermore, Nordquist (2015) defines filler as a meaningless word, phrase, or sound that marks a pause or hesitation in speech. During speech, speakers are likely to use expressions such as “well”, “I mean”, “actually”, “you know”, and “let me think” to create a delay to overcome difficulties in speech (Richards & Schmidt, 2012; Yenkimaleki & Van Heuven, 2021; 2022). In fact, pauses and fillers are crucial cognitive functions that allow the next stage in language processing to be planned (Yenkimaleki et al., 2023).

A number of studies have compared pauses in interpreting with those in the source speech. For instance, Alexieva (1988) examined pause patterns in simultaneous interpreting performed by student interpreters and found that pauses in the simultaneous interpreting output were less frequent and shorter in duration than those in the source speech. Similarly, Pöchhacker (1995) reported that pauses were significantly less frequent in the German interpretation compared to the English source speech. Wang and Li (2015) found that while pauses were less frequent in Chinese-English simultaneous interpreting, they were longer in duration than in the original speech. Other studies have reported similar findings. For example, Tissi (2000) observed that the occurrence of silent pauses in interpreting delivery correlates with those in the source text. Ahrens (2005) noted that there are fewer but longer pauses in target texts than in the source texts.

Other studies on pauses in interpreting have focused on the relationship between pauses, interpreting expertise, and directionality (Mead, 2000; 2002). For instance, Yang (2011) found that novice interpreters pause more frequently than expert interpreters. Expert interpreters, she observed, had proportionally fewer pauses before sentences and clauses, within phrases, and notably fewer pauses between the subject and the predicate. Similarly, Yin (2011) concluded that beginning learners of consecutive interpreting tend to overuse fillers and repeat words.

The relationship between working memory capacity and pauses in interpreting delivery rate has not been systematically investigated. Therefore, the present study seeks to address this gap by examining the association between working memory capacity and pauses in interpreting delivery rate. The findings could contribute to interpreting studies, interpreter training, and performance improvement. In this study, the definition of pauses by Brown and Yule (1989) was used to calculate the number of pauses in consecutive interpreting.

Research Questions

This study examines the relationship between working memory and interpreting delivery rate, as well as the association between working memory and the frequency of silent and filled pauses. Additionally, it investigates the predictive capacity of working memory concerning these variables. As previously noted, WORKING MEMORY serves as a critical prerequisite for interpreting, while delivery rate and pauses play a pivotal role in consecutive interpreting performance, influencing its overall quality. The following research questions guide this investigation:

1. Is there a significant relationship between working memory and interpreting delivery rate in consecutive interpreting?
2. Is there a significant relationship between working memory and the number of silent and filled pauses in consecutive interpreting?
3. Can working memory predict interpreting delivery rate and the frequency of pauses in consecutive interpreting?

Prior research (Amini et al., 2020, 2022; Yenkimaleki & Van Heuven, 2017) supports a positive correlation between working memory and consecutive interpreting performance, particularly between working memory and delivery rate in consecutive interpreting.

Method

Participants

Thirty Persian-speaking MA translation students (14 males and 16 females) aged 22–30 were randomly selected from the University of Isfahan. Participants were drawn from a pool of approximately 50 students who met two criteria: (a) achieving a minimum proficiency score of C2 (55+) on the Oxford Placement Test (OPT), and (b) scoring below 2.5 on a self-report questionnaire. This dual screening ensured a homogeneous cohort in terms of language proficiency and interpreting experience. The final sample thus comprised 30 proficient bilinguals with comparable English proficiency levels and similar theoretical and practical familiarity with interpreting.

Tasks

Working Memory Tasks

(Auditory and Forward) Digit Span Test: This test assesses verbal working memory capacity. The study utilized the Persian version of the test developed by Khodadadi and Amani (2014), which features fully automated administration and scoring procedures through specialized software.

Reading Span Test: This test measures general working memory. The Persian version of this test (Khodadadi, Asad Zadeh, Kalantar Ghoreishi, & Amani, 2014), developed and validated based on Persian language criteria, was used with an automatic scoring procedure in this study. The test scores both storing and processing abilities, which were summed to obtain the final score.

Consecutive Interpreting Task

The consecutive interpreting task utilized a 4.48-minute recorded video lecture in English on the topic *Why should we learn a new language?* delivered by a native American English speaker. The lecture contained no technical terminology, requiring only everyday language proficiency for accurate interpretation. The source text comprised 702 words delivered at a rate of 146.25 words per minute (WPM). Following each short segment, the researchers paused the video (e.g., for 40 seconds) to allow participants to complete their interpretation before proceeding. Participants were required to interpret each segment from English into Persian during these pause intervals.

Scoring the Interpreting Tasks

The interpreting tasks were evaluated using the revised version of Carrol's Scale (Tiselius, 2009), a holistic rubric comprising two components: intelligibility and informativeness. This non-componential rubric facilitates straightforward scoring while ensuring consistency. Three independent raters, all holding PhDs in interpreting and translation studies with at least five years of experience in the field, assessed the tasks. Each participant's final score represented the average of the three raters' evaluations. The scoring procedure demonstrated high reliability, with an inter-rater reliability coefficient of $r = .897$ ($p < .001$).

Procedure

Participants completed the data collection individually in a quiet classroom setting. Each session began with the Digit Span test, followed by the Reading Span test, and concluded with the consecutive interpreting task. The working memory tests were administered and scored automatically through a laptop computer in this predetermined order. For the consecutive interpreting portion, participants interpreted a recorded video lecture played on the laptop, providing their translation during each designated pause period. All interpreting performances were recorded using a digital voice recorder for subsequent analysis.

The recorded interpreting tasks were first transcribed verbatim by one of the raters, who listened carefully through high-quality headphones and reviewed each recording multiple times to ensure accuracy. Three qualified raters then independently scored the transcribed interpretations using the revised version of Carrol's Scale (Tiselius, 2009). Following the the Tiselius method, each interpreting unit was printed on separate pages with the interpreted version positioned at the top and the original text at the bottom. The intelligibility scale appeared at the top of each page, while the informativeness scale was placed at the bottom, maintaining a consistent format throughout the evaluation process.

Calculating the Interpreting Delivery Rate

In order to calculate the interpreting delivery rate, the raters listened to each interpreting task through a headset and used a chronometer, and calculated the duration of each interpreting task. Then, the number of words in each interpreting task was divided by total duration of the interpreting.

The WPS (Words per Second) scale was used to calculate the interpreting delivery rate, and the result was calculated based on WPM (Words per Minute) (Barik, 1973):

$$\text{Speaking Speed} = \frac{\text{Number of Words}}{\text{Time (Seconds)}}$$

Calculating the Number of Silent and Filled Pauses

The study adopted Brown and Yule's (1989) categorization for analyzing silent pauses in consecutive interpreting. Their framework categorizes pauses into three distinct types: (1) extended pauses (3.2-16 seconds), occurring when speakers provide sufficient information for comprehension or note-taking; (2) long pauses (1-1.9 seconds); and (3) short pauses (0.1-0.6 seconds). All silent pauses lasting at least one second were identified and included in the analysis. Raters carefully listened to each interpreting performance and systematically marked these pauses in the transcripts for precise quantification.

For filled pauses, the raters established consensus criteria for identification before analysis. They collaboratively determined which vocalizations qualified as filled pauses, then annotated all instances in the transcripts. Using these coded transcripts, raters conducted final tallies of both silent and filled pauses for each participant's performance.

Data Analysis

The analysis was conducted in two sequential phases. In the initial phase, descriptive statistics were calculated for all variables, with examinations of both skewness and kurtosis confirming normally distributed data. This normal distribution was further verified through a test of normality. Based on these results, the second phase employed parametric analyses. The Pearson Correlation Coefficient was applied to address research questions 1 and 2 regarding variable relationships. Subsequently, simple linear regression analysis was conducted to examine the predictive relationships posed in research question 3.

Results

Descriptive statistics for all study variables are shown in Table 1. These variables include Consecutive Interpreting performance, Reading Span, Digit Span, Interpreting Delivery rate, number of silent pauses, and number of filled pauses.

Table 1. Descriptive Statistics of All Variables

Variables	N	Mean	SD	Min	Max	Skewness	Kurtosis
CI Performance	30	9.79	1.75	6	12	-1.23	0.15
Reading Span	30	76.72	10.12	50	94.40	-.67	.72
Digit Span	30	7.93	1.25	5	10	-.64	.31
Interpreting Delivery Rate	30	128.03	12.69	100	144	-.70	-.58
Number of Silent Pauses	30	66.27	20.56	37	100	.11	-1.54
Number of Filled Pauses	30	28.47	9.18	12	41	-.39	-1.20

** Correlation is significant at the 0.01 level.

A Pearson Correlation analysis was conducted to examine the association between working memory and interpreting delivery rate, as well as between working memory and consecutive interpreting performance. According to the results, there was a significant and positive relationship between Reading Span and interpreting delivery rate while there was no significant association between Digit Span and interpreting delivery rate. Furthermore, there was a positive and significant relationship between both measures of working memory and consecutive interpreting performance (see Table 2).

Table 2. Pearson Correlations Among Variables

Variables	CI Performance	Reading Span	Digit Span	Interpreting Delivery Rate
CI Performance	1	-	-	-
Reading Span	.880(**)	1	-	-
Digit Span	.643(**)	-	1	-
Interpreting Delivery Rate	-	.714**	.311	1

** Correlation is significant at the 0.01 level.

A Pearson correlation was conducted to examine the association between working memory and number of silent and filled pauses. According to the results, there was no significant relationship between either measures of working memory and number of silent and filled pauses (see Table 3).

Table 3. Pearson Correlations Among Reading Span, Digit Span and Number of Silent and Filled Pauses

Variables	Reading Span	Digit Span	Number of Silent Pauses	Number of Filled Pauses
Reading Span	1	-	-	-
Digit Span	-	1	-	-
Number of Silent Pauses	.324	.046	1	-
Number of Filled Pauses	-.092	-.132	-	1

** Correlation is significant at the 0.01 level.

Given the nonsignificant Pearson correlations between (a) Digit Span and interpreting delivery rate and (b) both working memory measures and pause frequency, these variables were excluded from the regression model. A simple linear regression was conducted with interpreting delivery rate as the dependent variable and Reading Span as the independent variable. The model was statistically significant, $F(1, 29) = 29.114$, $p < .05$, $R^2 = .492$, indicating that Reading Span significantly predicted delivery rate ($\beta = .714$, $t = 5.396$, $p = .000$; see Table 4).

Table 4. Simple Linear Regression

Model 1	β	T	P	R^2 adjusted
Constant		4.633	.000	.492
Reading Span	.714	5.396	.000	

Note. Dependent Variable: Consecutive Interpreting Delivery Rate

Discussion

The first research question examined the relationship between working memory and interpreting delivery rate. The results revealed a significant positive correlation between reading span (one measure of working memory) and delivery rate, while no significant association emerged between digit span (the other working memory measure) and delivery rate.

The significant relationship between reading span and delivery rate may be attributed to the reading component inherent in consecutive interpreting, particularly when processing notes. As reading span represents a complex measure of general working memory capacity, these findings suggest that interpreters with higher working memory capabilities tend to maintain faster delivery rates. In contrast, digit span – which specifically assesses verbal working memory (phonological loop) – showed no significant impact on delivery rate. This implies that phonological processing alone may not substantially influence interpreting speed. However, further experimental studies are needed to validate these observations and support broader generalizations.

The second research question investigated the relationship between working memory and the frequency of silent and filled pauses in consecutive interpreting. The analysis revealed no significant correlation between these variables, suggesting that interpreting students with varying working memory capacities do not produce different pause patterns in their output. This finding represents an underexplored area in interpreting research, as no prior studies have specifically examined this relationship. The absence of existing literature on this topic highlights a potential gap for future investigation. Further research in this domain could contribute valuable insights to the field, ultimately informing pedagogical approaches to enhance interpreting performance.

The third research question examined whether working memory capacity could predict interpreting delivery rate and pauses in consecutive interpreting. Simple linear regression analysis demonstrated that reading span – as a robust measure of working memory – significantly predicted interpreting delivery rate. These results indicate that interpreters with greater working memory capacity consistently achieve higher delivery rates compared to those with more limited working memory capacity.

Working memory demonstrates a significant positive association with consecutive interpreting performance. However, its relationship with other consecutive interpreting components – particularly interpreting delivery rate and pause frequency – remains indeterminate. While greater working memory capacity correlates with faster delivery rates and enhanced overall performance, it does not necessarily reduce pause frequency. Working memory is perceived as "a multicomponent system responsible for active maintenance of information in the face of ongoing processing and/or distraction" (Conway et al., 2005). Thus, working memory involves controlling attention, inhibiting irrelevant information and keeping relevant information active (Engle, 2002). Concurrent processing (such as evaluating the sense of sentences or performing mental math calculations while remembering items) engages the central executive system for monitoring and updating the stored information (Morales, Padilla, Gomez-Ariza, & Bajo, 2015). Complex span task scores have been associated with attentional control abilities (Shipstead, Lindsey, Marshall, & Engle, 2014). These controlled attention mechanisms prove essential for information maintenance and retrieval, especially in high-interference contexts (Redick et al., 2012). The cognitive demands of interpreting – particularly the simultaneous processing, updating, and monitoring of linguistic information – likely strain these working memory systems, though the exact nature of this interaction requires further empirical investigation.

Current evidence suggests working memory tasks are rarely independent of one another, though empirical research precisely characterizing their interrelationships remains limited. As Ecker et al. (2010) demonstrate, working memory capacity strongly predicts working memory updating ability, indicating close connections between working memory span measures and updating processes. Mizuno (2005) adapted Cowan's (1988) model through an expanded embedded processes framework, incorporating language comprehension and production mechanisms alongside the core memory system. This modification highlights the critical interactions between linguistic and memory systems during interpretation.

Conclusions

This study investigated the relationship between working memory and consecutive interpreting performance, specifically examining delivery rate and pause frequency. The results revealed a significant positive correlation between reading span (as a measure of working memory) and interpreting delivery rate, while no significant association emerged between working memory capacity and pause frequency. Furthermore, working memory demonstrated predictive value for consecutive interpreting delivery rate.

These findings suggest that working memory influences specific aspects of interpreting performance (e.g., delivery speed) but not others (e.g., pause patterns), while maintaining an overall positive association with interpreting quality. As one of the first studies to explore these relationships in English-Persian interpreting, this research establishes a foundation for future investigations in this domain. The study's primary limitation involved sample size constraints, with thirty MA translation students participating due to the specialized nature of the field. Future research with larger participant pools could validate these findings across different contexts. Collectively, these results and subsequent studies will contribute to interpreter training methodologies and stimulate further research into cognitive aspects of interpreting performance.

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