

EFFECT OF CORE WORKING MEMORY TRAINING ON CONSECUTIVE INTERPRETING

EFEITO DO TREINAMENTO DE MEMÓRIA DE TRABALHO CENTRAL NA INTERPRETAÇÃO CONSECUTIVA

EFFECTO DEL ENTRENAMIENTO DE LA MEMORIA DE TRABAJO BÁSICO EN LA INTERPRETACIÓN CONSECUTIVA

Mostafa BAHRAMAN¹
Roya MOVAHED²

ABSTRACT: Interpreting seems to be one of the most demanding and complex language tasks, heavily dependent on working memory (WM). This study attempts to examine the effect of WM training on the improvement of consecutive interpreting. To achieve it, 20 students of Translation Studies at Kashmar Higher Education Institute were selected. The participants' skill in interpretation was rated by implementing an interpretation scale. Then, all the participants received instructions on how to expand their WM capacity through core working memory training. The group went through another evaluation session after the treatment. The results were analyzed by running a paired sample t-test. It was found that WM capacity expansion exercises had a significant effect on the accuracy subscale whereas target language quality and delivery, the other two subscales, proved minor and no improvements, respectively. The findings can be used to train interpreters or in other educational settings that requires attention and memory skills.

KEYWORDS: Working memory. Working memory capacity. Consecutive interpreting. Core working memory training

RESUMO: A interpretação parece ser uma das tarefas de linguagem mais exigentes e complexas, fortemente dependente da memória de trabalho (MT). Este estudo tenta examinar o efeito do treinamento de MT na melhoria da interpretação consecutiva. Para isso, foram selecionados 20 alunos de Estudos de Tradução do Instituto de Educação Superior Kashmar. A habilidade de interpretação dos participantes foi avaliada por meio da implementação de uma escala de interpretação. Em seguida, todos os participantes receberam instruções sobre como expandir sua capacidade de MT por meio do treinamento básico da memória de trabalho. O grupo passou por outra sessão de avaliação após o tratamento. Os resultados foram analisados executando um teste t de amostra pareada. Verificou-se que os exercícios de expansão da capacidade de MT tiveram um efeito significativo na subescala de precisão, enquanto a qualidade e a entrega do idioma de destino, as outras duas subescalas, mostraram pequenas e nenhuma melhorias, respectivamente. Os resultados podem ser usados para treinar

¹ Department of English Translation, Kashmar Higher Education Institute, Kashmar, Iran. ORCID: <https://orcid.org/0000-0002-1321-5743>. E-mail: m.bahraman@kashmar.ac.ir

² Department of English Translation, Kashmar Higher Education Institute, Kashmar, Iran. ORCID: <https://orcid.org/0000-0002-2493-9309>. E-mail: royamovahed.uoz@gmail.com

intérpretes ou em outros ambientes educacionais que requeiram habilidades de atenção e memória.

PALAVRAS-CHAVE: *Memória de trabalho. Capacidade da memória de trabalho. Interpretação consecutiva. Treinamento da memória de trabalho central.*

RESUMEN: *La interpretación parece ser una de las tareas lingüísticas más exigentes y complejas, que depende en gran medida de la memoria de trabajo (MT). Este estudio intenta examinar el efecto del entrenamiento en MT en la mejora de la interpretación consecutiva. Para lograrlo, se seleccionaron 20 estudiantes de Estudios de Traducción del Instituto de Educación Superior Kashmar. La habilidad de interpretación de los participantes se calificó mediante la implementación de una escala de interpretación. Luego, todos los participantes recibieron instrucciones sobre cómo expandir su capacidad de MT a través del entrenamiento de la memoria de trabajo central. El grupo pasó por otra sesión de evaluación después del tratamiento. Los resultados se analizaron ejecutando una prueba t de muestra pareada. Se encontró que los ejercicios de expansión de la capacidad de MT tuvieron un efecto significativo en la subescala de precisión, mientras que la calidad y la entrega del idioma objetivo, las otras dos subescalas, demostraron ser menores y sin mejoras, respectivamente. Los hallazgos se pueden usar para capacitar a intérpretes o en otros entornos educativos que requieran habilidades de atención y memoria.*

PALABRAS CLAVE: *Memoria de trabajo. Capacidad de la memoria de trabajo. Interpretación consecutiva. Entrenamiento de la memoria de trabajo básica.*

Introduction

Interpreting consists of presenting in the target language, the exact meaning of what is uttered in the source language either consecutively or simultaneously, preserving the tone of the speaker (MAHMOODZADEH, 1992). Whether novice or experienced, all interpreters find this profession demanding and challenging as they are required to have the ability to hold and retrieve language for the purpose of rendering. In fact, interpreting has been claimed to be a complex or high performance skill which requires intensive and appropriate practices to achieve expertise (TIMAROVÁ *et al.*, 2015, DONG *et al.*, 2018).

Phelan (2001, p. 4) makes a reference to the essential qualifications for an interpreter and states that “the interpreter needs a good short-term memory to retain what he or she has just heard and a good long-term memory to put the information into context”. The interpreting task, according to Osaka (1994), has a significant relation to the listening span, indicating that interpreting task is highly influenced by that part of memory which is involved in receiving, processing, and rendering information during interpreting, called working memory (OSAKA, 1994).

Working memory, referring to a definition by Baddeley (1992, p. 556), has been defined as “a brain system that provides temporary storage and manipulation of the information necessary for complex cognitive tasks” (BADDELEY, 1999). This system is responsible for storage and manipulation of information in mind. Besides, WM is involved in the control and regulation of operating processes. Baddeley and Hitch (1974) model of WM is largely known to the researchers (BADDELEY; HITCH, 1974). According to their model, WM consists of phonological loop, visual-spatial sketchpad, and central executive. Working memory is primarily important in focusing attention, problem solving, and following instructions.

Studies show that working memory capacity (WMC) can be expanded through well-designed exercises (DAHLSTROM *et al.*, 2005; PRINS *et al.*, 2011). Some studies conducted by Lustig *et al.* (2009) (MAKI; MARTIN-THORMEYER, 2009) and Morrison and Chein (2011) (MORRISON; CHEIN, 2011) indicated that WM training is highly promising, and can lead to WMC expansion.

Given the complex and demanding nature of interpreting which, to a great extent, relies on WM, many researchers have claimed that memory and attention skills are of significance role in the process of the task in question, such as Darò and Fabbro (1994), Cowan (2000) and Hulme (2000), to name a few. However, due to sparse experimental data and also inconsistency in findings, it is difficult to draw any firm conclusion in such an early stage. Besides, most of the studies conducted are concerned with the idea of spotting the differences of WMC between interpreters and non-interpreters, or the relationship between WMC and the quality of skillful interpreters' performance (KÖPKE; NESPOULOUS, 2006; TIMAROVÁ *et al.*, 2015; DONG *et al.*, 2018). In this sense, more research is required to shed light on the effect of the WM training and the task of interpreting. Therefore, by applying core training, the practice of continuous repetition of demanding memory tasks for the purpose of improving working memory performance, the current study was carried out in order to find answers to the following questions:

1. Is there any relationship between WM training and consecutive interpreting?
2. To what extent, can WM training affect the quality of consecutive interpreting in terms of three subcategories including accuracy, target language quality and delivery?

Background

The statement of having a good memory for an interpreter seems to be misleading as it refers to an interpreter's extraordinary ability to recall, in great detail, what they have acquired

throughout several years of reading and learning. Although this kind of recall can be regarded as a great privilege for anybody, it does, doubtlessly, not suffice for interpreting performance. Working in the moment, interpreters need to recall and recollect what other participants have just uttered in a communicative situation in which they are working. In this sense, a good WM is what they actually need.

The origins of WM can be related to the modern psychology. The concept of WM can be traced back to as early as William James' distinction of “primary” and “secondary memory” (JAMES *et al.*, 1890). To him, primary memory was the conscious present and secondary memory considered as the vast amount of information stored for a lifetime. In 1949, Hebb claimed that the brain is divided into separate storage systems: temporary and permanent. Over the past half century, several theories and models on memory mechanism have been proposed: the Atkinson-Shiffrin model (ATKINSON; SHIFFRIN, 1968), and the Baddeley and Hitch model (BADDELEY; HITCH, 1974), to name a few.

Working memory is “[a] component of memory which holds short-term information for the purposes of performing a current process” (MEARA, 2004). WM refers to a cognitive model which was elaborated by Alan Baddeley, an experimental psychologist and Graham Hitch whose main concern has been memory research over the last two decades (BADDELEY; HITCH, 1974). It is different from long-term memory, which is in charge of storing information for longer periods. WM can also be defined as the brain’s ability to consecutively manipulate information in dealing with complex cognitive tasks, or simply, the ability to hold and process the discrete information in relation to what a person is doing at any given time. From the beginning it was thought that WM has a limited capacity, based on the definition construed upon Baddeley’s view of WM (BADDELEY, 1999; BADDELEY; HITCH, 1994; BADDELEY, 2003, GATHERCOLE; BADDELEY, 1993; BADDELEY; HITCH, 1974), but following studies proved the probable expansion of working memory capacity in case of practice and manipulation of memory strategies.

Possibility of working memory capacity expansion (WMC)

The capacity of WM has been proposed to be restricted. Cowan (2001) asserts that a typical individual can only manipulate about four pieces of information at a time. However, people show slight differences in WMC. Miller (1956) proposed that WMC is seven plus or minus two, that is, people can remember seven chunks of information at once. Following Miller’s initial work, studies began to prove that reasoning, learning, and even handling stress

are all related to a healthy WMC. Some researchers have shown that WM training is highly promising (LUSTIG *ET AL.*, 2009; MORRISON; CHEIN, 2011). Klingberg *et al.* (2005) began studies to find ways if WMC could be expanded through training. They believe that WM could impact many different functions (DAHLSTROM *et al.*, 2005).

Strategies to expand WMC

A typical WM training program includes several WM-based tasks for 2-6 weeks. The training procedure involves repeated work by learners on their own (MORRISON; CHEIN, 2011). Emphasis has always been on working memory's limited capacity to retain information while simultaneously it is involved in processing the information (SWANSON *et al.*, 1990).

For the apparent expansion of WM, there are some strategies such as subvocal verbal rehearsal, chunking, and organization (MINEAR; SHAH, 2006). Subvocal verbal rehearsal refers to the conscious and effortful strategies, and often consists of more than simple repetition (DEHN, 2011). Chunking, another strategy, refers to the "grouping or clustering of discrete items into larger units". It is thought to be a process which occurs naturally, much like creating words out of phonemes. These trainings involve strategy training which is intended to teach effective approaches to encoding, maintenance, and retrieval from WM (MORRISON; CHEIN, 2011). Learners are required to remember increasing amounts of information of a particular type. The emphasis is on retention of information. Some strategy training tasks involve reliance on and facility with articulatory rehearsal (CONNERS *et al.*, 2008; TURLEY-AMES; WHITFIELD, 2003). Another technique to expand WMC is core training which involves repetition of demanding WM tasks that are designed to target domain-general WM mechanisms. The researchers have employed core working memory training techniques since it targets the Central Executive system of working memory, where attentional control regulates the flow of information into and from the brain. Central Executive is also in charge of filtering, updating, and monitoring the audio and visuospatial information.

Core working memory training: A technique in WMC expansion

Core working memory training or simply core training involves repetition of demanding memory tasks which are demanding to the memory. This training is energy-consuming and effortful so that it could stimulate brain's information processing capacity by applying a high cognitive load, resulting in the neuroplasticity and health benefits. It appears that core working

memory training produces effects of widespread transfer, probably due to the fact that they attempt to exert changes on domain-general mechanisms of WM (MORRISON; CHEIN, 2011). Some core training programs take the form of varying stimulus types to impact multiple components of WM system and consequently can lead to the improvement of WM performance (HOLMES *et al.*, 2005). Some studies have shown that memory training can result in some degree of post-training cognitive improvements.

Relevant studies of WM and consecutive interpreting

The highly legitimate hypothesis that memory and attention skills play a major role in the process of interpreting, in particular simultaneous, has been discussed by many authors and interesting predictions have been made (DARÒ; FABBRO, 1994; PADILLA, 1995; COWAN, 2000; HULME, 2000; SIGNORELLI, 2008; SIGNORELLI *et al.*, 2012; MORALES *et al.*, 2015).

In contrast to simultaneous interpreting, experimental research into working memory and consecutive interpreting has been sparse (KÖPKE; NESPOULOUS, 2006, TIMAROVÁ *et al.*, 2015). As mentioned before, most of them, however, investigate the differences of WMC between interpreters and non-interpreters, or the relationship between WMC and the quality of skillful interpreters' performance. Also, there are researchers like Mahmoudzadeh (1992) who takes the influential role of working memory on consecutive interpreting performance for granted and offers techniques to improve interpreters' performance (MAHMOODZADEH, 1992). Yet, the few experimental data are still far from any definitive conclusion. It is worth noting that a most recent study conducted by Dong *et al.* (2018) has readdressed the issue in question from a different angle, i.e., the influence of consecutive interpreting training on working memory (DONG *et al.*, 2018). The study has concluded that updating efficiency is more central to the consecutive interpreting task than WMC, at least for beginning interpreters students, and is therefore more exercised in consecutive interpreting training, leading to an interpreter advantage in updating efficiency.

Methodology

Participants

A total of 20 students with an average age of 21 (M=21.86) from both genders, studying as juniors in translation studies in Higher Education Center of Kashmar took part in this

research. In order for the researchers to select the target group, an Oxford Placement Test was used to create a homogeneous group of participants who had recently started to receive training as consecutive interpreters.

Materials

The researchers used some unheard audio files which were compatible with participants' level of language proficiency. These files were to get translated into Persian consecutively both before and after the treatment.

Oxford Placement Test

To create a homogeneous group, the researchers used this test to select participants of the same level in language proficiency.

Interpretation scale

The researchers applied a rating scale both before and after the treatment period. The researchers closely observed the participant's behavior and interpretation quality based on the scale in order to evaluate interpreters' performance in consecutive interpretation. The rating scale (see appendix, table 1) applied in this study was the one proposed by Lee (2008). Accuracy, target language (TL) quality, and delivery are three subcategories of this scale as the criteria for rating interpreting performance. The first item "accuracy" is based on the principle of equivalent effect, i.e., there should be a substantially similar relationship between the produced target form and the original message and that which was present between the source reader and the message. The quality of the rendition in terms of linguistic 'correctness', naturalness, and contextual appropriateness of language are assessed by TL quality which considers the features of grammaticality, morphology, phonology, syntax, style, register, and naturalness. Delivery is the last category in this scale, the assessment of which has nothing to do with the source text or knowledge of the source language. The components of this category encapsulate skills such as good public speaking and presentation and effective communication. In this criterion, articulation, smooth delivery and good voice projection are assessed. Eye contact and posture are important public speaking skills.

To assess the participants' performance, an analytic scale was used in this rating scale, that is, six bands were assigned for accuracy and target language (TL) quality and three bands

for delivery, making 80% weight for the first two and a 20% weight for the last criterion. The bands range from mastery of skill (6) to the lowest level of quality (1), and band 0 was included for ‘test abandonment’. An aggregated score of all three categories – ranged from 0 to 15 – was reported by the raters for each participant (See Appendix).

Study procedure

A total of 40 volunteer students registered for the study. The target group was created using Oxford Placement Test, resulting in 20 participants. Then each participant was exposed to some audio files. Participants’ performance was closely recorded and rated. Then, in a period of five weeks in ten sessions, they received WM training. The training was mostly focused on core working memory training which included repetition, rehearsal, visualization, and concentration tasks. Having completed the training sessions, participants took part in another session during which their skills in consecutive interpreting were rated. Using a paired sample t-test, the results were analyzed, using SPSS (ver.18).

Results and discussion

Table 1 presents a summative rating of consecutive interpreting rating both before and after the treatment. As pointed out, with the use of the scale, the researchers managed to evaluate the participants’ performance both before and after the treatment. The numbers – ranged from 0 to 15 – represent an average of the ratings presented by both observers before and after the treatment.

Table 1. Results of a summative rating of consecutive interpreting before and after the treatment

	Participants	Before treatment	After treatment
1	A	7	9
2	B	10	13
3	C	9	12
4	D	13	15
5	E	6	8
6	F	13	15
7	G	11	13
8	H	9	11
9	I	10	12
10	J	12	13
11	K	11	12
12	L	7	10

13	M	10	11
14	N	11	12
15	O	12	13
16	P	13	13
17	Q	9	10
18	R	11	12
19	S	7	8
20	T	7	12

Source: Devised by the authors

Table 2 provides descriptive statistics on a summative rating of consecutive interpreting. Here, the mean score for before the treatment ($M = 9.90$, $SD = 2.22$) was significantly higher than that for after the treatment ($M = 11.70$, $SD = 1.94$). In order to find if this difference is significant, paired sample t-test was conducted. The results are provided in Table 3.

Table 2. Descriptive Statistics of summative rating of consecutive interpreting

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
BEFORE	20	6.00	13.00	9.90	2.22	4.93
AFTER	20	8.00	15.00	11.70	1.94	3.80

Source: Devised by the authors

Table 3. Paired Sample t-Test for summative rating of consecutive interpreting

	Mean	Std. Deviation	Paired Differences		t	df	Sig. (2-tailed)		
			Std. Error Mean	95% Confidence Interval of the Difference					
				Lower				Upper	
Pair 1	BEFORE - AFTER	-1.80	1.10	0.24	-2.31	-1.28	-	19	0.0028

Source: Devised by the authors

Table 3 (see appendix) indicates that there is a significant difference between participants' performance before and after the treatment, that is, their general performance

improved, having received treatment. In order to find detailed analysis of interpretation before and after the treatment, the subscales of *Accuracy* (range from 0 to 6), *Target Language (TL) quality* (range from 0 to 6) and *Delivery* (range from 0 to 3) were recorded, the results of which are provided in table 4.

Table 4. Results of detailed rating of consecutive interpreting in terms of *Accuracy*, *TL quality* and *Delivery* before and after the treatment

	Participants	Accuracy		TL quality		Delivery	
		Before*	After**	Before	After	Before	After
1	A	4	6	2	2	1	1
2	B	4	5	3	5	3	3
3	C	3	5	4	4	2	3
4	D	5	6	5	6	3	3
5	E	3	5	2	2	1	1
6	F	5	6	5	6	3	3
7	G	4	6	4	4	3	3
8	H	3	5	4	4	2	2
9	I	4	6	3	3	3	3
10	J	4	6	5	5	3	3
11	K	4	5	4	4	3	3
12	L	3	5	3	3	1	2
13	M	3	4	4	4	3	3
14	N	4	5	4	4	3	3
15	O	4	6	5	5	2	2
16	P	6	6	5	5	2	2
17	Q	3	4	3	3	3	3
18	R	4	5	4	4	3	3
19	S	2	3	3	3	2	2
20	T	2	5	3	4	2	2

Before*: Before the treatment

After**: After the treatment

Source: Devised by the authors

Table 5 provides descriptive statistics on the three subscales namely accuracy (Acc.), target language quality (TLQ), and delivery (Del).

The results in Table 5 show that there was a difference in the scores for accuracy before the treatment ($M= 3.70$, $SD=.97$) and after the treatment ($M=5.20$, $SD=.83$). As shown, it is inferred that the mean score after the treatment is much greater than that before the treatment for accuracy (Acc.) ($3.70 < 5.20$); the same result is true for target language quality (TLQ) but the difference is not noticeable in this regard ($3.75 < 4$), where the results for before and after the treatment are ($M= 3.75$, $SD=.96$) and ($M=4.00$, $SD= 1.12$), respectively. As with delivery

the least difference is found (.10) where the means for delivery before and after the treatment are 2.40 and 2.50, respectively.

In order to find if the differences are significant, paired-sample t-test was run. The results in Table 6 (see appendix) indicate that there was a significant difference between participants' performance before and after the treatment; $t(19) = 9.47, p = .00$. It can be implied that accuracy can be improved once participants receive treatments on WM expansion.

Table 5. Descriptive statistics on detailed scaling of interpretation in terms of Accuracy (Acc.), target language quality (TLQ), and delivery (Del) for before and after the treatment

	N	Min	Max	Mean	SD	Variance	Skewness	Kurtosis
Acc. Before	20	2.00	6.00	3.70	0.97	0.95	0.30	0.54
Acc. After	20	3.00	6.00	5.20	0.83	0.69	-1.01	1.08
TLQ Before	20	2.00	5.00	3.75	0.96	0.93	-0.21	-0.81
TLQ After	20	2.00	6.00	4.00	1.12	1.26	0.00	-0.27
Del. Before	20	1.00	3.00	2.40	0.75	0.56	-0.85	-0.60
Del After	20	1.00	3.00	2.50	0.68	0.47	-1.07	0.08

Source: Devised by the authors

Table 6. Paired Samples Test on accuracy (Acc.) before and after the treatment

	Paired Differences				t	df	Sig. (2-tailed)	
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower				Upper
Pair 1 Acc.Before - Acc.After	-1.50	0.68	0.15	-1.82	-1.17	-9.74	19	0.00

Source: Devised by the authors

In order to confirm whether working memory training can improve target language quality (TLQ), the following results are provided. As shown in Table 7(see appendix), there has been a mean difference before and after the treatment (.25), but the difference is not significant; $t(19) = -2.03, p = 0.56$.

Table 7. Paired Samples Test on Target language quality (TLQ) before and after the treatment

	Paired Differences					t	df	Sig. (2-tailed)	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower				Upper
Pair 1	TLQBefore - TLQAfter	-.25	.55	.12	-.50	.00	-2.03	19	.05

Source: Devised by the authors

Finally, paired-sample t-test was run to check whether participants performed differently with regard to language delivery (DEL), before and after the treatment. The results are shown in Table 8 (see appendix).

Table 8. Paired Samples Test on Delivery (Del) before and after the treatment

	Paired Differences					t	df	Sig. (2-tailed)	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower				Upper
Pair 1	DELBefore - DELAfter	-.10	.30	.06	-.24	.04	-1.4	19	.16

Source: Devised by the authors

As shown, no significant difference is seen for delivery before and after the treatment; $t(19) = 1.4, p = .16$). Therefore, it can be concluded that treatment had no effect on participants' performance regarding delivery, before and after the treatment.

Conclusion

To summarize findings, it is evident that the exercises practiced by participants were useful in the improvement of consecutive interpreting. Since all the exercises had been devised in order to improve WMC, one possible conclusion is that WM expansion practices can directly influence the quality of consecutive interpreting. As already mentioned, four central strategies were applied to intervene in the process of working memory functioning, namely repetition, rehearsal, visualization, and concentration tasks. The first two are related to phonological loop, and the last two tasks are concerned with attention skills.

Based on the findings of this study, it was found that WM intervention can influence the quality of consecutive interpretation in general. In order to exactly locate where these exercises could exert changes, the researchers exploited the rating scale proposed by Lee (2008) which is composed of three subcategories, accuracy, target language (TL) quality and delivery. The first item “accuracy” implies the extent to which the interpreted rendition is dynamically the same as the source speech. It appears that expansion of working memory capacity is related to the ability of verbatim rendering through which the interpreter is capable enough to hold and faithfully utter the intended target equivalent. Concerning the second subcategory, target language quality (TL) which represents linguistic features such as grammaticality, morphology, phonology, syntax, style, register, and naturalness, the results indicated trivial differences in interpretation before and after the treatment. Therefore, it can be concluded that WM expansion exercises can, to some extent, increase these linguistic features. If more intense and elaborate practices get implemented, a bit more disputable results could arise. This issue renders itself to further research. The last subcategory, delivery, which encompasses skills such as good public speaking and presentation and effective communication, shows no improvement, after the treatment. It goes without saying that speech delivery skills such as voice projection, eye contact and appropriate body posture has nothing to do with memory expansion. The raters considered items of significance in both working memory and consecutive interpreting. Their main focus was to find whether memory intervention had effects on their interpreting performance. One point which merits noting is that since the observations were based on personal views, the results could run the danger of misinterpretation, thus yielding fake or unreal scoring which would ultimately lead to misleading conclusions. To remove any possibility of such incorrect outcomes, it is suggested that rating could be practiced with the involvement of more observers. To the researchers view, the scarcity of experiments conducted in this field has brought about conditions not convergent to a unified conclusion. In fact, the relationship between WM intervention and interpreting performance is still ambiguous and controversial. There are a few studies which have yielded results which are in line with those of the current study, including a study conducted by Padilla Benitez (1995). The discrepancies seen in study results pinpoint the requirement of more studies in this field in order to get a more convincing conclusion.

REFERENCES

ATKINSON, R. C.; SHIFFRIN, R. M. Human memory: A proposed system and its control processes. **Psychology of learning and motivation** (Vol. 2, pp. 89-195): Elsevier. 1968.

- BADDELEY, A. D. Essentials of Human Memory Cognitive Psychology, 1368. 1999.
- BADDELEY, A. Working memory and language: An overview. **Journal of communication disorders**, 36(3), 189-208. 2003.
- BADDELEY, A. D.; HITCH, G. Working memory. **Psychology of learning and motivation** (Vol. 8, pp. 47-89): Elsevier. 1974.
- BADDELEY, A. D.; HITCH, G. J. Developments in the concept of working memory. **Neuropsychology**, 8(4), 485. 1994.
- CONNERS, F. A.; ROSENQUIST, C. J.; ARNETT, L.; MOORE, M.; HUME, L. E. Improving memory span in children with Down syndrome. **Journal of Intellectual Disability Research**, 52(3), 244-255. 2008.
- COWAN, N. Processing limits of selective attention and working memory: Potential implications for interpreting. **Interpreting**, 5(2), 117-146. 2000.
- COWAN, N. The magical number 4 in short-term memory: A reconsideration of mental storage capacity. **Behavioral and brain sciences**, 24(1), 87-114. 2001.
- DAHLSTROM, K.; GILLBERG, C.; FORSSBERG, H.; WESTERBERG, H. Computerized training of working memory in children with ADHD a randomized, controlled trial. **Journal of the American Academy of Child and Adolescent Psychiatry**, 44, 177186. 2005.
- DARÒ, V.; FABBRO, F. Verbal memory during simultaneous interpretation: Effects of phonological interference. *Applied linguistics*, 15(4), 365-381. 1994.
- DEHN, M. J. **Working memory and academic learning: Assessment and intervention**: John Wiley & Sons. 2011.
- DONG, Y.; LIU, Y.; CAI, R. How does consecutive interpreting training influence working memory: A longitudinal study of potential links between the two. **Frontiers in psychology**, 9, 875. 2018.
- GATHERCOLE, S. E.; BADDELEY, A. D. Phonological working memory: A critical building block for reading development and vocabulary acquisition? **European Journal of Psychology of Education**, 8(3), 259-272. 1993.
- HOLMES, J.; GATHERCOLE, S. E.; DUNNING, D. L. Adaptive training leads to sustained enhancement of poor working memory in children. **Developmental Science**, 12(4), F9-15. 2009.
- HULME, C. Language processing mechanisms and immediate memory: Possible implications for simultaneous interpreting. **Ascona II Workshop on Complex cognitive processes: simultaneous interpreting as a research paradigm**. 2000.
- JAMES, W.; BURKHARDT, F.; BOWERS, F.; SKRUPSKELIS, I. K. **The principles of psychology** (Vol. 1): Macmillan London. 1890.

KÖPKE, B.; NESPOULOUS, J.-L. Working memory performance in expert and novice interpreters. **Interpreting**, 8(1), 1-23. 2006.

LEE, J. Rating scales for interpreting performance assessment. **The interpreter and translator trainer**, 2(2), 165-184. 2008.

LUSTIG, C.; SHAH, P.; SEIDLER, R.; REUTER-LORENZ, P. A. Aging, training, and the brain: a review and future directions. **Neuropsychology review**, 19(4), 504-522. 2009.

MAHMOODZADEH, K. Consecutive interpreting: Its principles and techniques. **Teaching Translation and Interpreting** (pp. 231): John Benjamins. 1992.

MAKI, P. M.; MARTIN-THORMEYER, E. HIV, cognition and women. **Neuropsychology review**, 19(2), 204. 2009.

MEARA, P. **Psycholinguistics: A Resource Book for Students**: J. Field; Routledge, London, 2003, xviii+ 231 pages: Pergamon. 3004.

MILLER, G. A. The magical number seven, plus or minus two: Some limits on our capacity for processing information. **Psychological review**, 63(2), 81. 1956.

MINEAR, M.; SHAH, P. Sources of working memory deficits in children and possibilities for remediation. **Working memory and education** (pp. 273-307): Elsevier. 2006.

MORALES, J.; PADILLA, F.; GÓMEZ-ARIZA, C. J.; BAJO, M. T. Simultaneous interpretation selectively influences working memory and attentional networks. **Acta psychologica**, 155, 82-91. 2015.

MORRISON, A. B.; CHEIN, J. M. Does working memory training work? The promise and challenges of enhancing cognition by training working memory. **Psychonomic bulletin & review**, 18(1), 46-60. 2011.

OSAKA, M. Riidingu-supan no kenkyu 5: doujituyaku tesuto to wakingu memori (Study of reading span 5: Test of simultaneous interpreting and the working memory) **Nihonshinrigakkai dai-58-kai taikai ronbunhu** (Proceedings of the 58th conference of the Japan Psychological Society) (Vol. 710). 1994.

PADILLA, P. **Procesos de memoria y atención en la interpretación de lenguas**. PhD diss., inédita, Universidad de Granada. 1995.

PHELAN, M. The interpreter's resource: Multilingual Matters. 2001.

PRINS, P. J.; DOVIS, S.; PONSIOEN, A.; TEN BRINK, E.; VAN DER OORD, S. Does computerized working memory training with game elements enhance motivation and training efficacy in children with ADHD? **Cyberpsychology, behavior, and social networking**, 14(3), 115-122. 2011.

SIGNORELLI, T. M. **Working memory in simultaneous interpreters**: City University of New York. 2008.

SIGNORELLI, T. M.; HAARMANN, H. J.; OBLER, L. K. Working memory in simultaneous interpreters: Effects of task and age. **International Journal of Bilingualism**, 16(2), 198-212. 2012.

TIMAROVÁ, Š.; ČEŇKOVÁ, I.; MEYLAERTS, R.; HERTOOG, E.; SZMALEC, A.; DUYCK, W. Simultaneous interpreting and working memory capacity. **Psycholinguistic and cognitive inquiries into translation and interpreting**, 101-126. 2015.

TURLEY-AMES, K. J.; WHITFIELD, M. M. Strategy training and working memory task performance. *Journal of Memory and Language*, 49(4), 446-468. 2003.

How to reference this article

BAHRAMAN, M.; MOVAHED, R. Effect of core working memory training on consecutive interpreting. *Rev. EntreLínguas*, Araraquara, v. 7, n. esp. 4, e021067, Nov 2021. e-ISSN: 2447-3529. DOI: <https://doi.org/10.29051/el.v7iesp.4.15603>

Submitted: 09/02/2022

Required revisions: 20/05/2022

Approved: 05/09/2022

Published: 10/11/2022

Appendix A

CRITERIA (EXAMPLES)	BAND	EXTENT OF FAITHFUL DELIVERY OF MESSAGE	LISTENING ABILITY
<p>Accuracy:</p> <p>- the quality of faithfully conveying the message of the speech with semantic and pragmatic equivalence i.e., reproducing the same meaning and intended effect</p> <p>- Deviations from the ST should be considered in terms of the effect on the coherence/logic and faithful rendering of the message</p> <p>- Examples of deviations: omissions, additions, and unjustifiable changes of the meaning</p>	6	The message was delivered accurately with intended effect.	Complete understanding of the message of the original speech
	5	The message was generally delivered with intended effect but a few minor deviations from the source text were found, which did not significantly affect the overall meaning or coherence.	Good understanding of the message of the original speech
	4	The overall message was delivered but some deviations from the source text with an impact on the meaning and effect but coherence was maintained.	Adequate understanding of the message of the original speech
	3	The message was delivered inaccurately with many deviations from the source text and coherence was compromised.	Inadequate understanding of the message of the original speech
	2	The message was delivered inaccurately with serious deviations from the source text and incoherence.	Poor understanding of the message of the original speech
	1	The interpreted message was incoherent and completely inconsistent with the source text.	Very limited understanding of the message of the original speech
	0	Test abandoned/unfinished.	
	Mark	/6	
CRITERIA (EXAMPLES)	BAND	GRADUATION OF TARGET LANGUAGE PRODUCTION	TARGET LANGUAGE PROFICIENCY
<p>TL Quality:</p> <p>- the quality of rendering in TL needs to be linguistically correct and appropriate in the context</p> <p>Examples of deviations from language norms : incorrect pronunciation, accent, and stress; incorrect grammar; unidiomatic language; interference from the</p>	6	Excellent target language production with few linguistic errors and appropriate target language expressions.	Excellent language
	5	Very good target language production with a few minor linguistic errors that do not hinder immediate target language comprehension and generally appropriate target language expressions.	Very good language proficiency
	4	Good target language production with a few linguistic errors that may hinder immediate comprehension, but quite understandable. A few minor inappropriate target language expressions were found.	Good language proficiency
	3	Adequate target language production with some linguistic errors that hinder comprehension	Adequate language Proficiency

source language; inappropriate language in the target culture and for the target audience (register misuse)		and some inappropriate target language expressions.	
	2	Inadequate target language production with many linguistic errors and inappropriate target language expressions were consistently found.	Inadequate language proficiency
	1	Poor target language production with inappropriate target language expressions	Poor language proficiency
	0	Test abandoned/unfinished	
	Mark		/6
CRITERIA PUBLIC	BAND	(EXAMPLES) EXTENT OF DELIVERY	SPEAKING ABILITY
Delivery: - quality of good public speaking - successful communication Examples of deviations: inarticulate speech, pauses, hesitation, false starts, fillers, irritating noise, repetition, excessive repairs or self - correction, unconvincing voice quality and monotonous intonation, & irritatingly slow speech rate	3	Excellent delivery with few deviations	Excellent presentation/communication
	2	Good delivery with a few deviations	Good presentation/communication
	1	Poor delivery with some deviations	Poor presentation/communication
	0	Test abandoned/unfinished	
	Mark		/3
Total mark			/15