Working Memory Capacity and the Implementation of New Information During Task Repetition

Capacidade de memória de trabalho e implementação de informações novas durante a repetição de tarefa

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Abstract: According to Bygate and Samuda (2005), task repetition can help students to integrate what they know with what they do, since it allows two different experiences of the same requirements of a task. Thus, such differences can result in changes from one speech production to another. Therefore, the objective of this study is to investigate which individuals, whether those with higher or lower working memory capacity, implement more new information during task repetition. A sample of 28 students from a public university underwent data collection which consisted of a working memory test (Speaking Span Test), a translation task, repeated twice, and two questionnaires.

In general, the results showed that higher working memory capacity individuals were those who most implemented new information during task repetition, in terms of the implementation of new lexical items. The results are discussed in the light of the literature in the fields of working memory and task repetition. Final considerations are made suggesting that task repetition, in addition to bringing gains to oral production in terms of fluency and accuracy, for example, makes participants in the higher working memory capacity group able to allocate more cognitive and attentional resources to implement a greater number of new lexical items in second task performances.

Keywords: Task Repetition; Working Memory; New Information Implemented.

Resumo: De acordo com Bygate e Samuda (2005), a repetição de tarefa pode ajudar os alunos a fazer a integração do que sabem ao que fazem, visto que permite duas experiências diferentes das mesmas exigências de uma tarefa. Desta forma, tais diferenças podem resultar em mudanças de um desempenho oral para outro. Portanto, o objetivo deste estudo é investigar que indivíduos, se aqueles com maior ou menor capacidade de memória de trabalho, implementam mais informações novas durante a repetição de tarefas. Uma amostra de 28 alunos de uma universidade pública foi submetida à coleta de dados que consistiu de um teste de memória de trabalho (*Speaking Span Test*), uma tarefa de tradução, repetida por duas vezes, e dois questionários. Em geral, os resultados mostraram que os indivíduos do grupo de maior capacidade de memória de trabalho foram aqueles que mais implementaram informações novas durante a repetição da tarefa, em se tratando da implementação de itens lexicais novos. Os resultados são discutidos à luz da literatura nas áreas de memória de trabalho e repetição de tarefas. Considerações finais são feitas sugerindo que a repetição de tarefas, além de trazer ganhos para a produção oral em termos de fluência e acurácia, por exemplo, faz com que participantes do grupo de maior capacidade de memória de trabalho possam alocar mais recursos cognitivos e atencionais para implementar um número maior de itens lexicais novos em segundos desempenhos da tarefa.

Palavras-chave: Repetição de Tarefa; Memória de Trabalho; Informações Novas Implementadas.

1 Introduction

Task-Based Language Teaching (TBLT) has been seen by several authors as an effective approach to language teaching and learning (BYGATE; SKEHAN; SWAIN, 2001; ELLIS, 2003). According to this

approach, the use of tasks is proposed as the main component of second language classes. Unlike other approaches according to which the focus is on the product, and the content stands out for being the target of learning, TBLT has the process as a priority. Thus, there is no prior specification of the content, but tasks that aim to engage students in the process of exchanging and constructing knowledge. Based on this assumption, the use of an intersemiotic translation task can contribute to this process, since it involves a language use process that resembles the real world, one of the defining traits of a pedagogical task. Texts made of images are perceived by our senses every day and are often translated by us into verbal texts. For example, when we see the image of a traffic accident and then report verbally to our friends the image we visualize.

Within the study of tasks, planning emerges as a construct that has also started to attract considerable attention, as a form of preparation for the performance of these tasks. Thus, one of the ways to carry out effective planning would be through task repetition, where the first encounter with a task is seen as a form of planning for a second encounter with the same task. It is important to highlight that we are not talking about mere repetition here, since when repeating a task, according to view we side with, participants choose their own language to express their meanings, and that language can vary, tasks are not scripted. According to Bygate (2018, p. 13), "what is repeated is a certain configuration of purposes and a set of content information". That is, there may be the implementation of new ideas during repetition.

Another point is that, one of the crucial questions about the teaching and learning process is to enable students to integrate their previous knowledge during their active use of language, that is, during performance. According to Bygate and Samuda (2005), task repetition can help students in that sense, by allowing them to integrate what they know with what they do. Such integration would be due to the fact that the repetition of a task allows two different experiences with the same requirements of a task. Such experiences would result in two different stages of knowledge, which can generate changes from one speech production to another.

In addition, since the benefits of task repetition may depend on the ability to retrieve what was planned during the first encounter with a task, this implies that individual differences in working memory capacity may play a role. Working memory is understood in this study as "the

capacity for controlled sustained attention in the face of interference" (ENGLE; KANE; TUHOLSKI, 1999, p. 104).

According to Baddeley (1992) there are two different approaches in which research on working memory has developed: the dual-task neuropsychological approach and the psychometric-correlational approach. The first approach consists of applying two tasks (for example, memorizing a list of numbers while processing certain information) and concerns observing and explaining the working memory structure, more specifically the three-component working memory model proposed by Baddeley and Hitch (1974 *apud* BADDELEY, 1990). On the other hand, the psychometric approach concerns the investigation of the relationship between working memory capacity and performance in complex cognitive tasks, such as L2 oral production, therefore, this approach was chosen by this study.

According to the psychometric approach, individuals with a higher working memory capacity would be more apt to perform certain tasks, which has been demonstrated in several studies (ENGLE; KANE; TUHOLSKI, 1999; JUST; CARPENTER, 1992). One hypothesis that can be generated from this assumption is that such individuals have a greater capacity for controlled attention, and consequently, they have a greater capacity for retrieving information from planning or from a first encounter with a task. However, previous studies (GUARÁ-TAVARES; CARVALHO, 2018; PAULA, 2020) have failed to confirm this hypothesis. That is, the number of information retrieved was statistically the same for both higher and lower span groups. The explanation for these results was that higher working memory capacity participants probably retrieved more information, but this was not confirmed because such individuals decided not to use all the information retrieved. Instead, they decided to implement new ideas during repetition.

Therefore, this study aims to further investigate how higher and lower working memory capacity individuals deal with the implementation of new information during task repetition.

2 Method

This study was motivated by one research question: Who implements more new information during task repetition, lower or higher working memory capacity individuals? In order to answer this question, an experimental and quantitative study was designed. In addition, in an

attempt to analyze the students' perception of the impact of task repetition on their performance, a qualitative analysis was also carried out through questionnaires applied at the end of each task.

2.1 Context and participants

Participants of the present study were twenty-eight intermediate English learners from a federal university in the northeast of Brazil. The cohort consisted of 14 male and 14 female participants, with ages ranging between 20 and 35 years old, thus an adult population. Most of the participants were undergraduate students at university from a variety of backgrounds (Biology, Engineering, Law, and History, among others).

2.2 Instruments

2.2.1 Speaking Span Test

The Speaking Span Test (SST) is a memory test, which was used in this study to measure the participants' working memory capacity. The test has been previously applied in other important studies that investigated the relationship between working memory capacity and oral production in L1 (DANEMAN, 1991), and in L2 (FORTKAMP, 1999, 2000). The rationale is that the working memory construct "reflects the ability of individuals to process and store information simultaneously, while performing a complex cognitive task, such as speaking. Therefore, the greater the working memory capacity, the better the performance in the speech extension task" (PREBIANCA, 2009, p. 67).

The SST was adapted to Portuguese in this study. It was first adapted to Brazilian Portuguese by Fortkamp (1999) and then by Prebianca (2009), whose adaptation is closer to the original test by Daneman and Green (1986) and Daneman (1991). Thus, this study follows the adaptation by Prebianca (2009) and assumes that the data obtained through the L1 version of the test more accurately reflects the thoughts of the participants, without the extra load of the L2 being inflicted in the memory system. This methodological decision is in agreement with Mitchell, Jarvis, O'Malley and Konstantinova (2015, p. 278), according to who: "tasks that limit the

influence of L2 knowledge will provide a more accurate measure of the individual cognitive processes that make up the WMC".

The SST version applied in this study consists of a total of 60 words in Portuguese organized in three sets. Each set, in turn, consists of sequences of 2, 3, 4, 5 and finally, 6 words. Each word in a sequence will appear on a computer screen for 1 second and, after 10 milliseconds, the next word will appear. This procedure is carried out until the sequence ends and then there are question marks that signal the number of words to be recalled from each sequence and, consequently, the number of phrases that must be produced with each word. In this way, participants are required to produce a sentence for each word. Such sentences must be syntactically and semantically acceptable, produced aloud, in the same form and exact order of presentation, without restrictions on the length or complexity of the sentences produced. After the end of each set, the participant presses a key on the computer keyboard so that the next set is presented.

The 60-word test phase was preceded by a mandatory 40-word training phase, so that the participants could become familiar with the test. All 100 words were nouns in Portuguese composed of seven letters. The words were presented through the PsychoPy software (PEIRCE, 2007, 2009) and were randomized within the sets, in order to reduce the effect of any undetected semantic or phonological relationships between them, since only the researcher checked the final list of items. The participants' responses were recorded, transcribed and analyzed.

The measures of working memory capacity were analyzed according to the maximum number of words (out of a total of 60) for which the participant was able to generate a sentence. In this way, a score was assigned to each sentence correctly formulated, according to the scoring criteria: correct = 1, incorrect = 0. The total score was calculated by adding up all scores, up to 60. The speech interval of one participant was the total number of sentences correctly produced. The sentences that did not follow the stipulated criteria (such sentences should be syntactically and semantically acceptable, produced aloud, in the same form and in the exact order of presentation) were not scored, thus, a lenient score was not calculated (DANEMAN; GREEN, 1986, DANEMAN, 1991, WEISSHEIMER; MOTA, 2011).

For example, if in a sequence of three words such as ACT, JUSTICE and NOTEBOOK[1], the participant formulated the sentences: "We must take some actions regarding racism", "I bought a new notebook" and "Justice takes time but it doesn't fail", no score will be credited. First, because in the first sentence the word ACTION does not obey the presented form (ACT), as well as the other sentences did not obey the exact sequence of presentation. Thus, only a strict score was used, as we believe that it probably brings out more accurate differences in the WMC. A lenient score, on the other hand, can generate a moderately higher score, as it allows minor deviations from the criteria to be partially scored (Autor, 2011), which could cause a false high score and, as a result, a ceiling effect, not allowing individual differences between participants to emerge.

2.2.2 Intersemiotic translation task

In order to compare students' speech performance in the first and second encounter with a task, an intersemiotic translation task was applied twice, one immediately after the other. The literature shows consistent effects of immediate task repetition on complexity, accuracy and fluency of students' speech (LAMBERT *et al.*, 2017, LYNCH; MACLEAN, 2000, WANG, 2014).

The task consists of a sequence of pictures that were analyzed by each participant for 50 seconds. Then, the participant was instructed to press the "record" button on the recorder and start telling a story based on the photos analyzed. That is, they had to read the images and translate them into an oral story, understanding the meaning in one way and translating it into another, which consists of an intersemiotic translation (JAKOBSON, 2007).

Soon after completing the first task, students were instructed to repeat the task under the same conditions. There was no time limit for completing the two tasks, and students were not informed in advance that the second task was the same as the first. In addition, the pictures were available for observation during the task. Such pictures show a couple in a restaurant.

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[1] Translated from the original words in Portuguese, which are: "atitude", "justiça" and "caderno".

It is important to note that the task used in the present study has been previously tested in other studies (WEISSHEIMER; MOTA, 2011) and it has been proved appropriate to be performed by intermediate level students, which is the participants' level of proficiency in this study.

2.2.3 Questionnaires

Two questionnaires were applied, one after each translation task, in order to analyze the participants' take on the task repetition experience. The objective was to have a general idea of how the students perceived the task and its repetition, as well as to relate such perceptions to different working memory spans.

2.3 Data collection procedures

The data collection of the present study was divided in three phases, as displayed in Table 1.

Table 1 – Data collection procedures

PHASE	SETTING
"Speaking Span Test" (SST).	Individually with the researcher / room
First performance of the intersemiotic translation task with the application of a questionnaire at the end of it.	Individually with the researcher / room
Second performance of the intersemiotic translation task (repetition) with the application of a questionnaire at the end of it.	Individually with the researcher / room

Source: Elaborated by the authors.

The first phase was the application of the Speaking Span Test to assess participants' working memory capacity. This phase was preceded by training with a shorter version of the test. The second phase of data collection took place on a different day and consisted of the first application of the intersemiotic translation task. During the performance of the activity, the researcher remained at the back of the room to provide privacy to participants. At the end, the students answered a questionnaire about their impressions on the task performed. The third phase of data collection took place on the same day, soon after the first performance of the task, and consisted of the repetition of the task. This second encounter

with the task took place under the same conditions as the first encounter. At the end, participants answered a second questionnaire about the second task performance.

In the next section, we describe how the groups with lower and higher memory spans were divided, since data analysis is intrinsically linked to the categorization of working memory scores.

2.4 Categorization of working memory scores

In this research, tertile splits were used, instead of quartile splits. That is, a division was made using a median. Following this division, those participants who obtained scores lower than the median were categorized as having lower memory spans, and those who obtained scores above the median were categorized as having higher memory spans. Thus, only those participants who reached the median were discarded. This type of division into tertile splits has been commonly applied in the literature, especially when the sample size is not numerous enough to allow division into quartile splits (WHITNEY; ARNETT; DRIVER; BUDD, 2001), which is our case.

Therefore, in the present study, the median score obtained was 32. Participants who scored above 32 were included in the higher span group, and those who scored below 32 were included in the lower span group. Thus, only 2 participants were excluded from the sample, since they had scored exactly 32, which resulted in the following number of participants in our research: 14 in the lower span group and 14 in the higher span group.

Finally, we describe how the data were analyzed in this study.

2.5 Data analysis

In order to answer our research question, participants' performances in the two translation tasks were compared in order to identify the new information in the repetition task, which was not present in the first encounter with the task. For this, two categories of information were included: (a) percentage of new lexical items (content words: nouns, verbs, adjectives and adverbs), dividing the number of new lexical items present in the repetition task by the total words in the same task and multiplying that result by 100, and (b) percentage of new clauses, dividing the number of new clauses present in the repetition task by the total number of clauses in this task, and multiplying the result by 100.

With these measures calculated, a comparison was made between the averages of new information implemented by each of the groups. In order to verify if the differences between the groups for each measure (new lexical items and new clauses implemented) reached statistical significance, a T-test was applied to compare the percentage of new lexical items, and a Wilcoxon test was applied to compare the percentage of new clauses; since, for this latter variable, the assumption of normality for the application of T-tests had been rejected.

3 Results and discussion

To reiterate, this research sought to answer the following research question: Who implements more new information during task repetition, lower or higher working memory capacity individuals? To answer this question, Table 2 shows the p-values for the tests of comparison between the number of new information implemented by lower and higher span groups. It is important to note that the null hypothesis means that the number of new information implemented by each group is statistically the same. For p-values lower than 0,05, it is stated that there is a significant difference in the number of new information implemented by each group. Therefore, by the p-values found in Table 2, it can be stated that (1) During repetition, participants that belong to the higher working memory capacity group had, on average, significantly higher scores of new lexical items compared to participants in the lower working memory capacity group; that is, the null hypothesis was rejected and (2) There is not enough evidence to suggest that between the groups there is a difference in magnitude of new clauses implemented. That is, the percentage of new clauses implemented in the repetition task was statistically the same for both groups.

Table 2 – P-values for performance comparison tests between lower and higher working memory capacity groups and new information scores

	T-test	Wilcoxon-Mann-Whitney test
Percentage of new lexical items implemented during repetition	0,0191	-
Percentage of new clauses implemented during repetition	-	0,1605

Source: Elaborated by the authors.

These results, which attribute to the higher working memory capacity group the greatest number of new information implemented (lexical items), is also reinforced by the results of the qualitative data analysis. When asked about the amount of information reused from the first encounter with the task during the repetition task, the vast majority of participants reported having used enough information from the first encounter with the task, and the lower working memory participants were the ones who most reported having made this reuse of ideas. As for the number of new information implemented during the repetition, the higher working memory group was the one that most reported having performed such a procedure. This result can be seen in more detail in Graphic 1 below.

Before setting out on an attempt to explain these results, it is important to highlight that the present study followed the thread of two other studies (GUARÁ-TAVARES; CARVALHO, 2018; PAULA, 2020). Guará-Tavares & Carvalho (2018) investigated whether participants in the higher Working Memory capacity group retrieved more information from pre-task planning and implemented such information in their performance. On the other hand, Paula (2020) investigated which individuals, whether those with lower or higher working memory capacity, retrieved more information from a first encounter with the task and implemented such information when repeating it.

In both studies, the result was that the number of information retrieved by both groups was statistically the same, both for lexical items retrieved and for clauses retrieved. The explanation for this result was also the same: the higher Working Memory capacity group was better able to retrieve more information from the first encounter with the task, but its participants decided not to use everything because they had a greater amount of new ideas to implement, and had the objective of combining the retrieved ideas from the first encounter with the new ideas effectively. Possibly, this attitude made the percentage of retrieved information to be statistically equal for both groups.

Therefore, it seemed to be a logical next step to investigate whether, statistically, the number of new information implemented by participants with higher working memory capacity was actually greater than the number obtained by the lower working memory capacity group.

Given that the higher working memory capacity group in our study implemented more new information (new lexical items) than the lower working memory capacity group, let us now turn to the attempt

to explain such a finding. If the higher working memory capacity group is the one with the greatest capacity to retrieve information, why didn't they implement such information completely when repeating the task? Instead, they implemented a great amount of new information.

Graphic 1 - Amount of retrieved information and new information implemented by the working memory capacity groups
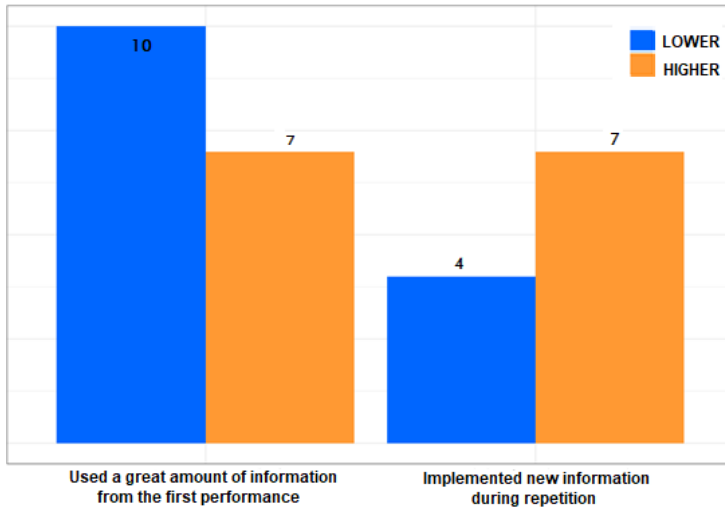
Source: Elaborated by the authors.

In order to illustrate our analysis, in Chart 1 we can see below an example of a task transcribed by a participant from each group (lower and higher working memory capacity), where the highlighted words represent the new lexical items implemented during task repetition. We can notice that the percentage of new lexical items implemented by the participant in the higher working memory capacity group (21.49%) is higher than the percentage obtained by the participant in the lower working memory capacity group (6.8%).

Chart 1 – Transcribed tasks

PARTICIPANT 12- LOWER WORKING MEMORY CAPACITY GROUP

Last night, a couple went out to dinner. / Her name was Betty / and his name was Paul. / They went out to dinner in a big restaurant in town / and they asked for a meal and a bottle of wine. / While they were having the meal, / Paul was thinking /about making bad things with Betty / because of the alcohol effect/ even broke even broke a glass on her head. / But Paul would never do something to Betty/because he loved her. / In the end, Paul decided to throw a piece of his food on Betty/ and she shouted at him./ And the bad thought of Paul stayed just on his head.

REPETITION

Last night, an old couple Last night an old couple went town to dinner in a big restaurant in town. / Her name was Betty / and his name was Paul. / They asked for two meals, one for Betty and one for Paul. / While they were eating, / because of the alcohol effect, / Paul was having bad thoughts /about doing bad things to Betty. / Things like broke a glass on his head/ or kick her. / But in the end, Paul, that would never do something to Betty / because he loved her, / decided to throw a piece of his food on Betty. / And she shouted at him. / And they ended up happy / as they were / when they arrived at the restaurant.

PARTICIPANT 3 – HIGHER WORKING MEMORY CAPACITY GROUP

A couple was was having dinner in their twenty-year anniversary/ and all the husband could think about was /how he could kill his wife. / I guess they didn't get along anymore/ because the woman was always correcting his actions /and he was a playful person. / She was a serious person. /He imagined stepping on her face, / biting her nose /and hitting her with chandelier. /But all he did was/to throw a pea on her face./ And again, she complained about him. /And they continued to eat their to eat their dinner/ as they they always done / since they got married.

REPETITION

An old couple was having their first date/and the woman didn't seem to be interested in /talking to the man./ So, he was bored./ And all he could think about was/ how he could get rid of her./ And he thought of many possibilities/like stepping on her face, /hitting her with the chandelier /and biting her nose. / So, all he do was/ to throw a little piece of his food on her face. /And she didn't seem to mind./All she did was/ she just complained /and they kept eating their dinner /and they seem to be satisfied./ And they didn't talk to each other.

Source: Elaborated by the authors.

Based on the assumption that the experience and language from the first encounter with the task may serve as a type of planning that can be retrieved and implemented in the second encounter with the same task (BYGATE, 2018), it is indeed expected that the result will be a more sophisticated speech sample not only in grammar terms, but especially in terms of lexical variety, since the student was allowed to integrate a wider range of resources in his or her performance. In the first encounter with the task, there are many things to be decided: what message to create, what kind of language to be used, etc. In the second encounter with the task, with these decisions having already been made, the student will probably find himself or herself under less pressure.

The higher working memory capacity group was the one that most benefited from the task repetition condition, being the memory group with the greatest capacity for retrieving information, since participants seemed to have had more attentional resources. As they already had a much larger range of lexical items and structures already selected in memory, resulting from the retrieval of information from the first performance, this group was also the one that felt most comfortable and confident to take risks. In other words, they were already so self-confident with the range of information they had selected that they decided to improvise, implement new ideas for their second performances, generating more lexically diverse speech.

4 Final considerations

In this study we sought to answer the research question: Who implements more new information during task repetition, lower or higher working memory capacity individuals? What we could observe by the results was that participants that belong to the higher working memory capacity group had, on average, significantly higher percentages of new lexical items compared to participants in the lower working memory capacity group. Such result led us to try to explain why higher working memory capacity participants implement more new information during task repetition if they are also the group that are most apt to retrieve information from the first encounter with a task, since they have more attentional resources.

We all know that the emotional issue is crucial for language students when it comes to improvising oral discourse (BROWN, 2001). Anxious students with low self-esteem are unlikely to feel confident enough to improvise and consequently have a successful speech performance. Therefore, what was observed through the results is that task repetition, in addition to other benefits for both groups, also brought self-confidence to the participants in the higher working memory capacity group. Having a great amount of established vocabulary and structures retrieved from the first performance made participants in the higher working memory group to be more confident to take risks and implement new ideas. In this way, the construct opened doors and encouraged the participants of this group to believe in their skills to a greater extent and to use a new and more creative lexical repertoire.

The results should be seen as modest and suggestive, rather than conclusive, due to limitations related to the sample size. The study was conducted with only twenty-eight participants. Due to this small sample size, the division into extreme groups was performed based on tertile splits, instead of quartile splits, which may have impaired the categorization of groups into higher and lower working memory capacity, making the differences between the scores not so marked. Thus, as a suggestion for future studies, a sample with a larger number of participants would be interesting. The study is important insofar as it treats task repetition as an important pedagogical tool to promote benefits in the speech performance of language students.

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