UNIVERSIDADE FEDERAL DE SANTA CATARINA
CAMPUS TRINDADE
CENTRO DE COMUNICAÇÃO E EXPRESSÃO
PROGRAMA DE PÓS-GRADUAÇÃO EM INGLÊS

BRUNO DE AZEVEDO

# DOES WORKING MEMORY CAPACITY PREDICT MULTITASKING PERFORMANCE? AN INVESTIGATION OF LITERAL AND INFERENTIAL COMPREHENSION IN BILINGUALS' HYPERTEXT READING WHILE LISTENING TO MUSIC

FLORIANÓPOLIS - SC
2022

Bruno de Azevedo

# **Does working memory capacity predict multitasking performance?** an investigation of literal and inferential comprehension in bilinguals' hypertext reading while listening to music

Tese submetida ao Programa de Pós-graduação em Inglês: Estudos Linguísticos e Literários da Universidade Federal de Santa Catarina para a obtenção do título de Doutor em Inglês: Estudos Linguísticos e Literários

Orientadora: Profa. Dra. Lêda Maria Braga Tomitch
Coorientadora: Profa. Dra. Ingrid Finger

Florianópolis - SC
2022

Ficha de identificação da obra elaborada pelo autor,
através do Programa de Geração Automática da Biblioteca Universitária da UFSC.

Azevedo, Bruno de
Does working memory capacity predict multitasking performance? : an investigation of literal and inferential comprehension in bilinguals' hypertext reading while listening to music / Bruno de Azevedo ; orientadora, Lêda Maria Braga Tomitch, coorientador, Ingrid Finger, 2022.
223 p.

Tese (doutorado) - Universidade Federal de Santa Catarina, Centro de Comunicação e Expressão, Programa de Pós Graduação em Inglês: Estudos Linguísticos e Literários, Florianópolis, 2022.

Inclui referências.

1. Inglês: Estudos Linguísticos e Literários. 2. Memória de Trabalho. 3. Multitarefas. 4. Leitura. 5. Distração Auditiva. I. Tomitch, Lêda Maria Braga. II. Finger, Ingrid. III. Universidade Federal de Santa Catarina. Programa de Pós-Graduação em Inglês: Estudos Linguísticos e Literários. IV. Título.

Bruno de Azevedo

**Does working memory capacity predict multitasking performance?** an investigation of literal and inferential comprehension in bilinguals' hypertext reading while listening to music

O presente trabalho em nível de doutorado foi avaliado e aprovado por banca examinadora composta pelos seguintes membros:

Profa. Lêda Maria Braga Tomitch, Dra.
Universidade Federal de Santa Catarina

Profa. Ingrid Finger, Dra.
Universidade Federal do Rio Grande do Sul

Profa. Claudia Finger-Kratochvil, Dra.
Universidade Federal da Fronteira Sul

Profa. Donesca Cristina Puntel Xhafaj, Dra.
Universidade Federal de Santa Catarina

Profa. Rosane Silveira, Dra.
Universidade Federal de Santa Catarina

Certificamos que esta é a **versão original e final** do trabalho de conclusão que foi julgado adequado para obtenção do título de Doutor em Inglês: Estudos Linguísticos e Literários, na área de concentração Estudos da Linguagem.

Documento assinado digitalmente
Rosane Silveira
Data: 22/08/2022 18:04:42-0300
CPF: 715.936.839-87
Verifique as assinaturas em https://v.ufsc.br

Rosane Silveira, Dra. – Coordenação do Programa de Pós-Graduação

Documento assinado digitalmente
Leda Maria Braga Tomitch
Data: 22/08/2022 16:18:04-0300
CPF: 166.478.231-15
Verifique as assinaturas em https://v.ufsc.br

Profa. Lêda Maria Braga Tomitch, Dra. – Orientadora

Florianópolis, 2022.

*To all Brazilian researchers who have struggled and strived at hard times…*

## ACKNOWLEDGMENTS

“Scientists reel as Brazilian government backtracks on research funds” (RODRIGUES, 2021).

It is well known that the scientific community has struggled with the current government cutting funds for science. Despite *his* “anti-science maneuvers”, as described by Rodrigues (2021) in her article on Nature, researchers around Brazil have resisted and made ends meet to carry out their pieces of research. Thus, I would like to start my acknowledgment section by thanking our National Council for Scientific and Technological Development *(Conselho Nacional de Desenvolvimento Científico e Tecnológico – CNPq)* for the two-year scholarship which allowed full dedication to my study. I must also say thanks to *Instituto Federal de Santa Catarina* (IFSC) for granting me a fourteen-month work leave so I could devote all my attention to this work.

This piece of research has been carried out by so many hands that I shall express my gratitude for the so many friends and researchers who have helped along the way. But first, I must thank myself for being brave enough to embark on this long journey filled with challenges. One, in particular, the pandemic of COVID-19 which challenge me to adapt this whole study to respect social distancing.

Second, I would like to thank my advisor, Professor Lêda Tomitch, for her tireless job as a mentor. Ever since we met at *Unochapecó* at *Especialização de Ensino da Língua Inglesa,* she has taught me so much! First, she taught me how to write academically, then, she taught me how to carry out research. Besides being this excellent tutor, she has been understanding and was able to respect the time I needed to get back on track after being hit by the turmoil that 2020 placed on me and everybody else. Thanks for your confidence and your patience.

Third, I would like to thank this amazing Professor who joined our research team and has collaborated so much! Professor Ingrid Finger, the moment I heard your talk at UFSC on Bilingualism and Cognition I knew I had a lot to learn from you! Thanks for accepting being an examinator for my qualifying exam which then resulted in this partnership in which you became my co-advisor. Your passion, knowledge, and enthusiasm are inspiring!

My very special thanks to Davi Oliveira, who was the light at the end of the tunnel. When the pandemic burst and I was looking for ways to carry out my experiment

remotely, after piloting several online platforms which were either expensive or not functional at all, Davi came up with his project called LAPSI – *Laboratório de Psicolinguística* – which he designed to help researchers have free access to a tool to design their experiments. This study, therefore, has been the first one to be conducted at LAPSI and it was a complete success! Thanks to Davi's work, and his infinite patience whilst setting up the experiment, the data collection took place without endangering anybody. In addition to that, Davi also collaborated with the statistics of this work by running the statistical tests after I had assembled and transformed all data.

I would also like to thank Professor Donesca C. Puntel Xhafaj, who I also met at *Unochapecó* and who has been helping me ever since. Her contribution to this work has been unique and started at the beginning of this piece of research when she attended my presentation for the Open Seminar at UFSC. Then, she was part of the committee for my qualifying exam, she helped me recruit participants (her students), and now as a member of my defense committee. Thanks for all your help and kindness along the way, and your careful reading and contribution to my work!

I must also thank Professor Claudia Finger-Kratochvil for kindly accepting my invitation to be part of my defense committee. I don't remember the year, but I do remember I took some of her classes as a special student in the Linguistics Graduate Program at *UFFS* in *Chapecó*. I also remember that during my MA, she dearly sent me a physical copy of a book she had a chapter in it (that chapter was fundamental for my MA thesis). Thanks for being part of my trajectory and being an inspiration for me!

I would like to express my sincere gratitude to Professor Rosane Silveira, who has also contributed a lot to the researcher I am today. I took three courses with her ever since I joined UFSC: *Teoria e Descrição Linguística* and *Produção e Percepção da Fala em L2* during my MA and Statistics during my PhD. Even though I struggled during these last two, they helped me a lot as a teacher and a researcher. Thanks for accepting my invitation for reading this work and contributing with your deep knowledge. Your professionalism, kindness, and deep knowledge are true examples for me!

I would also like to thank Professor Leonilda Procailo for accepting to be a member of the defense committee. I must also acknowledge that your PhD work has been very useful and I proudly cite the beautiful and careful piece of research you conducted.

A special thanks to my colleagues who contributed by being raters in this study: Claudia, Davi, Dionatan, Gabriela, Iara, Juliana, Leonilda, and Sidnei. Your work has definitely increased the reliability of this piece of research! Also, thanks to those colleagues who took the pre-pilot study: Daniel, Dionatan, Juliana, and Lêda.

To my dearest friend and colleague, who has been an anchor and complaint buddy throughout these four years! Jane, thanks a million for being there for me, for sharing complaints and stickers with me. It was very reassuring to know that I was not alone in this sinking boat (just kidding!). Plus, thanks for helping me with one of the instruments of this piece of research. Your knowledge of English as a Lingua Franca was fundamental for the text used in my experiments.

To my friend and colleague from IFSC, Marina, who helped me understand first-degree equations so that I could understand linear regression models so I could finally make sense of my data.

I must say thanks to the participants of this study. Without your participation, this piece of research would not have happened. Thanks for having dedicated your time to carry out this experiment.

Last, but definitely not least, I am deeply grateful to my family, who has always supported my academic adventures and understood my absence. A special thanks to my mother Vânia and my sister Vanessa, who were the emotional support I needed towards the end of this process. I love you unconditionally.

## ABSTRACT

Multitasking is a ubiquitous habit that has dramatically increased in the last few years. Researchers agree on the detrimental effects of multitasking on study tasks such as reading (CLINTON-LISELL, 2021; MAY; ELDER, 2018). However, they are far from reaching a consensus regarding the effects of one specific type of multitasking: listening to music while reading (VASILEV; KIRKBY; ANGELE, 2018). The core of reading comprehension is the construction of a coherent mental representation of the text read (VAN DEN BROEK; KENDEOU, 2022), which demands that several component processes are orchestrated in a coordinated manner by the limited-capacity system known as working memory (JUST; CARPENTER, 1992). In addition to individual variation in the ability to process and maintain the outcomes of comprehension (DANEMAN; CARPENTER, 1980), working memory is differently deployed depending on the comprehension level, in which literal comprehension demands fewer resources than inferential comprehension (ALPTEKIN; ERÇETIN, 2011). In addition to that, reading onscreen might also add extra demand from readers' working memory, given its multilayered environment (DESTEFANO; LEFEVRE, 2007). Taken that, mental representations in reading might be compromised in a multitasking setting, especially considering the joint execution of two language-related tasks such as reading and listening to music with lyrics. With that in mind, this study aimed at investigating whether working memory capacity (WMC) predicts multitasking performance. More specifically, we investigated whether working memory capacity and Condition predict (1) literal comprehension; (2) inferential comprehension of a hypertext; and (3) the recall of hypertext information. Sixty-five proficient bilinguals from several regions of Brazil participated in this experimental study carried out remotely using a platform called *Lapsi* (*Laboratório de Psicolinguística).* Participants self-reported their proficiency and provided background information regarding their experience with English through an adaptation of the *Language Experience and Proficiency Questionnaire* (SCHOLL; FINGER, 2013)*,* and performed a Self-Applicable version of the Reading Span Test (OLIVEIRA; WOELFER; TOMITCH, 2021). Participants were randomly assigned to one of the two conditions – control participants read a hypertext while listening to non-lyrical music (binaural beats) while experimental participants read a hypertext while listening to lyrical music (pop songs). Reading comprehension was assessed using a written free recall (RONDON; TOMITCH, 2020) and comprehension questions which tapped literal and inferential comprehension (PEARSON; JOHNSON, 1978). A retrospective questionnaire provided additional information on participants' performance on the experimental tasks, their multitasking profile and background experience with music. Multiple linear regression analyses showed that working memory capacity significantly predicted inferential, but not literal comprehension and statistically significant interactions showed that this effect was only observed in the experimental condition. Additionally, participants with higher WMC outperformed lower WMC counterparts in the recall of text ideas. In relation to condition, mean scores revealed that, despite the lack of difference in the recall of main and secondary ideas, participants in the control condition recalled more ideas in general, considering the significant difference in the recall of details. A complementary analysis showed a correlation between main ideas, secondary ideas, and details, suggesting that main ideas had the highest probability of being recalled and details had the lowest probability of being recalled in both conditions. A post hoc exploratory analysis revealed that self-reported proficiency did not predict multitasking performance, but factors related to linguistic experience did. Retrospective results

showed that most participants of the study do not seem to listen to music while reading, but those who do prefer non-lyrical pieces to avoid distraction. Overall, findings support the literature on individual differences in working memory in reading as a multilevel construct, bilingualism as a spectrum of linguistic experiences and theories of auditory distraction.

**Key-words:** Working Memory; Multitasking; Reading; Literal Comprehension; Inferential Comprehension; Listening to Music; Auditory Distraction.

## RESUMO

Realizar várias tarefas simultaneamente – *Multitasking* - é um hábito onipresente que tem aumentado drasticamente nos últimos anos. Há um consenso entre pesquisadores acerca dos efeitos prejudiciais das multitarefas em tarefas de estudo, como a leitura (CLINTON-LISELL, 2021; MAY; ELDER, 2018). No entanto, pesquisadores estão longe de chegar a um consenso sobre os efeitos de um tipo específico de multitarefa: ouvir música durante a leitura (VASILEV; KIRKBY; ANGELE, 2018). O principal aspecto da compreensão leitora é a construção de uma representação mental coerente do texto lido (VAN DEN BROEK; KENDEOU, 2022), que exige que vários processos componentes sejam orquestrados de maneira coordenada pelo sistema de capacidade limitada conhecido como memória de trabalho (JUST; CARPENTER, 1992). Além de diferenças individuais na capacidade de processar e manter os produtos da compreensão (DANEMAN; CARPENTER, 1980), a memória de trabalho é empregada de forma diferente dependendo do nível de compreensão, ou seja, a compreensão literal exige menos recursos cognitivos do que a compreensão inferencial (ALPTEKIN; ERÇETIN, 2011). Além disso, a leitura na tela também pode exigir mais da memória de trabalho dos leitores, dado seu ambiente multicamadas (DESTEFANO; LEFEVRE, 2007). Diante disso, as representações mentais na leitura podem ser comprometidas em um ambiente multitarefas, especialmente considerando a execução conjunta de duas tarefas relacionadas à linguagem, como ler e ouvir música com letras. Com isso em mente, este estudo teve como objetivo investigar se a capacidade de memória de trabalho (CMT) prediz o desempenho em multitarefas, mais especificamente, investigamos se a capacidade de memória de trabalho e condição predizem (1) compreensão literal; (2) compreensão inferencial de um hipertexto; e (3) a recordação de informações de um hipertexto. Participaram deste estudo experimental sessenta e cinco bilíngues proficientes de várias regiões do Brasil. A coleta de dados foi realizada remotamente através de uma plataforma chamada *Lapsi* (Laboratório de Psicolinguística). Os participantes autoavaliaram sua proficiência e forneceram informações básicas sobre sua experiência com o inglês por meio de uma adaptação do Questionário de Experiência e Proficiência Linguística, e realizaram uma versão autoaplicável do Teste de Capacidade de Leitura (OLIVEIRA; WOELFER; TOMITCH, 2021). Os participantes foram designados aleatoriamente para uma das duas condições – o grupo controle leu um hipertexto enquanto ouvia música sem letras (batidas binaurais) e o grupo experimental leu um hipertexto enquanto ouvia música com letras (músicas pop). A compreensão leitora foi avaliada usando uma tarefa de recordação livre por escrito (RONDON; TOMITCH, 2020) e perguntas de compreensão que abordaram a compreensão literal e inferencial (PEARSON; JOHNSON, 1978). Um questionário retrospectivo forneceu informações adicionais sobre o desempenho dos participantes nas tarefas experimentais, sobre o perfil multitarefas e experiência prévia com música. Análises de regressão linear múltipla mostraram que a capacidade de memória de trabalho previu significativamente a compreensão inferencial, mas não a literal e interações estatisticamente significativas mostraram que esse efeito só foi observado na condição experimental. Além disso, os participantes com maior CMT obtiveram melhor desempenho na recordação de ideias do texto em relação aos participantes com menor CMT. Em relação à condição, os escores médios revelaram que, apesar da ausência de diferença na recordação de ideias principais e secundárias, os participantes da condição controle recordaram mais ideias em geral, considerando a diferença significativa na recordação de detalhes. Uma análise *post-hoc* mostrou uma

correlação entre ideias principais, ideias secundárias e detalhes, sugerindo que as ideias principais tiveram a maior probabilidade de serem recordadas, e os detalhes tiveram a menor probabilidade de serem recordados em ambas as condições. Uma análise *post hoc* exploratória revelou que a proficiência autoavaliada não previu o desempenho multitarefa, mas sim fatores relacionados à experiência linguística. Os resultados retrospectivos mostraram que a maioria dos participantes do estudo parece não ouvir música durante a leitura, mas os que ouvem preferem músicas sem letras para evitar distrações. Em linhas gerais, os resultados corroboram com a literatura sobre diferenças individuais na memória de trabalho em leitura como um construto multinível, bilinguismo como um espectro de experiências linguísticas e teorias da distração auditiva.

**Palavras-chave:** Memória de Trabalho; Multitarefas; Leitura; Compreensão Literal; Compreensão Inferencial; Ouvir Música; Distração Auditiva.

## LIST OF FIGURES

## LIST OF TABLES

## TABLE OF CONTENTS

# 1. INTRODUCTION

> At the turn of the millennium, a number of popular-scientific writings began to hail the birth of a new generation of learners variously designated as the Net Generation and digital natives. Born and raised in fully digitized lifeworlds, technologies were said to have changed the way these young people think. A key tenet in this techno-optimist literature was that this new generation of learners shared an uncanny ability to perform several tasks at once, or what is also known as multitasking (AAGAARD, 2019)

The naturality of multitasking has been normalized among the so-called techno-optimists, as described in the citation above. In fact, the capitalist society has created this illusion of the 'doing more in less time' as a condition for ascending in professional and/or academic life. Such is the case that we have completely adopted the multitasking lifestyle. To mention a few, we constantly see ourselves listening to a lecture while googling something, we check our instant messaging apps while reading, and we attend online meetings while doing some paperwork, among many others. As a matter of fact, a recent large-scale analysis of multitasking behavior during remote meetings confirmed that people do multitask more when meetings are online (CAO et al., 2021). Interestingly, the authors also found that 30% of meetings involved e-mail checking[1]. The authors also found that multitasking may be positive in the sense that it improves workers' productivity and negative due to attention loss.

This negative aspect of multitasking has been supported by the author from the opening quotation of this chapter, who set out to analyze the concepts used in the literature to refer to multitasking and claimed that "the word does not in fact denote a quantitative enumeration of tasks, but a qualitative distinction between on- and off-task activity. In other words, multitasking is functionally equivalent to distraction" (AAGAARD, 2019, p. 87). In this study, however, a more general definition of multitasking is adopted, to say, multitasking is considered the concurrent execution of two (or more) tasks which simultaneously demand cognitive resources for the execution of these tasks. A similar

[1] The study was carried out in 2020 when people were working from home. The researchers collected "metadata (without any content information) on remote meetings (Microsoft Teams), email usage (Microsoft Outlook), and file edits (Onedrive/Sharepoint) of US employees from Microsoft" (CAO et al., 2021, p. 3).

definition can be found in Salvucci and Taatgen (2011; 2008), who categorized multitasking according to the time taken between task switches, to say, *concurrent multitasking* which means performing two or more tasks at the same time or with short intervals between tasks – *sequential multitasking*.

Some aspects were taken into consideration for the definition of multitasking adopted in this study. The first one concerns the distinction between *sequential* to *concurrent* multitasking (SALVUCCI; TAATGEN, 2008, 2011). Sequential multitasking could be equated to *task-switching*, that is, alternating between tasks with very short intervals (less than a second to a few seconds), while concurrent multitasking has to do with *dual-tasking*, that is, performing two or more tasks at the very same time (SALVUCCI; TAATGEN, 2011; WORRINGER et al., 2019). The second aspect considered the claim that multitasking refers to "the concurrent performance of two or more cognitive tasks, and not just passively experiencing multiple media stream inputs […] there must be two ongoing concurrent streams of active thought to qualify as multitasking" (JUST; BUCHWEITZ, 2014, p. 1).

As a 'hot topic', especially in pandemic times where people transferred their offices and classrooms to the virtual environment, and consequently, spend more time on their computers and mobile devices, multitasking has consumed people and has been accepted as the new normal. It seems common to be navigating online whilst listening to a lecture, for instance. This common behavior has worried parents and educators, leading researchers to investigate the effects of multitasking on learning and reading, as shall be briefly mentioned in the next subsection.

Taken that, based on years of research on the topic have allowed investigators to claim that (1) multitasking whilst reading is a fact, (2) but the human mind has limited cognitive resources, (3) therefore, multitasking whilst reading might overload one's cognitive system, (4) especially considering the complexity of reading; (5) since people vary in their cognitive resources, there might be individual differences in one's ability to multitask, (6) especially in onscreen reading which differs from reading on paper (CHO; AFFLERBACH, 2017; CLINTON-LISELL, 2021; DESTEFANO; LEFEVRE, 2007; POLLARD; COURAGE, 2017; SALMERÓN et al., 2018). Having said that, the next

subsection further contextualizes these claims by briefly presenting some current findings on multitasking.

## 1.1. CONTEXT OF INVESTIGATION

The study of multitasking has gathered researchers from several fields, such as Psychology (VASILEV; KIRKBY; ANGELE, 2018), Education (CLINTON-LISELL, 2021), Applied Linguistics (BAILER; TOMITCH, 2016) who have invested time and effort in the study of the relationship between multitasking and learning and/or reading comprehension. To exemplify, an up-to-date meta-analysis on multitasking and reading carried out by Clinton-Lisell (2021) highlighted several important aspects of what is already known about the topic in addition to the authors' findings, an important contribution to the field.

Among these aspects, Clinton-Lisell (2021) mentions that it is already known that cognitive resources are limited. Indeed, it is widely accepted that working memory, the system deployed for the execution (storing and processing) of complex cognitive processes such as reading (BADDELEY, 2017a), is highly deployed for constructing meaning from text, that is to say, whilst reading readers must be able to "store the theme of the text, the representation of the situation to which it refers, the major propositions from preceding sentences, and a running, multilevel representation of the sentence that is currently being read" (JUST; CARPENTER, 1992, p. 122). In addition to that, working memory is limited in terms of resources for executing these complex cognitive tasks, and people vary in their working memory capacity (henceforth WMC) (DANEMAN; CARPENTER, 1980; TOMITCH, 2020). All in all, considering the orchestration of an array of information in order to construct meaning from text, it is hypothesized that there might be individual differences in working memory capacity that predict the ability to multitask.

In fact, given the limited capacity of working memory, it is wondered "how individuals are able to perform cognitive complex tasks such as reading, where several subprocesses must occur in a coordinated manner, in real-time, so that the final goal of

comprehension, is achieved" (TOMITCH, 2020, p. 52, my translation)[2]. These subprocesses are subdivided into *lower-level* comprehension processes such as *literal comprehension* and *higher-level* comprehension processes, such as *inferential comprehension* (GAGNÉ; YEKOVICH; YEKOVICH, 1993[3]; GRABE, 2009). Thus, it seems paramount to investigate how these two levels of comprehension are dealt with by an individual within a multitasking situation. To be more precise, while *literal comprehension* means being able to derive what is explicitly stated in the text verbatim and therefore demands less working memory resources, *inferential comprehension* means going beyond what is literally expressed by integrating text chunks, constructing main ideas, and elaborating on the text, which entails more cognitive resources from working memory (ALPTEKIN; ERÇETIN, 2011; GRABE, 2009). It is hypothesized in this study, therefore, that multitasking might not be as detrimental for *literal comprehension* as it might be to *inferential comprehension*, given the distinct demands in working memory involved in each of these kinds of reading levels.

Another aspect that deserves attention is whether the use of cognitive resources is conditional upon the reading medium. To exemplify, Clinton-Lisell (2021) highlighted that "multitasking has a greater negative effect when reading from paper than screens" (p. 788), since reading on paper is connected to study habits and consequently considered more focused reading while onscreen reading leads readers to multitask more (CLINTON-LISELL, 2021). In fact, Destefano and LeFevre (2007) explain that hypertext reading – a text which has access to other texts and sources of information – might demand more from readers' working memory capacity given that readers must decide which links to click, and must also integrate information from all the texts read into building a mental representation. Similarly, readers' working memory might be overloaded once readers have not fully acquired *navigation, integration* and *evaluation* skills for hypertext reading (SALMERÓN et al., 2018). To be more precise, (1) readers must know how to select hyperlinks and web pages in the vast array of information online *(navigation)*; (2) they

[2] Original: "como os indivíduos conseguem executar tarefas cognitivas complexas como a leitura, onde vários subprocessos devem ocorrer de maneira coordenada, em tempo real, para que o objetivo final, a compreensão, possa ser alcançado" (TOMITCH, 2020, p. 52).
[3] A full account on Gagné et al.'s reading model is given on chapter 2, in the section 2.1.1.

must also be able to “integrate multiple pieces of information and multiple presentation formats (texts from different web pages, text and animations)” (p. 91) *(integration)*; and (3) readers must be able to critically evaluate information found online in terms of quality and reliability *(evaluation)* (SALMERÓN et al., 2018). Having said that, this study investigated multitasking in hypertext reading[4], under the hypothesis that onscreen reading would place more demands on working memory.

Ever since the seminal study by Daneman and Carpenter (1980), which investigated the relationship between reading comprehension being conditional upon working memory capacity, much has been known regarding individual differences in WMC in reading (see IN’NAMI; HIJIKATA; KOIZUMI, 2021; TOMITCH, 2020 for reviews). In the same way, the role of working memory in multitasking has been connected to Executive Functioning (EF), “a set of general-purpose control mechanisms […] that regulate the dynamics of human cognition and action” (MIYAKE; FRIEDMAN, 2012, p. 8). For multitasking, people need to *inhibit* dominant input in order to focus; *switch* between tasks; *update* working memory representations. With this in mind, some researchers claimed that the act of knowing and using two or more languages – being bilingual (BHATIA et al., 2012) – would be equated to a multitasking situation, and consequently, bilinguals would be better multitaskers when compared to monolinguals (BIALYSTOK, 2011; POARCH; BIALYSTOK, 2015; SÖRMAN et al., 2017). The main argument is that bilinguals keep their known languages active at all times, but the act of *inhibiting* one language whilst using another and *shifting* between languages would deploy the same cognitive system used in multitasking – Executive Functioning.

So much attention has been given to this issue that more than one hundred studies have been published attempting to support the hypothesis that bilingualism bolsters executive functions (PAAP, 2019). Alongside this growing interest came the debate of whether such a bilingual advantage exists (MORTON; HARPER, 2007; PAAP, 2019; PAAP; GREENBERG, 2013). For instance, while some studies found advantages in some executive functioning tasks for bilinguals, others have not found differences

[4] Given the pandemic of COVID-19, in which experiments had to be conducted online, it was unable to compare paper reading to onscreen reading.

across groups (ANTONIOU, 2019; POARCH; KROTT, 2019 for reviews). Researchers attribute such controversy to the complexity of bilingualism as a construct (BACKER; BORTFELD, 2021; DE BRUIN, 2019; DELUCA et al., 2019; PAAP, 2019), in which "bilingualism has been routinely operationalized as a categorical variable (bilingual/monolingual), whereas it is a complex and dynamic experience with a number of potentially deterministic factors" (DELUCA et al., 2019, p. 1). Therefore, individual experiences in bilingualism must be considered (ANTONIOU, 2019; DE BRUIN, 2019; LEIVADA et al., 2021; LUK; BIALYSTOK, 2013; SURRAIN; LUK, 2019). To be more precise, researchers must "have a good understanding of participants' characteristics and consider a range of experiences which can, along with bilingualism, affect an individual's cognition" (SCHOLL; FONTES; FINGER, 2021, p. 144). With that in mind, it is paramount to trace bilinguals' language background considering multilayered aspects derived from the bilingual experience (ANTONIOU, 2019; DE BRUIN, 2019; LEIVADA et al., 2021; SCHOLL; FONTES; FINGER, 2021; SURRAIN; LUK, 2019) such as age-related factors and language experience factors that might have contributed to language acquisition (SCHOLL; FINGER, 2013; SCHOLL; FINGER; FONTES, 2017). This study, therefore, traced the participants' (adult proficient bilinguals) language background in order to explore any relationship between multitasking during reading.

## 1.2. STATEMENT OF THE PURPOSE

Taking the aforementioned aspects into consideration, the main objective of this piece of research is to investigate whether working memory capacity is a predictor of multitasking performance, operationalized here as reading comprehension of a hypertext in two conditions: reading a hypertext whilst listening to music without lyrics (henceforth non-lyrical music) as the control condition; reading a hypertext whilst listening to music with lyrics (henceforth lyrical music) for the experimental condition.

As for the specific objectives, the first is to investigate whether WMC and Condition are predictors of literal comprehension of a hypertext under the hypothesis that neither WMC nor Condition will affect reading comprehension. The second specific

objective is to investigate whether WMC and Condition are predictors of inferential comprehension of a hypertext under the hypothesis that both WMC and Condition will affect reading comprehension. The third specific objective is to investigate whether WMC and Condition are predictors of reading comprehension of a hypertext, here operationalized as the recall of text ideas (main ideas, secondary ideas, and details) (OLIVEIRA; TOMITCH, 2021; RONDON; TOMITCH, 2020), under the hypothesis that participants with higher working memory capacity will recall more text ideas in relation to lower WMC counterparts in the experimental condition.

The fourth specific objective is to explore the extent to which linguistic experience (how English was learned, age of onset and age of fluency, contributing factors to learning English, and the frequency of activities in English) and self-rated proficiency predict multitasking performance, under the hypothesis that bilingualism as spectrum of linguistic experiences might provide some advantage in multitasking. These objectives and hypotheses are further presented in the Method chapter.

## 1.3. SIGNIFICANCE OF THE STUDY

This subsection briefly describes some limitations observed in previous studies on multitasking and reading, and contributes, therefore, to filling the unresolved gaps of some previous studies. In addition to that, this study adds to the literature an important contribution to how cognitive resources in working memory relate to multitasking performance.

The literature on multitasking and reading does not seem to have reached a consensus regarding the effects of multitasking in reading. On the one hand, some studies did not find evidence for reading comprehension being affected by multitasking (BOWMAN et al., 2010; FANTE; JACOBI; SEXTON, 2013; FOX; ROSEN; CRAWFORD, 2009); while on the other hand, other studies showed different results. To be more precise, a study that investigated the effects of video content on reading comprehension found that comprehension was affected differently depending on the type of video (LIN; LEE; ROBERTSON, 2011), while a study that investigated the effects of online multitasking on

college students' reading comprehension of expository text concluded that more studies are needed to claim that multitasking affects learning, reading comprehension and recall of the material (TRAN; CARRILLO; SUBRAHMANYAM, 2013).

Some of these studies (e.g. BOWMAN et al., 2010; FANTE; JACOBI; SEXTON, 2013; FOX; ROSEN; CRAWFORD, 2009) share a common limitation: they considered multitasking what in fact seems to be *task-switching* (WORRINGER et al., 2019) – or sequential multitasking, (SALVUCCI; TAATGEN, 2011) instead of *dual-tasking* perspective – concurrent multitasking (SALVUCCI; TAATGEN, 2011). The interchangeable use of the concepts 'multitasking', 'dual-tasking', and 'task-switching' has somehow made it difficult to generalize results from the studies in reading, considering that performance might vary from sequential to concurrent multitasking. For instance, it seems hard to state that 'multitasking affects reading' by comparing a study which had participants interrupt reading to text-message to a study where participants read with the TV on. The present study, therefore, adds to the existing literature on concurrent multitasking in reading in addition to providing further evidence on this controversial issue.

A clear example of concurrent multitasking is reading and listening to music, which is common practice among people, as shown by recent surveys. For instance, Kononova and Yuan (2017) found that 72% of young adults[5] listened to music while studying or working. David et al. (2015) found that listening to music while studying was the most common activity among university students[6]. Taken that, some studies have explored whether reading comprehension is compromised while listening to music, to mention, two important meta-analyses, performed by Kämpfe, Sedlmeier and Renkewitz (2011) and Vasilev, Kirkby and Angele (2018). Both studies investigated the impact of background music and found that listening to such music has brought a detrimental effect on reading. To the best of our knowledge, this study is the first to address music listening while reading in a population of adult proficient Portuguese-English bilinguals.

Previous research on multitasking and reading did not address which comprehension level was being tested in the experimental conditions (BOWMAN et al.,

[5] A total of 524 university students (mean age 21), participated in the survey (KONONOVA; YUAN, 2017).
[6] A total of 992 university students (mean age 19.7) participated in the survey (DAVID et al., 2015).

2010; FOX; ROSEN; CRAWFORD, 2009; PASHLER; KANG; IP, 2013; TRAN; CARRILLO; SUBRAHMANYAM, 2013). In other words, these studies have not addressed whether multitasking is detrimental (or not) to *literal* and/or *inferential comprehension*. In fact, only Lin et al. (2011) and Cho et al. (2015) had some categorization of the comprehension questions used in their study, as shall be detailed in chapter 2, section 2.3.1. Thus, this study contributes to deepening our understanding of the relationship between multitasking and comprehension levels.

This study also brings an important contribution to the field by investigating whether working memory capacity predicts multitasking performance. To the best of our knowledge, a few studies (JOHANSSON et al., 2012; POLLARD; COURAGE, 2017) have correlated WM measures with reading comprehension.

Finally, considering that previous studies that found advantages in bilinguals' performing executive-function related tasks considered bilingualism as a binary construct (monolingual/bilingual) (e.g. BIALYSTOK, 2011; POARCH; BIALYSTOK, 2015; SÖRMAN et al., 2017) instead of taking it as a spectrum of linguistic experiences that might shape cognition (ANTONIOU, 2019; BACKER; BORTFELD, 2021; DELUCA et al., 2019; SCHOLL; FINGER; FONTES, 2017), this study contributes to exploring to what extent self-rated proficiency and linguistic experience factors influence in multitasking performance. In the next section, the organization of this dissertation is detailed.

## 1.4. ORGANIZATION OF THE DISSERTATION

This Ph.D. Dissertation is organized into five chapters. Chapter 1 introduces this work in addition to presenting the context of investigation and the statement of the purpose. Chapter 2 covers the theoretical background of this study, starting with an overview of multitasking and a detailed account on reading, such as its cognitive infrastructure, how mental representations are constructed, and some features of digital reading. Then, some important models of working memory are presented attempting to bridge them with multitasking and reading. The last section establishes the niche of this study by reviewing previous studies on working memory capacity in literal and inferential

comprehension, reading in a multitasking environment, and reading while listening to music. Chapter 3 explains the method adopted, featuring the objectives, hypotheses, information on the participants, the study design, the ethical procedures, a detailed account of the instruments for data collection, and the procedures for data collection and analysis. Chapter 4 reports and discusses the results obtained in terms of hypotheses testing and exploratory data analyses. Chapter 5 presents the final remarks, limitations, and suggestions for further research, in addition to the pedagogical implications of the study main findings.

## 2. REVIEW OF LITERATURE

> The ability to write well is not a gift. Sure, the special something that sets apart a Tolstoy or Shakespeare or Salman Rushdie or Isabel Allende is a gift, a talent born of disposition, experience, and commitment. But just to be able to communicate clearly with the written word takes no special talent; it's a skill like any other (WAX, 2008).

The excerpt above was taken from the slides Professor Lêda Tomitch used in the course "*O texto acadêmico em Estudos Linguísticos*", during my first year as a master's student. As she approached 'the value of writing', she carefully insisted that writing is a matter of practice, or in her own words "writing is a process". With that in mind, this chapter is the result of a long process of writing which started with a dissertation project for the Ph.D. entrance exam and evolved into a research project for the qualifying exam, which finally resulted in this chapter (which had many versions, respecting the writing process).

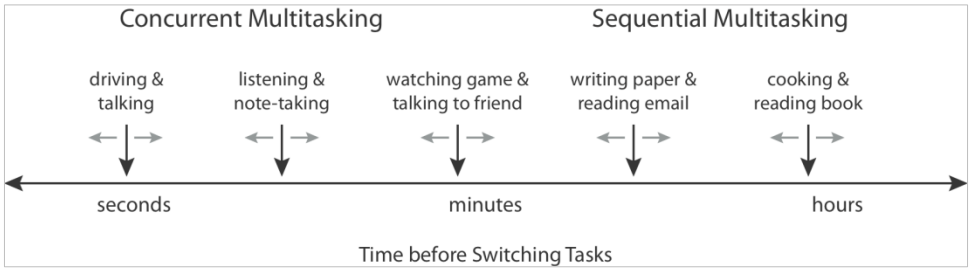
This chapter presents the theoretical background underlying this study. It is divided into three main sections. The first section, "Understanding Multitasking and Reading" brings an overview of the term multitasking followed by the definition that we adopted along this work, ending with an example of multitasking where reading is one of the tasks. This first section contains four subdivisions, to say, "Reading as a complex cognitive process", which shortly explains the cognitive load reading poses on the system; "The cognitive infrastructure of lower-level and higher-level comprehension", which details how the mind operates in different comprehension levels; "Digital Reading: an overview", which briefly presents some conceptualization of onscreen reading and how it relates to working memory; and "Mental representations in reading", which approaches the architecture of the construction of mental representations in reading. The second section, entitled "Working memory in multitasking" addresses some influential models and their relationship with multitasking in the sections "A multicomponent model of working memory", "an embedded-process approach to working memory", and "working memory and executive attention". The second section ends with a subsection named "individual differences in working memory capacity", which presents an overview of the relationship

between working memory and additional language reading along the years and how they are related to the scope of this study. The third and last section, entitled “establishing the niche: reviewing previous studies” presents, as the name suggests, a review of previous studies related to the scope of this study, which is subdivided by “working memory capacity in literal and inferential comprehension of digital texts”, “reviewing of studies of multitasking and reading”, followed by a subsection entitled “reading and listening to music”, which helps set the tone of the research niche of this study.

## 2.1. UNDERSTANDING MULTITASKING AND READING

The term multitasking, oftentimes found in the literature as dual tasking, refers to performing two or more tasks at the same time (BAILER; TOMITCH, 2016; JUST; BUCHWEITZ, 2014). This definition is certainly broad, so we will split this characterization into two, namely sequential and concurrent multitasking, adopting Salvucci and Taatgen’s (2009; 2011) conceptualization. These authors explain that multitasking “can be represented along a continuum in terms of time spent on one task before switching to another” (SALVUCCI; TAATGEN; BORST, 2009, p. 1819), as it is depicted in Figure 1, below.

Figure 1 - The Multitasking Continuum.




Source: Salvucci; Taatgen (2009).

On the left side of the continuum concurrent multitasking is displayed, while sequential multitasking is represented on the right side. By sequential multitasking, the authors refer to performing one task for a long period (minutes to hours) before switching to another task, while by concurrent multitasking, they refer to performing two tasks at the

same time or with short interruptions, that is, “people switch tasks at sub-second intervals up to every few seconds” (SALVUCCI; TAATGEN, 2011, p. 8). By sub-second, Salvucci (2008) is referring to task-switching in the window of one second or less. Salvucci and Taatgen (2011) explain that each multitasking situation must be analyzed in its specificities, that is, the context and the tasks of the situation play a role. For instance, two people might be watching a movie and talking at the same time, meaning that this multitasking situation must be analyzed in order to fit into the continuum (Figure 1).

In the realm of this study, reading a hypertext whilst listening to music containing lyrics will be considered *multitasking*, therefore, it could be placed on the concurrent side of the multitasking continuum. Reading requires the construction of a mental representation of the text read – which is a cognitively demanding and sophisticated task – while listening demands auditory processing, which is also a load to cognitive processing. With this in mind, the next sections approach (1) the complexity of reading; (2) the cognitive infrastructure of reading in terms of comprehension levels; (3) an overview of digital reading, and (4) the construction of mental representations in reading.

### 2.1.1. Reading as a complex cognitive process

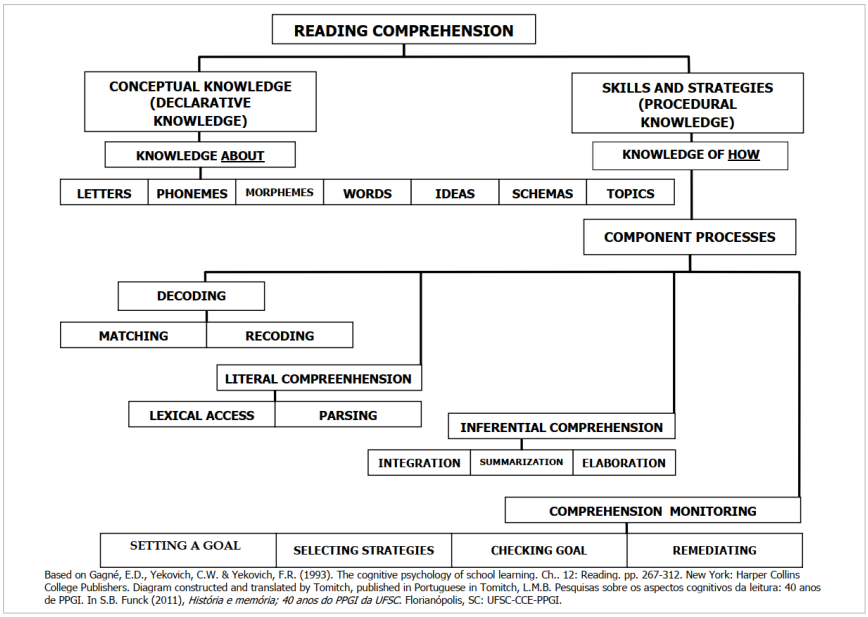
Back in the day, people often deemed reading and listening as passive skills, while speaking and writing were seen as active skills to be learned and therefore mastered by any second/additional language[7] user. However, in the next lines, we shall demonstrate why reading is far from being something passive. Some reading models, on the one hand, viewed reading as a serial bottom-up process, where reading begins with letter decoding and ends with comprehension (GOUGH, 1972), while others, on the other hand,

[7] Despite the fact that I have adopted English as a Lingua Franca as my own view of English, some authors reviewed in this study do not adopt the same perspective of the English language. Therefore, in the review of literature, the terms second/additional or even foreign language might appear in an interchangeable way, henceforth L2. By English as a Lingua Franca (ELF), I have followed Finardi’s (2016) discussion on the status of English in Brazil, which argues that English is a language used by people all over the world, challenging the view that we are foreigners using the language of hegemonic countries (see FINARDI, 2016 for a full discussion).

overemphasized the role of background knowledge, where readers barely relied on printed cues and over-relied on building predictions (GOODMAN, 1967). As a response to these two extreme models, scholars considered that both printed cues and background knowledge were important for reading (RUMELHART, 2013). Therefore, reading is considered an interactive process in the sense that readers' background knowledge interacts with the information presented in the text (CARRELL; DEVINE; ESKEY, 1988), at the same time that readers' knowledge (syntactic, semantic, orthographic, lexical) is used for making sense of the text (ESKEY, 1988; RUMELHART, 1985). It is interesting to point out that there is a common belief that the text itself contains meaning, but in fact texts "are merely marks on page, which readers must convert into language information as they engage in the complex process of reading" (ESKEY, 1988, p. 96). In a nutshell, readers bring their background knowledge, expectations, emotions, and limitations to the reading event in order to interact with the text.

Fluent reading demands an array of knowledge that starts early in literacy and continues to be improved throughout life. Gagné, Yekovich and Yekovich described a reading model which captures the types of knowledge deployed in fluent reading comprehension, as assembled by Tomitch (2011) in Figure 2, below.

Figure 2 - Reading Comprehension Model (GAGNÉ; YEKOVICH; YEKOVICH, 1993)




Source: (TOMITCH, 2011)

According to the model, fluent reading demands declarative knowledge, that is, knowledge about letters, phonemes, morphemes, words, schemas and topics (GAGNÉ; YEKOVICH; YEKOVICH, 1993). Reading also requires procedural knowledge, that is, knowledge of "how to read" (GAGNÉ; YEKOVICH; YEKOVICH, 1993, p. 267). The procedural knowledge comprises several component processes, which should account for fluent reading. These component processes can be divided into *lower-level* (decoding and literal comprehension) and *higher-lever* (inferential comprehension and comprehension monitoring). In decoding, word recognition takes place, be it as a direct association of print (matching) or sounding out the word (recoding). In literal comprehension, word meaning is accessed (lexical access) and propositions[8] are formed by assembling words together using syntactic rules (parsing). These propositions represent the meaning of the text, which is called the *microstructure* of the text (KINTSCH, 2013). Microstructure formation depends on bridging inferences and/or anaphora

[8] Propositions are idea units and resemble the meaning of the text as it is constructed by the reader (KINTSCH, 2013).

resolution in order to connect propositions as a coherent whole (KINTSCH; RAWSON, 2005). In inferential comprehension, this is referred to as integration (GAGNÉ; YEKOVICH; YEKOVICH, 1993). However, the meaning of the text is more than recognizing and accessing word meanings and forming propositions (KINTSCH; RAWSON, 2005), that is, the reader should be able to provide a summary of the text, which contains the gist – the *macrostructure* (KINTSCH, 1998), a process called summarization by Gagné and colleagues (1993). Together, the *micro-* and *macrostructure* of the text form the *textbase*, the semantic basis of the text (KINTSCH, 1998, 2013). The textbase alone will provide a shallow comprehension, so readers must integrate the textbase with background knowledge for creating a *situation model.* In Gagné et al.'s model, this is called elaboration. Last, in comprehension monitoring, the reader sets a goal for reading and selects the appropriate strategies for reaching such goal. While reading, the reader checks whether the goal is being met, if not, remediation processes will make sure that the goal – comprehension – takes place (GAGNÉ; YEKOVICH; YEKOVICH, 1993).

Because the mind must operate all these processes in order to construct meaning from text, reading is considered a complex cognitive process. Put differently, "in reading comprehension, the reader must store pragmatic, semantic, and syntactic information from preceding text and use it in disambiguating, parsing, and integrating subsequent text" (DANEMAN; CARPENTER, 1980, p. 450), in the same way that the reader must be able to "store the theme of the text, the representation of the situation to which it refers, the major propositions from preceding sentences, and a running, multilevel representation of the sentence that is currently being read" (JUST; CARPENTER, 1992, p. 122). These authors emphasize that language comprehension, be it spoken or written, provides a great example of the complex information processing system. All these processes must be executed in the limited capacity system called working memory, which will be detailed in the next section. In a broad sense, however, working memory (WM) is regarded as the limited capacity system responsible for storing and manipulating information necessary to perform complex cognitive tasks, such as thinking, reading, and calculating (BADDELEY, 2017a). Additionally, it is well accepted that individuals vary in reading comprehension

due to their individual differences in working memory capacity (DANEMAN; CARPENTER, 1980; JUST; CARPENTER, 1992). With this in mind, the next section approaches issues pertaining to reading comprehension and working memory.

### 2.1.2. The cognitive infrastructure of levels of comprehension

> Taking into account the complex process of reading comprehension and the limited capacity of working memory, one is tempted to ask how a reader manages to construct a meaningful representation of the text considering the great storage and processing demands required in the process of reading (TOMITCH, 2003, p. 24).

The answer to the question posed by Tomitch (2003) has been the issue of investigation of more than 40 years of research (e.g. DANEMAN; MERIKLE, 1996; IN'NAMI; HIJIKATA; KOIZUMI, 2021; LINCK et al., 2014; SHIN, 2020). Daneman and Carpenter (1980) first postulated that working memory capacity is crucial for reading comprehension and individuals range in such capacity. Later, Just and Carpenter (1992) proposed A Capacity Theory of Comprehension: individual differences in working memory, which posed that "the nature of a person's language comprehension depends on his or her working memory capacity" (p. 124). Important for the scope of this study, this theory approaches how *lower-level* comprehension processes (decoding and literal comprehension) and *higher-level* comprehension processes (literal comprehension in this study) differ in terms of capacity usage in working memory.

In order to understand how this theory relates to *lower-* and *higher-level* comprehension processing, an overview of the theory is needed. According to Just and Carpenter (1992), storage and processing in working memory are mediated by *activation*, which happens through text encoding, long-term memory retrieval, or processing itself[9]. Just and Carpenter (1992) provide two explanations on how individuals range in their working memory capacity, to say*, total-capacity explanation and processing efficiency*

[9] The authors use the word 'computation' instead of processing to refer to "symbolic manipulations that are at the heart of human thinking - such operations as comparison, retrieval, and logical and numerical operations"(JUST; CARPENTER, 1992, p. 123).

*explanation.* The former refers to a variation in the amount of activation in working memory that happens according to task demands. That is to say, “performance differences among […] readers of different working memory capacities are smaller when the comprehension task is easy, and larger when it is demanding” (JUST; CARPENTER, 1992, p. 145). In sum, “when the comprehension task is easy, high and low span readers exhibit about the same performance, no significant differences are observed; whereas when the task is demanding, the differences between the two groups are large and systematic” (TOMITCH, 1999, p. 35). The *processing efficiency explanation*, in its turn, explains what determines resource allocation when the demand exceeds the supply. Just and Carpenter (1992) claim that “those processes that are less demanding of resources might be favored at time of inadequate resource supply” (p. 144). Lower-level comprehension processes, for instance, are considered less demanding than higher-level comprehension processes. Additionally, “higher-level processes in comprehension […] may be not executed or not executed fully in times of inadequate resource supply” (JUST; CARPENTER, 1992, p. 144). Both explanations may shed light on individual differences in working memory capacity, especially considering that both explanations are not “mutually exclusive” (JUST; CARPENTER, 1992, p. 145).

With the argument that research on individual differences in reading comprehension has focused on lower-level, higher-level and working memory capacity separately, Hannon (2012) set out to explore the relationship among these sources of individual differences in reading comprehension using structural equation models (SEMs)[10]. More specifically, the author tested the cognitive components-resource model of reading comprehension (CC-R model), which hypothesizes a relationship among lower-level processes, higher-level processes and the limited system for manipulating all this information during processing, namely working memory.

Before exploring the model, it is important to trace a parallel between the author’s view of lower- and higher-processes with the perspective adopted in this work, following Gagné, Yekovich and Yekovich (1993). Hannon (2012) considers word decoding and

[10] Structural Equation Modeling is a statistical method which tests causal relationship among multiple variables (BOLLEN; NOBLE, 2011 for a full review).

lexical access as lower-level processes, while Gagné, Yekovich and Yekovich (1993) regard word decoding, lexical access and syntactic parsing as lower-level processes. As for higher-level processes, Hannon (2012) includes “those processes that are used to process larger units of information, such as ideas or propositions” (p.147), while Gagné, Yekovich and Yekovich (1993) consider that “integrative processes connect two or more propositions together” (p. 275). Inferential comprehension in Gagné, Yekovich and Yekovich’s (1993) model includes not only integrative processes, but also summarization and elaboration, as detailed in the previous section. The latter, in Hannon’s model, is deemed as knowledge-integration, that is, joining background knowledge to text-based information. It seems, therefore, that Hannon’s model left parsing and summarization processes aside in her model, as compared to Gagné, Yekovich and Yekovich’s model. Alternatively, she might have considered parsing and summarization processes as inherent of meaning construction. This assumption is derived from Hannon’s claim that in lower-level word processes, more specifically, “word fluency directly influences sentence processing speed” (p. 128), which might evidence that parsing processes are implied in her model.

In order to establish a causal relationship between lower-level, higher-level processes and working memory, Hannon (2012) raised some assumptions and tested them empirically using path analysis (see FAN et al., 2016 for a full account on path analysis used in SEMs) that is to say, “each unidirectional arrow represents a direct path and its direction of influence” (HANNON, 2012, p. 129). For the purposes of this study, only some of author’s the assumptions will be approached, to mention, lower-level and higher-level processes are independent constructs in adult readers; and lower-level processes do not consume cognitive resources from working memory (HANNON, 2012). The author found support for both assumptions in her study. More specifically, she claimed that the CC-R model supported the hypotheses that “lower-level word processes do not consume limited working memory resources” (p. 141) and “lower-level word processes and higher-level processes are separate constructs” (p.140). However, these findings deserve further investigation, especially considering that her study was one of the first to advocate for separate processes for lower-level and higher-level in adult readers. The

next section approaches digital reading, which is deemed as a highly cognitive task due to the fact that the digital environment poses more demands on working memory.

### 2.1.3. Digital reading: an overview

People's reading behaviors have changed dramatically over the past few years, especially with the rise of the Internet and access to mobile devices (BARON, 2020; BRÅTEN; BRAASCH; SALMERÓN, 2020), which have incorporated a new reading format: onscreen reading or digital reading. A great portion of this shift in reading behavior dates back to 1991 with the World Wide Web and the creation of Google Books in 2002 (BARON, 2020). Commercial developments such as Amazon's launching Kindle eReader in 2007, Apple's launching iPad in 2010 and the growing number of smartphones – a mobile phone with internet access-availability have also contributed to changes in reading behaviors (BARON, 2020).

Besides the medium differences from print to digital reading, the possibility of reading multiple texts through hyperlinked information within a text has been a key feature of digital reading. A hypertext, therefore, consists of a non-linear text with links that provide access to other pages which might contain other texts, videos, ads, among many others (BRÅTEN; BRAASCH; SALMERÓN, 2020). Thus, hypertexts have changed the way people read considering the reader's freedom to choose which links to click (BRÅTEN; BRAASCH; SALMERÓN, 2020). This has led researchers to raise two main issues: first, learning would benefit from hypertexts; and second, hypertexts would overload readers' cognitive system.

The first view considers learning as a dynamic event, that is, it is nonlinear and multidimensional, thus, knowledge acquisition calls for nonlinearity and multidimensionality as well (SPIRO et al., 2003; SPIRO; JEHNG, 1990; SPIRO; KLAUTKE; JOHNSON, 2015). Spiro and colleagues (2003) explain that knowledge is represented in many ways in people's minds, not necessarily in a linear manner, therefore, the nonlinearity of hypertexts would resemble how knowledge is represented (SPIRO et al., 2003). In addition to that, Spiro and colleagues (2015) defend that reading to learn in

online environments enables a “truly reader authored understanding” (p. 46) given that readers/learners are able to search through relevant texts according to their interests and read those texts strategically so that reading/learning goal is achieved. All in all, the nonlinearity feature of hypertext would facilitate learning from reading.

The second view claims that hypertext reading would overload the reader’s cognitive system – working memory which is responsible for storing and manipulating complex cognitive tasks. To be more precise, hypertext reading differs from a linear text in two manners: first, the decision-making imposed by following links; and second, the integration of text fragments from several texts. As a result, readers might place more demands on working memory by having to make decisions on which links to click; and/or having to integrate pieces of information from multiple texts (DESTEFANO; LEFEVRE, 2007).

Under the hypothesis that hypertext reading would increase demands on working memory, DeStefano and LeFevre (2007) reviewed 38 studies from 1990 to 2004 involving university undergraduate students. The authors found that readers with poorer prior knowledge and lower working memory capacity had more difficulty in reading comprehension in hypertexts which contained additional resources such as semantic maps, and graphical overviews, among others. The authors explain that the presence of these features “increased cognitive load and thus may have required working memory capacity that exceeded readers’ capabilities” (DESTEFANO; LEFEVRE, 2007, p. 1636). In addition to that, the authors confirmed their hypothesis that individuals with lower working memory capacity struggle more with hypertext reading given the demands placed on the cognitive system by the structure of hypertexts.

Specifically, digital reading demands advanced reading skills as compared to a single-page linear reading. According to Salmerón and colleagues (2018), digital readers (1) must be able to *navigate* to select the appropriate sources to read and sequence their reading; (2) must be able to *integrate* information from different web pages; (3) must be able to *evaluate* the quality of the information accessed. Together, *navigation, integration* and *evaluation* provide a clear-cut framework of the advanced skills required for the comprehension process in digital reading (SALMERÓN et al., 2018).

In fact, Salmerón et al. (2018) have reviewed some evidence on individual differences concerning the mastery of *navigation* and *integration* skills, but for the purpose of this study, only those related to working memory will be mentioned. The first evidence suggests that efficient *navigation* is related to improved visuospatial working memory capacity (SALMERÓN et al., 2018). By efficient navigation, the authors refer to “spending more time on exploring and comparing the contents of the hypermedia environment from various perspectives and less time with the processing of irrelevant contents” (p. 96). However, some training on navigation might be needed for the improved visuospatial WM effects to begin to appear (SALMERÓN et al., 2018). As an example of WM in *integration* skills, the authors cite DeStefano and LeFevre's (2007) study to claim that the ability to integrate information is conditional upon working memory capacity, as previously reviewed in this section. Although approached by researchers as separate skills (e.g. STADTLER; BROMME; ROUET, 2017), these three skills must work collaboratively during digital reading (SALMERÓN et al., 2018). To be more precise, the authors explain that

> For example, a student may work on an inquiry assignment on dinosaur extinction and start by googling the term (= navigate). A Search-Engine Results Page (SERP) shows a number of potential information sources, with the first two representing competing theories about the issue. Thus, the student needs to study both in order to identify the nature of the controversy (= integrate) and consider whether they complement or contradict each other. Also, the student needs to evaluate if both sources seem reliable. If not, more navigation may be needed in order to find relevant and useable information sources. Hence, there is a reciprocal relation between the three competencies (SALMERÓN et al., 2018, p. 92)

With that in mind, we might speculate that the coordination of these three processes might burden working memory if readers have not fully acquired these skills. More specifically, in order to construct meaning from a digital text, the reader must be able to navigate, integrate, and evaluate pieces of information from the digital environment at the same time s/he has to store and manipulate an array of information for constructing the mental representation of the text read, as detailed by the models of mental representation construction approached in the next section.

### 2.1.4. Mental representations in reading

It is established in the reading research field that comprehension entails the construction of a mental representation of the text read (GERNSBACHER, 1997; KINTSCH, 2013; VAN DEN BROEK et al., 1999; VAN DIJK; KINTSCH, 1983). Among reading researchers, there is no such thing as a single definition of mental representation, given the complexity of such construct. In this work, a mental representation is considered the outcome (or trace) of the text read represented in form of propositions (idea units) which tend to resemble how the text has been encoded in readers' memory (KINTSCH, 1998; KINTSCH; RAWSON, 2005). A mental representation includes verbal material but is not restricted to it. Imagery, personal experiences, and emotions can also be part of a mental representation (KINTSCH; RAWSON, 2005).

In this section, we will briefly describe some models of mental representation and how they are constructed. First, the *Construction-Integration Model of Text Comprehension,* proposed by Kintsch (1998; 2013), will be explained, followed by *The Landscape Model of Reading* by van den Broek and colleagues (1999), and last, *The Structure Building Framework*, proposed by Gernsbacher (1997). These models provide a clear role for working memory in constructing meaning from text, and therefore converge with the scope of this work.

The *Construction-Integration Model of Text Comprehension* (KINTSCH, 1998, 2013) describes the construction of mental representation in terms of levels. The *surface-level memory* consists of words and phrases from the actual text. However, the meaning of the text is not solely constituted on the surface level, especially because it is not of interest to know "how many words someone remembers but in how many and which ideas are remembered" (KINTSCH, 2013, p. 810). It is at the *propositional level* that the ideas conveyed by the text are constituted in form of propositions – which are idea units and resemble the meaning of the text as it is constructed by the reader (KINTSCH, 2013).

The *textbase* – the semantic basis of the text – is formed by the *microstructure* and the *macrostructure.* The *microstructure* of the text is constituted by the network of propositions which depict the meaning of the text, while the *macrostructure* is the global

organization of these propositions (KINTSCH, 1998, 2013). The sole *textbase* (with its *micro*- and *macrostructure*) may not account for comprehension, which means that readers' background knowledge (schemata) should be added to the representation for the creation of a *situation model*. Therefore, the mental representation of the text read is constructed by joining the *textbase* and the *situation model* (KINTSCH, 1998). It is important to highlight that the construction of a *situation model* is conditional upon readers' beliefs, interests, purposes, reading goals, and the amount of prior knowledge (KINTSCH, 2013).

The Construction-Integration (CI) model (KINTSCH, 1998, 2013), therefore, attempts to model comprehension processes by claiming that, in the early stages, comprehension is disorganized, only when awareness is reached, it becomes more organized (KINTSCH, 1998). In the author's words, "in this model mental representations are formed by weak production rules that yield disorderly, redundant, and even contradictory output. However, this output undergoes a process of integration, which results in a well-structured mental representation" (KINTSCH, 1998, p. 94-95). Now, we shall explain how the CI model predicts processes at the level of the *microstructure, macrostructure,* and *situation models.*

At the *microstructure* level – the local structure of the text – when ambiguities in word meaning emerge during reading, "instead of trying to construct only the correct meaning of a sentence, the CI model generates several plausible meanings in parallel and only later, when a rich context is available, sorts out which construction is the right one" (KINTSCH, 2013, p. 815). The author explains that constructions that are not suited for the context are suppressed, while those which suit the context are enhanced, both happening in the integration phase.

At the *macrostructure* level – the global structure of the text which contains its gist – is formed in the CI model applying the *macrorules* (KINTSCH, 1998, 2013; KINTSCH; VAN DIJK, 1978; VAN DIJK, 1977), to say, (1) *selection* of relevant propositions, and

consequently, the deletion of irrelevant propositions[11]; (2) *generalization* of ideas which entails the substitution of a subordinate proposition by a superordinate proposition such as in “I bought apples, mangoes and bananas” by “I bought fruits” (see KINTSCH 1977 for a full account); (3) *construction* of propositions, which happens by combining propositions, reducing information without deleting it, and introducing information via inferencing, or simply put, “the substitution of a general proposition describing a whole sequence of interrelated propositions” (KINTSCH, 2013, p. 818-819). It is important to mention that “the macrorules are applied under the control of a schema, which constraints their operations so that macrostructures do not become virtually meaningless abstractions and generalizations” (KINTSCH; VAN DIJK, 1978, p. 366).

Comprehension is not purely based on the text itself, therefore, readers’ background knowledge should be added to the propositional network so that a *situation model* could be constructed (KINTSCH, 1998). In fact, the author highlights that the lack of readers adding their own knowledge and experience during reading often produces a poor and incoherent propositional network. Language knowledge, world knowledge, and pragmatic knowledge of the communicative situation are some potential sources of knowledge which are crucial for the construction of *situation models*.

In a nutshell, the CI model demonstrates how an array of information sources are triggered throughout comprehension “inducing fluctuations in the activation of concepts, propositions, and relations throughout the comprehension process until the network reaches a ‘stable’ state assumed to correspond to the mental representation” (TAPIERO, 2007, p. 26). In fact, fluctuations and several sources of activation are the basis of *The Landscape Model of Reading.*

*According to the Landscape Model of Reading,* a mental representation is constructed as the reading unfolds, meaning that there is the activation of concepts and propositions as reading advances (VAN DEN BROEK et al., 1999; VAN DEN BROEK; RAPP; KENDEOU, 2005). To be more precise, as the reader progresses through the text,

[11] What determines whether propositions are relevant or irrelevant is deeply discussed in van Dijk (1977). In a nutshell, a proposition is irrelevant when it is not fundamental for the interpretation of a subsequent proposition.

concepts are activated according to four possible sources of activation. The first source might be the current text, that is, the prevailing reading of a sentence and proposition; the second consists of carrying the recently activated concepts; the third source comprises concepts that had been activated even earlier, that is, the “the current episodic text representation” (VAN DEN BROEK; RAPP; KENDEOU, 2005, p. 306); the fourth and last source of activation is the reader’s background knowledge.

Access to the sources of activation is provided by two types of mechanisms, (1) *cohort activation* which is effortless and automatic and (2) *coherence-based retrieval* which is intentional and strategic (VAN DEN BROEK; RAPP; KENDEOU, 2005; YEARI; VAN DEN BROEK, 2011). In *cohort activation*, elements in the text fluctuate in activation as reading progresses in cycles, in which reading a new sentence or proposition corresponds to a new cycle. In this case,

> The architecture of the model assumes that when a concept is activated during reading, all other concepts currently activated become associated with it. Thus, each concept connects with other, related concepts becoming a cohort. In turn, when any of the individual concepts in a cohort become active, the other concepts are also activated. This mechanism is passive and operates under a limited pool of activation (VAN DEN BROEK; RAPP; KENDEOU, 2005, p. 306).

In *coherence-based retrieval,* readers engage in strategic behavior in search of coherence (LINDERHOLM et al., 2004; VAN DEN BROEK; RAPP; KENDEOU, 2005). That is to say, background knowledge or concepts from previous cycles may be activated in order to achieve the readers’ goals and standards (LINDERHOLM et al., 2004). In fact, the *standards of coherence* are determined by the readers’ goals, text complexity, and individual differences (LINDERHOLM et al., 2004; VAN DEN BROEK; RAPP; KENDEOU, 2005). Together, the aforementioned processes depict “a landscape of fluctuating activations of text elements which, in turn, lays the foundation for the emergence of a coherent memory representation of a text at hand” (YEARI; VAN DEN BROEK, 2011, p. 638).

The key feature of The Landscape Model is the need for both *memory-based* and *constructionist* processes to work collaboratively in order to deliver a coherent mental representation of the text read (VAN DEN BROEK; RAPP; KENDEOU, 2005; YEARI; VAN

DEN BROEK, 2011). The *memory-based view* predicts that “connections between text segments and background knowledge are formed via effortless, autonomous spread of activations through existing associations in readers’ semantic and episodic memory” (YEARI; VAN DEN BROEK, 2011, p. 636), while the *constructionist view* posits that “a text representation is constructed via a strategic, effortful memory search (…) aimed at retrieving information from prior text or background knowledge” (YEARI; VAN DEN BROEK, 2011, p. 636).

Interestingly, the *Landscape Model* shares some similarities with the CI model (KINTSCH, 1998, 2013) in the sense that memory-based spread of activation process – resembling the *construction* component in the CI model – is succeeded *coherence-based* inference generation – which corresponds to the *integration* component in Kintsch’s model (VAN DEN BROEK; RAPP; KENDEOU, 2005). In addition to that, the model can also be compared to Just and Carpenter’s theory that processing and storage in working memory are fed by activation, and once the information is activated, it should be available for further processing, unless this information is not sufficient for the comprehension task, then forgetting and displacement may take place. Therefore, “representations constructed early in a sentence may be forgotten by the time they are needed later in the sentence” (JUST; CARPENTER, 1992, p. 123).

Finally, the *Structure Building Framework* advocates that “the goal of comprehension is to build coherent mental representations or structures” (GERNSBACHER, 1997, p. 266). In order for that to happen, some processes are needed: laying a foundation, mapping, shifting, suppression and enhancement. The author explains that readers first lay a foundation for the mental representation, followed by the development of mental representation which happens through some sort of mapping of new and old information (from working memory) in a sort of matching process for building the mental representation. Suppression and enhancement happen according to the need for the construction of the mental representation, that is, “memory nodes are enhanced when the information they represent is necessary for further structure building; they are suppressed when the information they represent is no longer needed” (GERNSBACHER, 1997, p. 267). In addition to that, the author notes that readers should be able to suppress

background noise as they read, which is further discussed when the theories of auditory distraction are presented in this work.

The three aforementioned models have one commonality with *The Capacity Theory of Comprehension:* activation (JUST; CARPENTER, 1992), reviewed previously. In general, The CI model posits that in the construction of a mental representation concepts are activated whenever needed, that is, “activation is spread around in the propositional network that has been constructed” (KINTSCH, 2013, p. 815). In the Landscape Model, “concepts and propositions fluctuate in their activation as the reader progresses through the text” (VAN DEN BROEK et al., 1999, p. 71), and in the Structure Building Framework, once concepts have been activated, suppression or enhancement takes place (GERNSBACHER, 1997). Thus, in consonance with Just and Carpenter’s (1992) theory, storage and processing are both enacted by activation.

Just and Carpenter view capacity as the ability to store and process information from input. They explain that during reading, information from the written text is encoded in memory and/or retrieved from long-term memory and hence becomes activated, during comprehension, for the current task. Nevertheless, if the activated information is not needed for the comprehension task at hand, it is forgotten or displaced. This generates a limitation, though. By the time the previously encoded information is needed, it might no longer be available, since it may have been forgotten or displaced (JUST; CARPENTER, 1992). Last, the processes which occur during comprehension happen in parallel, that is, “at the time the comprehender develops the expectation of encountering a verb, she or he could also be calculating other syntactic, semantic, and pragmatic features of the sentence” (JUST; CARPENTER, 1992, p. 123). Considering the sophistication of constructing a mental representation in working memory, we predict that multitasking is detrimental to comprehension. In fact, Just and Carpenter also discuss the effects of external memory load on the comprehension of sentences. They explain that subjects who maintained a series of numbers or words in memory during comprehension had their resources limited for sentence comprehension (JUST; CARPENTER, 1992). In other words, resources have been shared for multitasking.

All in all, we predict that the construction of mental representations, which depends on activation, might suffer from multitasking, especially given that limited attentional resources constrain the intermediate and final products of comprehension (JUST; CARPENTER, 1992). In digital reading, as it is the goal of the investigation in this study, the construction of mental representations might severely suffer, taken that readers "can get easily distracted, confused, and 'off-track' in the online environment with multilayered textual structures, without a clearly defined scope and sequence" (CHO; AFFLERBACH, 2017, p. 113). In addition to that, the authors advocate that digital reading demands highly strategic behavior in order to "construct, deconstruct, and reconstruct interrelationships of sources, links, systems, and the spaces in which these online textual elements are stored, retrieved, and conjoined" (CHO; AFFLERBACH, 2017, p. 114).

## 2.2. WORKING MEMORY IN MULTITASKING

Several scholars have been interested in the study of working memory, given its importance in complex cognition. Such is the case that a book entitled "Models of Working Memory: Mechanisms of Active Maintenance and Executive Control" (MIYAKE; SHAH, 1999b) approached the most influential theoretical perspectives of working memory. More than twenty years later, the topic has still gathered researchers around a brand-new book "Working Memory: State of Science" (LOGIE; CAMOS; COWAN, 2021a), bringing varying perspectives on the construct. Most recently, the role of working memory in first and second language acquisition, processing, impairment, and instruction has been further explored by distinguished researchers around the world in *The Cambridge Handbook of Working Memory and Language* (WEN; SCHWIETER, 2022).

For the purpose of this piece of work, some important models will be approached, to mention, Baddeley's[12] multicomponent model of working memory, which views WM as

[12] Along the years of research on WM, Alan Baddeley, Nelson Cowan and Randall Engle have worked and published with several researchers in the field, which resulted in the evolution of the WM we have available nowadays. In order to do justice to all of the researchers who worked with them along almost 50 years of research on WM when I mention 'Baddeley's/Cowan's/Engle's model', for instance, I intend to include all of these scholars' contributions and not be exhausted in my citations.

a system with limited capacity responsible “for the temporary maintenance and processing of information in the support of cognition and action” (BADDELEY; HITCH; ALLEN, 2021, p. 10); Cowan’s model, which conceives WM as “the ensemble of components of the mind that hold a limited amount of information temporarily in a heightened state of availability for use in ongoing information processing” (COWAN, 2017, p. 1159); and Engle’s model, which sees working memory “as the cognitive system that permits the maintenance of goal-relevant information” (MASHBURN; TSUKAHARA; ENGLE, 2021, p. 176) and is part of a larger executive attention framework, as shall be detailed shortly.

Interestingly, there has been a movement toward integrating theories of working memory (to mention a few, LOGIE; BELLETIER; DOHERTY, 2021; MIYAKE; SHAH, 1999a; WEN; LI, 2019; WEN; SCHWIETER, 2022), especially for serving the purpose of those scholars who “are more concerned with the applications of the WM concept in more practical areas of human cognition” (WEN; LI, 2019, p. 365). More specifically, Wen and Schwieter (2022) explain that several theories of WM have “provided contrasting and complementary perspectives on the different facets of the construct” (p.911), but “their seemingly disparate research paradigms and distinctive foci can sometimes lead to incompatible definitions of the very same construct” (p.911). Therefore, Wen and Schwieter (2022) advocate for a “a generalizable model or theory of working memory that transcends multiple perspectives and models” (p.911)

For instance, on the one side lies the *domain-specific* view of WM featuring several components functioning to achieve a goal, such as Baddeley’s multicomponent model[13] (BADDELEY, 2012; BADDELEY; HITCH, 1974; BADDELEY; HITCH; ALLEN, 2021). On the other side lies the *domain-general* view of WM featuring a “single-resource view” of WM (WEN, 2015, p. 42), for example, the Capacity Constrained Theory of Comprehension (JUST; CARPENTER, 1992); The Embedded-Processes Approach (COWAN, 1999; COWAN; MOREY; NAVEH-BENJAMIN, 2021); and similarly, The Executive Attention Theory of WM (ENGLE, 2018; ENGLE; KANE; TUHOLSKI, 1999;

[13] A full discussion on the modular nature of Baddeley’s model of WM is available in Baddeley (2017).

MASHBURN; TSUKAHARA; ENGLE, 2021). With that in mind, the following sections shall approach the aforementioned models of WM relating them to the scope of this study.

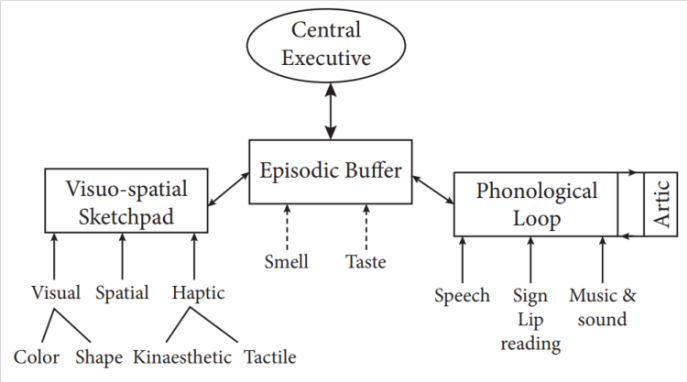
### 2.2.1. A Multicomponent model of working memory – MMWM

Alan Baddeley was the precursor of the study of working memory with the seminal work co-authored by Graham Hitch in 1974, in which they proposed a system responsible for maintenance and processing information during processing that derived and differed from short-term memory (STM) (BADDELEY; HITCH, 1974). Despite the fact that at times researchers use STM and WMC interchangeably, Baddeley differentiates STM from WM, where the former refers to “simple temporary storage of information”, while the latter “implies a combination of storage and manipulation” (BADDELEY, 2018, p. 334), a view adopted along this work.

Notably, the author defines WM as “a limited capacity system for the temporary storage and processing of information required for complex cognition” (BADDELEY; HITCH; ALLEN, 2021, p. 11). Baddeley’s current model of working memory is a unitary model comprised of several components which interact to make the system work as a whole[14] (BADDELEY; HITCH; ALLEN, 2021). These several components give name to Baddeley’s current model, the Multicomponent Model of Working Memory, comprised of the central executive, the visuospatial sketchpad, the episodic buffer, and the phonological loop (BADDELEY, 2012, 2015; BADDELEY; HITCH; ALLEN, 2021). The current version of the MMWM is depicted in Figure 3, below.

Figure 3 - The multicomponent model of working memory

[14] In response the editors of the book “Working Memory: state of the science” asking whether WM was considered a unitary or non-unitary system (LOGIE; CAMOS; COWAN, 2021a). To be more precise, Logie Camos and Cowan (2021a) asked authors whether their WM theoretical framework considered WM as “a highly flexible **domain-general** system that supports both temporary maintenance and ongoing processing, or a collection of **domain-specific** systems that cooperate in supporting task performance?” (p. 3).




Source: Baddeley, Hitch and Allen (2021).

In a nutshell, the MMWM presents components for temporarily storing visual and phonological information (the visuospatial sketchpad and the phonological loop, respectively), a component for storing information retrieved from the environment and long-term memory (the episodic buffer), and the central executive which coordinates all these components. Each component will be detailed as follows.

the central executive, regarded as the most complex – and least explored – component of WM, is responsible for the focus of attention, attention splitting and switching in task performance (BADDELEY, 2012). It can be stated, therefore, that the central executive is crucial for multitasking and shares a common infrastructure with that of the Executive Functions (EF)[15] of *1) updating, 2) shifting* and *3) inhibiting* (MIYAKE; FRIEDMAN, 2012). The first EF, *updating*, corresponds to updating and monitoring working memory representations, or put differently, it consists in individuals' ability to monitor incoming information and decide whether it is relevant to the current task so that the working memory representation can be updated in order to fit the demands of the task at hand. In reading, for instance, maintaining previous and incoming information from the text being read is crucial for constructing a mental representation (DANEMAN; CARPENTER, 1980; JUST; CARPENTER, 1992). The second EF, *shifting*, corresponds to juggling between tasks, to be more precise, shifting back and forth among tasks. In addition to that, this EF can also be referred to as an attention switching mechanism which

[15] As stated above, EFs are analogous to the components of WM. For a detailed account on the different views on the relationship between EFs and WM, see Diamond (2013).

corresponds to the “disengagement of an irrelevant task set and the subsequent active engagement of a relevant task set” (MIYAKE et al., 2000, p. 55). In reading, navigating through a hyperlinked text could be an example of deploying this EF component. The third EF, *inhibiting*, regards inhibiting dominant incoming information whenever necessary (FRIEDMAN et al., 2008; MIYAKE; FRIEDMAN, 2012). Although the latter has not been stated as part of the central executive in Baddeley’s model, we believe that attentional control is dependent upon inhibiting irrelevant information for the task at hand.

As the latest component added to the model, the episodic buffer is assumed to work as a storage system which holds visual and verbal information in the form of episodes both from other WM components and long-term memory (BADDELEY, 2015). Baddeley explains that the visuospatial sketchpad and the phonological loop (1) hold visuospatial and verbal information respectively, (2) bind this information, and (3) feed into the Episodic Buffer, which in turn (4) makes information available to conscious awareness in the form of episodes (BADDELEY, 2015; BADDELEY; HITCH; ALLEN, 2021; BADDELEY; HITCH, 2019). A practical example of the episodic buffer being employed would be the case of the Reading Span Test where subjects are asked to read sentences and recall the last word of each sentence (DANEMAN; CARPENTER, 1980; TOMITCH, 2003), in which this subcomponent would work as a buffer store where sentences would be held for later recall of the final words (BADDELEY, 2012).

The visuospatial sketchpad is believed to be responsible for storing visual and spatial information during processing (BADDELEY, 2012, 2015), such as in decoding (letter shape identification in reading). In fact, Baddeley (2015) speculates that the visuospatial sketchpad might “play a role in the acquisition of novel script, such as that used in Arabic or Hebrew, or in visually complex orthographies such as Chinese (p.25). The author, nevertheless, emphasizes that little is known about the visuospatial sketchpad, and more research is needed.

It is the phonological loop, in its turn, which is the most influential component in both first and second language learning and processing (BADDELEY, 2015, 2017b; BADDELEY; HITCH, 2019). The component comprises “a short-term store capable of maintaining verbal information for a few seconds, coupled with a rehearsal system based

on covert or overt articulation" (BADDELEY, 2017b, p. 1). In first language learning, evidence has shown that the phonological loop plays an important role in vocabulary learning. For instance, in a review of studies involving vocabulary learning in several populations (e.g. typical children and adults, neuropsychological patients and special developmental populations) Baddeley and colleagues suggested that "the limited-capacity resource of the phonological loop is available to support the construction of more permanent representations of the phonological structure of new words" (BADDELEY; GATHERCOLE; PAPAGNO, 1998, p. 191). Put simply, the phonological loop is considered to contribute to learning the phonological aspects of vocabulary. In addition to that, the authors suggested that the phonological loop's primary function is processing novel speech input (BADDELEY; GATHERCOLE; PAPAGNO, 1998).

In second language learning, the phonological loop also contributes to vocabulary learning. Baddeley (2015) explains that the capacity of the phonological loop determines the rate of vocabulary learning but also "a richer vocabulary is associated with increased verbal memory capacity, probably because the richer substrate of language habits allows elaborate and effective coding within the phonological loop" (BADDELEY, 2015, p. 24). In second language processing, a recent meta-analytic review involving nearly 4000 participants across 79 studies (LINCK et al., 2014) supported the claim of the phonological loop functioning in L2 processing. According to these researchers, "verbal WM measures were somewhat more highly correlated with L2 outcomes than nonverbal WM measures"[16] (LINCK et al., 2014, p. 872).

In an attempt to integrate multiple models of WM in the search for ecological validity for second language acquisition (SLA), Wen (2015) proposed a model of WM which emphasizes the role of executive and phonological components of WM in SLA. The objective here is not to bring another model into the discussion, but to demonstrate how executive and phonological processes are employed within the scope of this study. Under the definition that WM is "the limited capacity of multiple mechanisms and processes

[16] Linck and colleagues (2014) refer to verbal measures as those tasks which involve processing linguistic stimuli, such as sentence reading, while nonverbal WM measures refer to processing nonlinguistic stimuli such as visuospatial images.

implicated in L2 domains and activities" (WEN, 2015, p. 52), the author advocates that both phonological and executive components are crucial for the processes involved in L2 acquisition and processing. The phonological WM, for instance, encompasses short-term store and articulatory rehearsal mechanisms, which resemble the phonological loop in Baddeley's model. The Executive WM, in turn, works as the control of attention and executive control functions of *updating, shifting,* and *inhibition* (MIYAKE; FRIEDMAN, 2012). Interestingly, earlier in this chapter, Baddeley's central executive was compared with the Executive Functions as posited by Miyake and Friedman (2012), a comparison also made by Wen (2015) in his model. Thus, in order to make his claim, Wen (2015) carries out a research synthesis of studies which have "converged on the separate and distinctive roles of phonological component of WM (PWM) and its executive component (EWM) in specific SLA" (WEN, 2015, p. 49). This research synthesis is, in turn, expanded into a 2019 book chapter (WEN; LI, 2019), leading the authors to suggest that:

> Regarding phonological WM, it has been generally found to be closely related to some acquisitional and developmental aspects of such mental representational domains as vocabulary learning (e.g., in acquiring new phonological forms, in predicting vocabulary size, etc.), grammar learning (e.g., in learning of implicit or unanalysed chunk-based knowledge, particularly among beginning and intermediate learners as opposed to advanced learners), and development of L2 fluency (by objective assessment). On the other hand, the executive WM component has been shown to be more relevant to a number of cognitively demanding processes mainly involved in L2 skill learning, including selective processes in reading and speaking as well as some L2 interactional processes in grammar learning (explicit learning, noticing of corrective feedback, etc.) (WEN; LI, 2019, p. 380–381).

All in all, these findings allow Wen and Li to claim that phonological and executive components of working memory play an important role in a variety of domains and skills in SLA. Last, Wen explains that Baddeley follows a more 'structural' view of WM, non-unitary[17] (LOGIE; CAMOS; COWAN, 2021a) in which various components exert different

[17] Interestingly, Wen and Li consider Baddeley's model to be non-unitary while Baddeley himself claims that his model is unitary. He explains that WM is regarded as "a unitary system comprising an alliance of interactive components […] in the sense that the components interact in an integrated and coherent way making it useful to consider the system as a whole" (BADDELEY, 2021, p. 23).

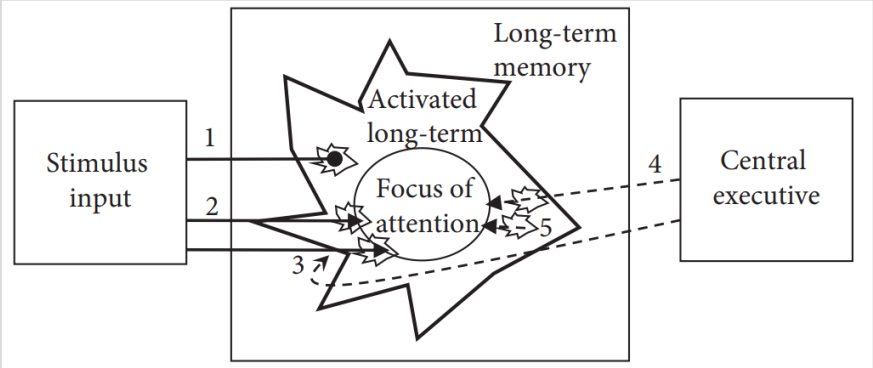
functions in the system, as opposed to a more ‘functional’ view (unitary) in which WM is viewed as a domain-general system, as it is the case of the next model, Cowan’s Embedded-Process Approach to WM.

### 2.2.2. An Embedded-Process approach to working memory

Cowan’s Embedded Processes Model of Working Memory (COWAN, 1999, 2014) is most recently defined as “the ensemble of components of the mind that hold a limited amount of information temporarily in a heightened state of availability for use in ongoing information processing” (COWAN; MOREY; NAVEH-BENJAMIN, 2021, p. 45). In the realm of this study, Cowan’s model brings an important tenant concerning the roles of control and attention in information processing. To explain, attention and control play an important role in “shuttling items into and out of the focus of attention, allowing binding and conceptual formation to take place” (COWAN; MOREY; NAVEH-BENJAMIN, 2021, p. 45). Tracing a parallel between his model and the concepts of Executive Functioning (MIYAKE; FRIEDMAN, 2012), it seems that *inhibiting, updating and shifting* are conditional upon the control mechanisms and the focus of attention. This will be explained in detail during the discussion of the model.

According to Cowan (1999), working memory involves three main features which work in an embedded manner: (1) long-term memory, which entails memory for inactive items but containing retrieval cues; (2) a portion of long-term memory that is activated but out of the focus of attention; and (3) the activated memory that is in the focus of attention and awareness. By ‘activated memory’, Cowan (1999) refers to sensory and abstract activation which could be in any modality, which essentially differs from the subcomponents in Baddeley’s model. The way processes work, in an embedded manner, is depicted in Figure 4:

Figure 4 - The Embedded Processes Model of Working Memory




Source: Cowan, Morey and Naveh-Benjamin (2021)

Each number shown in Figure 4 represents information processing within the model, to mention, “(1) habituated stimulus, (2) physically changed stimulus recruiting attention and orienting, (3) deliberately attended stimulus, (4) information deliberately retrieved from long-term memory, and (5) automatic association that attracts attention.” (COWAN; MOREY; NAVEH-BENJAMIN, 2021, p. 47). Working memory is supplied with not only sensory information from the environment, but also sensory representations provided by long-term memory. Taken that, Cowan and colleagues observe that the order in which information is processed within the system is paradoxical in the sense that information does not enter WM unless it interacts with LTM, in the same way that information cannot be stored in LTM unless it was held in WM beforehand (COWAN; MOREY; NAVEH-BENJAMIN, 2021). Thus, according to the authors, adding a two-way arrow between the two systems (see Figure 4) might be an alternative to resolve this paradox.

The focus of attention, as shown in Figure 4, is represented in the ellipses inside the jagged shape which depicts the activated information of long-term memory. It is the central executive that controls voluntary processing and the focus of attention which is allocated (1) automatically according to predominant stimuli in the environment (e.g., loud sounds, abrupt changes in the environment); and (2) voluntarily in cognitive complex tasks controlled by the Central Executive (COWAN, 1999). The author adds that attention might be “directed away from particular features in memory rather than toward them” (COWAN, 1999, p. 65), which he refers to as inhibition. Simply put, information which is kept active but outside the focus of attention might in fact be inhibited in case the capacity exceeds.

Inhibition seems to be, therefore, an important process in order to keep one active stream of information in the focus of attention. Shifting, on the other hand, might occur when the focus of attention is placed on a different stimulus than the one previously active.

In addition to that, some other implications might be drawn from Cowan's model for the scope of this study. The first one regards attention deployment in complex processing, in the sense that attention-demanding tasks limit information processing (COWAN, 1999), in this case, "the severe limit in attention describes the limit in how much can be perceived or held in the focus of attention at once. Because of this severe limit, there are conflicts between two sets of items to be held in working memory […], *and when storage has to occur at the same time as processing.* (COWAN; MOREY; NAVEH-BENJAMIN, 2021, p. 65). It is important to realize that reading demands WM resources not only for storing semantic, pragmatic, and syntactic information needed for establishing relations among words, sentences, and paragraphs, but also for processing input, lexical access, parsing and inferential processes (DANEMAN; CARPENTER, 1980; TOMITCH, 2020). However, Cowan explains that there might be an off-load from the focus of attention to the activated portion of long-term memory that might help performance in two concurrent tasks, which in fact, might be the case of multitaskers who succeed at performing two concurrent tasks. Another possible argument for explaining successful multitasking performance relates to strategic behavior in allocating attention (COWAN; MOREY; NAVEH-BENJAMIN, 2021). Next, we approach Engle's model which also approaches attentional resources in WM.

### 2.2.3. Working Memory and Executive Attention

Randall Engle's approach to individual differences in working memory capacity started after Daneman and Carpenter's (1980) publication, in a study which hypothesized that WMC would not be task-dependent (TURNER; ENGLE, 1989). In sum, the authors carried out a series of experiments containing arithmetic operations, sentence reading, followed by word recall, whose findings showed that complex span tasks (e.g. the Reading Span Test) predicted reading comprehension (see TURNER; ENGLE, 1989 for a

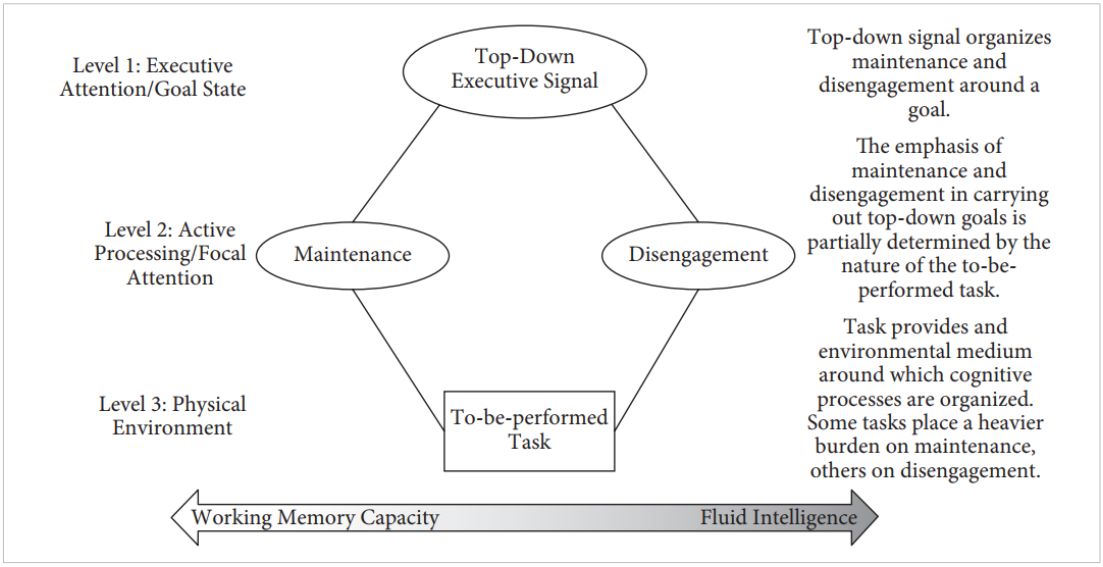
complete account). Thus, researchers claimed that complex span tasks “apparently reflect some ability that is fundamentally important to higher-level cognition because measures of working memory capacity reliably predict performance in a wide variety of real-world cognitive tasks” (ENGLE; KANE; TUHOLSKI, 1999, p. 103).

With that mind, the authors defined working memory “as a system consisting of (a) a store in the form of long-term memory traces active above the threshold, (b) processes for achieving and maintaining that activation, and (c) controlled attention” (ENGLE; KANE; TUHOLSKI, 1999, p. 104). Most importantly, WMC is defined as the capacity of *controlled attention* in the system, in other words, “we assume that working memory capacity is not really about storage or memory per se, but about *the capacity for controlled, sustained attention in the face of interference or distraction*” (ENGLE; KANE; TUHOLSKI, 1999, p. 104). Put differently, WMC is not only about maintaining and suppressing information, in that greater WMC results in greater ability in attentional control and inhibition (ENGLE, 2002).

Nevertheless, after years of research[18], such definition was updated in a later paper (ENGLE, 2018), in which he advocates that WMC is related to the “ability to maintain information in the maelstrom of divergent thought” (p. 192) and hence WMC tasks would reflect this ability. Inhibition, in its turn, would be more connected to the concept of fluid intelligence – the reasoning ability under novel circumstances (DRAHEIM et al., 2022; ENGLE; KANE; TUHOLSKI, 1999; MASHBURN; TSUKAHARA; ENGLE, 2021). In a recent chapter detailing the study of individual differences in WMC (MASHBURN; TSUKAHARA; ENGLE, 2021), the authors explain that WMC is situated in a broader framework of complex cognition which is controlled by an executive attention system. The Maintenance and Disengagement Framework (Figure 5) suggests that top-down executive attention controls processing. In this framework, attention is unitary in the sense that it “cannot be divided but can be switched back and forth between tasks quickly” (MASHBURN; TSUKAHARA; ENGLE, 2021, p. 176).

[18] For a complete account, see Draheim et al. (2022) and Mashburn, Tsukahara and Engle (2021).

Figure 5 - The relationship between working memory capacity and fluid intelligence from the maintenance and disengagement perspective




Source: Mashburn, Tsukahara, Engle (2021); Shipstead, Harrison, Engle (2016)

Figure 5 demonstrates how the maintenance and disengagement framework works. In detail, in level 1, *executive attention* organizes processing according to the goal (goal-directed processing); in level 2, *maintenance* deploys attention to "keep representations in an active, accessible state in the face of distraction or interference" (MASHBURN; TSUKAHARA; ENGLE, 2021, p. 194), while disengagement eliminates irrelevant/outdated information from the representation. The arrow at the bottom of Figure 5 demonstrates that WMC is related to maintenance while fluid intelligence (Gf) is connected to disengagement. The authors explain that

> individual differences in WMC arise when task demands place a greater emphasis on maintenance of information, though these tasks will also require disengagement of information to some degree […] [while] individual differences in Gf arise when a task places a greater emphasis on disengagement from no-longer relevant information (MASHBURN; TSUKAHARA; ENGLE, 2021, p. 194).

Therefore, according to this perspective, it seems that multitasking places a heavier demand on both maintenance (WMC) and disengagement (Gf) since multitaskers must maintain active the representation under processing (what might be thought of as a primary task such as reading) whilst inhibiting distractions from a secondary task (such as

a TV noise, for instance). In fact, this view of individual differences in WMC somewhat differs from the one presented in the next section.

### 2.2.4. Individual differences in working memory capacity

Working memory is highly deployed in complex cognitive tasks, such as reading, calculating, and reasoning (BADDELEY; HITCH; ALLEN, 2021; COWAN; MOREY; NAVEH-BENJAMIN, 2021), and one of the sources of differences in carrying out such tasks comes from the capacity individuals have in holding and manipulating information during processing (JUST; BUCHWEITZ, 2014; TOMITCH, 2020). The nature of these individual differences in WMC is believed to have roots in the trade-off between storage and processing, as Daneman and Carpenter (1980) suggested. According to them, storage and processing compete for resources, in the sense that a task that demands heavy processing lacks resources for storage, or a second alternative would be if "the demanding task generated intermediate products that displaced the additional information" (DANEMAN; CARPENTER, 1980, p. 451).

With this in mind, Daneman and Carpenter (1980) devised a test which places a burden on both storage and processing resources of working memory. The Reading Span Test (henceforth RST) consists of having participants read a set of sentences in which they have to memorize and try to retrieve the last word of each sentence. The authors argue that "if good readers use less processing capacity in comprehending the sentences, they should be able to produce more sentence final words than poor readers" (DANEMAN; CARPENTER, 1980, p. 452). Nowadays, the RST is a well-established tool for investigating individual differences in working memory capacity and reading (TOMITCH, 2020). In fact, Tomitch (2020) reports findings of many years of research correlating reading and working memory capacity, as measured by the RST devised by Daneman and Carpenter (1980) and adapted to Brazilian Portuguese by Tomitch (1995, 2003)[19]. In

[19] Tomitch (2021) explains that Woelfer (2016), Oliveira (2016) and Procailo (2017) used the test devised by Tomitch (1995, 2003), while Bailer et al. (2013) adapted some of the sentences in the test to fit the population of the study (teenagers).

a nutshell, findings have shown that higher working memory capacity individuals (1) are better at identifying the main ideas of L1 and L2 texts (TORRES, 2003); (2) are more able to attend to form and meaning in reading (BAILER; TOMITCH; D'ELY, 2013); (3) are advantageous in inferential comprehension (WOELFER, 2016); (4) recall more information from the text and inferred more unknown words (5) are better readers in *reading to summarize* and *reading to criticize* considering the quality of the summaries produced (PROCAILO, 2017).

Under the claim that the relationship between WMC and L2 reading has yielded mixed results, In'nami, Hijikata, and Koizumi (2021) carried out a meta-analysis with 74 studies on the topic. The authors added that moderator variables such as *task variables* (WM and L2 reading measures/tasks) and *learner variables* (proficiency level) needed further examination. The authors found a weak relationship between L2 reading and WM, which seems to align with previous meta-analyses. They explain that "repeatedly obtaining relatively weak relationships across meta-analyses suggests that the impact of WM on L2 reading is small but consistent" (IN'NAMI; HIJIKATA; KOIZUMI, 2021, p. 17). Some interesting findings regarding the moderators[20] affecting this relationship should be highlighted.

First, task content (whether span tasks were verbal, nonverbal, or combined) did not moderate the relationship between WM and reading comprehension, lending support to the *domain-general view of WM* "that WM is involved in maintaining and processing relevant information requiring complex cognition, such as language comprehension across domains, and is not limited to processing particular linguistic stimuli" (IN'NAMI; HIJIKATA; KOIZUMI, 2021, p. 17). The *domain-general view of WM* claims that individuals with higher working memory capacity might have "more attentional resources to perform a task regardless of the specific nature of the task" (CONWAY, 1996, p. 579), as opposed to the *task-specific view* that posits that "individual's capacity varies according to the efficiency in relation to the processes correlated with a particular task" (BAILER; TOMITCH; D'ELY, 2013, p. 142).

[20] Moderators are variables that moderate (affect) the correlation between two variables (MODERATOR VARIABLE, 2022)

Second, regarding the language used in WM span tasks (whether L1 or L2), results showed that reading significantly correlated to L2 WM span tasks, which seems to be in line with some studies (ALPTEKIN; ERÇETIN, 2009; SHIN, 2020) but differs from other studies in the field (LINCK et al., 2014; TOMITCH, 2020). Despite the results obtained, the authors advise “use L1 WM measures to minimize interference of L2 proficiency with WM capacity” (IN’NAMI; HIJIKATA; KOIZUMI, 2021, p. 17), converging with previous studies (OLIVEIRA; TOMITCH, 2021; TOMITCH, 2003; WOELFER; TOMITCH, 2019).

The third and last moderator variable regards the WM task mode, to say, paper-based or computer-based. In’nami and colleagues explain that WM task mode did not moderate WM-L2 reading relationship, in line with a recent study, carried out by Oliveira, Woelfer and Tomitch (2021), which compared the paper-based version of the reading span test (DANEMAN; CARPENTER, 1980; TOMITCH, 2003) with a self-administered computer-based version of the same test. The test was validated given that “the results show a statistically significant moderate positive correlation between the two versions” (OLIVEIRA; WOELFER; TOMITCH, 2021, p. 63).

All in all, In’nami and colleagues’ meta-analysis brings important collaborations to the understating of the relationship between working memory capacity and L2 reading, especially those related to moderator variables, such as task content, language of the span tests, and WM span test mode, all of which are somehow tapped in this piece of research. In addition to that, working memory capacity plays a fundamental role in explaining how individuals differ in complex cognitive tasks.

In relation to individuals’ ability to multitask, for instance, a recent study hypothesized that “working memory would be a robust predictor of effective multitasking” (POLLARD; COURAGE, 2017, p. 452), and thus set out to investigate whether individual differences in WMC played a role in a study task. Pollard and Courage (2017) had participants read a study article under one of the three conditions: (1) Multitasking, in which they had to attend both to the TV in the background and reading the study material; (2) Ignore, in which participants had to only read and ignore TV; and (3) control – either reading or watching TV, in which questions about it would be asked later. Results have

shown that participants with higher working memory capacity were also the ones with better performance in the multitasking condition, which led the authors to claim that “working memory capacity predicts effective multitasking” (POLLARD; COURAGE, 2017, p. 450).

Buchweitz (2012), on the other hand, did not find correlations between WMC and multitasking performance. The study had twelve college students listen to either a single spoken sentence or two concurrent sentences (different sentences for each ear) and judge them accordingly while they were scanned using fMRI. The Reading Span Test (DANEMAN; CARPENTER, 1980) was used for investigating WMC. Despite the lack of evidence for correlations between WMC and multitasking ability, an interesting feature regarding functional properties of multitasking in the brain was found. Participants with lower working memory capacity presented larger time shifts in brain activation peaks in the multitasking condition, suggesting that the human brain seems to adapt to the demands of multitasking. In a review of studies of multitasking, Bailer and Tomitch (2016) observe that “lower WMC participants displayed larger time shifts may be because they were not as able as higher capacity individuals to keep the results of two areas activated together when there were so many results to keep active” (p.426).

Given the mixed results, it seems that individual differences in working memory capacity deserve further investigation. Thus, in this study, it is predicted that higher working memory capacity individuals could be better multitaskers than their lower working memory counterparts. The next section shall approach individual differences in working memory capacity considering digital reading as a multilevel construct, devised into literal and inferential comprehension dimensions.

## 2.3. ESTABLISHING THE NICHE: REVIEWING PREVIOUS STUDIES ON READING AND MULTITASKING

> “Researchers typically treat reading comprehension itself as a global construct, paying little attention to its multilevel representational architecture and the role played by each level in comprehension” (ALPTEKIN; ERÇETIN, 2009, p. 628).

The multilevel representational architecture described by the cited authors regards the *lower-level* of comprehension (literal comprehension) and the *higher-level* of comprehension (inferential comprehension), as described in section 2.1.1. To start with, it is important to make an explanation on the meaning of the words *lower-* and *higher-* levels of comprehension, which, according to Grabe (2009) “lower-level does not mean that they are simple or undemanding; rather, they form a group of skills that have the potential to become strongly automatized” (p. 21); which is crucial for fluent reading, like decoding and literal comprehension. Higher-level comprehension processes, in its turn, are called so due to the requirement of attentional resources for carrying out more complex operations such as integrating, building main ideas and elaborating on the text read (ALPTEKIN; ERÇETIN, 2009; GAGNÉ; YEKOVICH; YEKOVICH, 1993; GRABE, 2009).

Human's cognitive system, more specifically working memory, is limited in its capacity of holding and manipulating information (BADDELEY, 2012), in addition to the fact that individuals vary in their working memory capacity (DANEMAN; CARPENTER, 1980) in the realm of reading results in comprehension being constrained by individuals’ working memory capacity (DANEMAN; CARPENTER, 1980; JUST; CARPENTER, 1992; TOMITCH, 2003). In their *Capacity Theory of Comprehension*, Just and Carpenter (1992) explain that “when the task demands are high enough to strain capacity, individuals with smaller working memory capacity should be less able to perform computations quickly or store the intermediate products” (p. 143), which in fact, has been evidenced along the years (IN’NAMI; HIJIKATA; KOIZUMI, 2021; LINCK et al., 2014; TOMITCH, 2020). Additionally, “depending on the reader’s interaction with a given level [lower or higher] working memory capacity is differentially involved” (ALPTEKIN; ERÇETIN, 2009, p. 628), in the sense that literal comprehension demands less working memory resources in relation to inferential comprehension in proficient reading (JUST; CARPENTER, 1992). With this in mind, the first subsection is devoted to reviewing studies which approached individual differences in terms of working memory capacity in both literal and inferential comprehension processes. Ideally, for this study, it would have been expected a review of studies investigating individual differences in literal and inferential comprehension in

multitasking situations; however, to the best of our knowledge, there seems to lack of studies focused on this issue. In fact, in the forthcoming section (2.3.2), two studies that manipulated the comprehension questions to tackle both literal and inferential comprehension will be reviewed, to mention Lin, Lee and Robertson (2011) and Cho, Altarriba and Popiel (2015). It is important to note, however, that neither of them investigated individual differences in working memory capacity.

The second subsection of section 2.3, in its turn, reviews studies in multitasking where reading is one of the tasks, considering the shared knowledge on the topic, as Clinton-Lisell (2021) points out: (1) multitasking whilst reading is a fact; (2) cognitive resources are limited; (3) this is not a brand-new topic of investigation. However, some issues are still left unresolved, such as the comprehension measures used in studies involving multitasking and reading. To be more specific, some studies under the term of reading comprehension have measured comprehension using multiple-choice questions, which seem to be limited for assessing the complexity of reading comprehension (RUPP; FERNE; CHOI, 2006). With this in mind, the aforementioned subsection shall bring some arguments on the shortcomings of multiple-choice (henceforth MC) questions for assessing reading comprehension in reading research, followed by a review of recent studies on multitasking in reading which have used such reading assessment methodology. Then, a study which did not use MC questions but is relevant to the scope of the investigation reported in this Dissertation will be presented.

The third and last subsection will approach the multitasking niche that this study investigated: reading while listening to music. A short historical background on research on the topic is presented, followed by some recent research avenues, such as the role of music in the human reward system, eye movements during reading and listening to music, and the relationship between music listening and reading outcomes.

### 2.3.1. Working memory capacity in literal and inferential comprehension of digital texts

Starting with the study of the opening quotation of this section, Alptekin and Erçetin (2009) investigated the relationship of working memory to second language reading, more specifically, (1) whether literal and inferential comprehension were tapped by different reading tasks; and (2) whether two types of RST tasks impacted literal and inferential comprehension. Thirty Turkish undergraduate students participated in the experiment (between-subject design), which consisted of reading a narrative text on a computer screen. Literal and inferential comprehension was assessed by means of multiple-choice questions devised according to Pearson and Johnson's taxonomy (1978), the same used in this study. *Textually explicit* questions tapped literal comprehension, whilst *textually and scriptally implicit* questions tapped inferential comprehension.

As for the procedures for RST, a modified version of Daneman and Carpenter's (1980) test was used, consisting of unrelated sentences followed by a grammaticality judgment test to ensure sentence processing. A key aspect of this study regards the use of sentences in participants' L2 (English), under the argument of an L2 working memory predicting L2 syntactic comprehension (MIYAKE; FRIEDMAN, 1998 apud ALPETKIN; ERÇETIN, 2009, p. 631) and L2 reading comprehension (HARRINGTON; SAWYER, 1992; WALTER, 2004 apud ALPETKIN; ERÇETIN, 2009, p. 631). Another important feature of this study was the measurement of the storage component of WM by means of recall and recognition tasks. In terms of recognition RST, participants selected sentence-final words from a given list, as opposed to recall RST, in which participants reported sentence-final words (ALPTEKIN; ERÇETIN, 2009). These two RST procedures were used given the inquiry of whether these different testing procedures have an impact on studies on individual differences in reading comprehension, under the hypothesis that "the use of these typologically different questions may induce response outcomes that shape the construct" (ALPTEKIN; ERÇETIN, 2009, p. 630).

Results from Alptekin and Erçetin's study confirmed their hypothesis that recall-based RST is related to inferential comprehension but not to literal comprehension. The authors explained that the recall procedure demands the same processes used in inferential comprehension. In addition to that, despite similar performance in both groups, participants in the recognition RST were better in the storage component of WM, while

those in the recall RST showed more individual differences in WMC in inferential comprehension. The authors argue that the recall RST demands more from WM because it needs to retrieve information stored in long-term memory (LTM) using “internally generated retrieval cues” (ALPTEKIN; ERÇETIN, 2009, p. 634). Last, the positive correlation between L2 inferential comprehension and L2 recall-based RST enabled these researchers to claim that these two tasks tap similar cognitive resources, that is, “reasoning beyond the text or integrating several relevant pieces of information across paragraphs requires similar cognitive abilities as those characteristic of span task” (ALPTEKIN; ERÇETIN, 2009, p. 636).

A similar study was also carried out by Alptekin and Erçetin, who investigated the relationship between working memory in L1 (Turkish) and L2 (English) and L2 literal and inferential comprehension. In their 2009 study, the authors measured WMC by means of the RST in English only. In their 2010 study, however, they hypothesized that regardless of the language used in the RST, WMC in either language would be deployed for reading comprehension (ALPTEKIN; ERÇETIN, 2010). Alptekin and Erçetin (2010) also hypothesized that higher-span readers would be better at storing and processing in the L1 than in the L2. Last, they speculated that “a stronger relationship would be observed between L2 WM capacity and literal and inferential comprehension in the L2 than between L1 WM capacity and literal and inferential comprehension in the L2” (ALPTEKIN; ERÇETIN, 2010, p. 209).

Thus, the RST was administered in both languages, with a two-week interval between sessions. As for comprehension measures, twenty multiple-choice questions devised according to Pearson and Johnson’s (1978) taxonomy were used, similar to their 2009 study. Forty-three Turkish bilinguals who attended university participated in the study. Their findings showed that processing in L2 proficient participants is better in L1, but no differences were found in storage. In a nutshell, the authors concluded that “WM capacity interacts with language proficiency in that differences between L1 and L2 reading spans are less significant in the case of proficient L2 users” (ALPTEKIN; ERÇETIN, 2010, p. 213). Nevertheless, a recent meta-analysis has found correlations between L1 and L2 measures of WM and L2 reading, that is to say, “L2 reading with L1 and L2 WM measures

was of similar size across high- and low-proficiency learners" (IN'NAMI; HIJIKATA; KOIZUMI, 2021, p. 18), opposing, therefore, Alptekin and Erçetin's claim that L2 WM and L2 reading would be analogous to L1 WM and L2 reading. In fact, L2 proficiency as a confounding factor deserves further examination (LINCK et al., 2014; SHIN, 2020).

Alptekin and Erçetin (2010) also found correlations between L1 and L2 span tasks, which confirmed their hypothesis that WMC would be deployed irrespective of the language being used[21]. Last, literal comprehension did not correlate with any WM span task, suggesting that literal comprehension depends on "language proficiency and surface readability features (e.g. decoding, syntactic parsing) and, consequently, does not impose on WM capacity a heavy 'intrinsic' cognitive load, that is, the load determined by the inherent complexity of the reading task itself" (ALPTEKIN; ERÇETIN, 2010, p. 214). The authors evidenced that higher levels of L2 proficiency might have contributed to both *micro*- and *macrostructure* formation without posing a burden to WM. Inferential comprehension, in its turn, correlated with L2 WM, through the L2 RST, which lead the authors to claim that "L2 inferential comprehension seems to be directly related to L2 WM capacity rather than to L1 WM capacity" (ALPTEKIN; ERÇETIN, 2010, p. 213).

On the grounds of a lack of studies interested in both content familiarity[22] and working memory capacity on literal and inferential comprehension in L2 reading, Alptekin and Erçetin (2011) speculated whether (1) L2 WMC would affect L2 literal and inferential comprehension; (2) content familiarity would affect literal and inferential comprehension; (3) there would be an interaction between WMC and content familiarity on literal and inferential comprehension. Sixty-two Turkish university students took part in the study, which consisted of a RST in L2, reading a nativized[23] text and answering some multiple-choice comprehension questions. The former adopted the same procedures as the 2009 and 2010 studies, using Pearson and Johnson's (1978) taxonomy.

---

[21] For a comprehensive debate on WM Task Language, see Shin (2020) and In'nami, Hijikata and Koizumi (2021).
[22] Content familiarity refers to domain knowledge (ALPTEKIN; ERÇETIN, 2011), or schemata, that is, readers' background knowledge (CARRELL; DEVINE; ESKEY, 1988).
[23] Nativization consists of adapting the text to the social context of the readers, which included changing settings, locations, characters and occupations, and culture specific customs and beliefs (ALPTEKIN; ERÇETIN, 2011).

Results have demonstrated that the L2 RST was significantly related to inferential comprehension, but not to literal comprehension. In other words, “while both high- and low-span readers’ performance in literal understanding was similar irrespective of the content type used […] high-span readers outperformed low-span readers in inferential comprehension” (ALPTEKIN; ERÇETIN, 2011, p. 255). The authors explained that lower and higher span readers’ similar performance in literal comprehension might have occurred due to higher levels of proficiency, thus, WM resources have not been extensively used. In inferential comprehension, in its turn, more resources were needed to draw inferences, which explains why higher-span readers outperformed their lower-span counterparts (ALPTEKIN; ERÇETIN, 2011).

Results have also shown that content familiarity facilitates inferential comprehension only. The authors explained that domain knowledge might have enriched the processing of inferencing, while literal comprehension remained unaffected due to overreliance on the surface of the text. Interestingly, Alptekin and Erçetin endorse that literal and inferential comprehension would function independently, that is to say, "the LTM contributions that allow for content familiarity to promote inferential comprehension in the L2 do not necessarily cater to the improvement of literal understanding, thereby suggesting that higher-order and lower-order reading operations reflect independent cognitive systems at work” (ALPTEKIN; ERÇETIN, 2011, p. 257). Last, results have rejected the hypothesis that there would be an interaction between WMC and content familiarity on literal and inferential comprehension, leading the authors to suggest that “WM capacity and content familiarity operate independently, and their effects on L2 reading comprehension are additive rather than interactive” (ALPTEKIN; ERÇETIN, 2011, p. 257).

Moving to the Brazilian context, one study[24] investigated inference generation and WMC in digital reading (PROCAILO; TOMITCH, 2020). This study departs from the

[24] Only this study fit the purpose of this section. Studies such as Fontanini and Tomitch (2009), which compared linear and hypertext L2 reading and WMC, and Roscioli and Tomitch (2021), which investigated the influence of WMC on inferential comprehension, were considered for this section, but both did not match the scope of the discussion. The former did not approach the literal and inferential dimensions of reading, despite the fact that comprehension questions addressing such dimensions were included in the study. The latter, in contrast, approached paper-based linear reading.

concept of text linearity, in which linear texts refer to “the straightforward sequence of interrelated words, phrases, paragraphs” (FONTANINI, 2007, p. 43) and are more connected to traditional text formats (FONTANINI; TOMITCH, 2009), while non-linear texts are defined as such “for containing links and nodes in which information is conveyed by the writer and accessed by the reader according to the latter’s choices and needs” (PROCAILO, 2017, p. 19), also known as hypertexts.

Procailo and Tomitch (2020) investigated digital reading in L2 delving into two reading purposes, to say, reading to criticize and reading to summarize. In addition to that, the authors explored whether WMC and purpose played a role in strategy use. Firstly, it is important to mention that two formats of digital texts were considered in their study, *linear* and *nonlinear* texts. Having said that, Procailo and Tomitch (2020) explored (1) what types of inferences were drawn by lower and higher WMC readers in linear digital text and nonlinear hypertext reading; (2) how WMC relates to argument recall in each text format; and (3) how WMC relates to reading purpose, that is, reading to summarize and criticize. Thirty Brazilian university students, all proficient in English, participated in the study composed of three tasks, to say, reading a digital linear text and a hypertext (between- and within-subject design) containing controversial issues; taking an RST in Brazilian Portuguese; verbalizing whatever came to their minds while reading (Verbal Protocol). Participants’ verbal reports were categorized according to Linderholm and van den Broek’s (2002) framework[25].

Results indicate a trend suggesting differences between lower- and higher-span readers in inference generation and strategy use. Lower-span readers have found strategies while reading the hypertext, which enabled them to “elaborate, evaluate and associate more when reading to criticize” (PROCAILO; TOMITCH, 2020, p. 344). However, they generated more misunderstandings in digital linear reading, both in reading to summarize and to criticize. As opposed to that, higher-span readers generated more

[25] Linderholm and van den Broek categorized inferences into “associations, evaluative comments, elaborative inferences, predictive inferences, reinstatement inferences, metacognitive comments, paraphrases, […] text repetitions,[…] summarizations (main idea of the paragraph) and misunderstandings” (PROCAILO; TOMITCH, 2020, p. 331–332). For a complete explanation on each type, see page 780 (available here).

paraphrases and summarizations, which are more cognitively demanding. The authors add that “during hypertext reading, qualitative analysis shows that both groups took decisions that could benefit the process: link access shows more commitment to explore the entire text in this condition” (PROCAILO; TOMITCH, 2020, p. 344). Similarly, the authors found that reading to summarize is more demanding than reading to criticize, according to results of argument recall. However, no statistical significance was obtained among conditions. Last, a moderate correlation among conditions showed that lower-span participants had longer reading times when reading to summarize (PROCAILO; TOMITCH, 2020). All in all, “while low-spans found strategies to cope with the constraints of the task, high-spans relied on text-based inferences, producing more summarizations, text repetitions, and paraphrases, ending up producing more concise and comprehensive summaries” (PROCAILO; TOMITCH, 2020, p. 346).

In this section, some studies that consider the multilevel representational architecture of digital reading in a second language[26] were reviewed. Overall, these studies indicate that working memory capacity seems to be more related to inferential comprehension rather than to literal comprehension. Specifically, Alptekin and Erçetin (2009) showed that recalling final words, instead of only recognizing them, correlated with inferential comprehension but not with literal comprehension. Similarly, they found that the reading span task conducted in the participants’ L2 correlated with L2 inferential comprehension (ALPTEKIN; ERÇETIN, 2010). Additionally, Alptekin and Erçetin (2011) found that domain knowledge and WMC, functioning independently, seem to support inferential comprehension. Despite the fact that the studies from Alptekin and Erçetin (2009, 2010, 2011) approached linear-digital reading, as opposed to nonlinear digital reading (hypertext), their findings are important for understanding literal and inferential comprehension in the context of additional language reading. Last, Procailo and Tomitch (2020) found that inference generation varies according to individual differences in working memory capacity, in line with previous studies.

[26] As mentioned in the introduction, I adopt a view of English as a Lingua Franca (FINARDI, 2016). However, given the fact that the researchers of the reviewed studies adopt views of English as second/foreign language, the term L2 was used in this section.

### 2.3.2. Reviewing studies on multitasking and reading

According to Rupp and colleagues (2006) comprehension is poorly assessed by Multiple-Choice (MC) questions, due to their overreliance on what is explicitly stated in the text and lack of integration between text information and the reader's background knowledge. To be more precise, the semantic underpinning of a text is formed by the junction of the microstructure and the macrostructure – the textbase (KINTSCH, 1998, 2013). At the sentence level, the microstructure conveys the meaning of the text in the form of propositions, while the macrostructure is the global organization of these ideas (KINTSCH, 1998; KINTSCH; RAWSON, 2005). It is hypothesized, therefore, that in MC questions, test-takers segment text into chunks according to prompts given in the questions, over-relying on the textbase[27] (RUPP; FERNE; CHOI, 2006), which is problematic due to the fact that a situation model[28] needs to be built on the text read, otherwise comprehension will be shallow (KINTSCH; RAWSON, 2005).

Ozuru and colleagues (2013) suggest that test-takers might over-rely on prior knowledge in order to answer MC questions. In their comparison of comprehension measured by open-ended and MC questions, the authors found that MC was correlated with the level of prior knowledge participants had on the text used in the experiment, because the information contained in the prompts of the MC question serves as a cue for retrieval of information. In open-ended questions, on the other hand, some sort of active processing is needed so that test-takers can answer the question correctly (OZURU et al., 2013). In sum, open-ended questions and MC questions "measure different aspects of comprehension processes" (OZURU et al., 2013, p. 215).

Aebersold and Field (1997) argue that MC questions may be used to confuse the test taker instead of assessing comprehension. The authors present some arguments against the use of MC questions, for instance, (1) test-takers might guess the correct

[27] The textbase represents the literal meaning of the text, as intended by the author of the text (KINTSCH; RAWSON, 2005; KINTSCH, 1998). Kintsch (1998) explains that comprehension usually entails supplementing background knowledge from the reader.
[28] The Situational Model, therefore, is the junction of the "text-derived propositions (the textbase)" and background knowledge from the reader (KINTSCH, 1998, p. 49).

answer preventing the researcher to assess comprehension; and (2) the distractors created in these type of questions are unfair since there are answers which are too close to the correct one (AEBERSOLD; FIELD, 1997).

Moving to the studies which investigated multitasking in reading, Fox and colleagues (2009) investigated whether instant messaging (IM) was detrimental to comprehension under the hypothesis that IM affected reading comprehension. Sixty-nine undergraduate students from a psychology course participated in the study whose conditions consisted of having half of the participants interact via instant messenger while reading a passage (the IM condition); participants reading the text after having chatted via instant messenger (no-IM condition). Participants' reading times were recorded. After reading the text, participants answered the comprehension test which consisted of multiple-choice questions, which, according to the authors, would test recognition memory and fill-in-the-blank questions in order to measure recall memory. Their hypothesis that multitasking affects text recognition and recall was not supported. However, participants in the IM condition did take longer to complete the multiple-choice test, which seems to be normal considering that participants were switching between tasks – reading and instant messaging.

Similarly, Bowman and colleagues (2009) examined instant messaging while reading a textbook in a group of eighty-nine psychology students. Three experimental conditions were used, IM before reading, IM during reading, and no IMs (control). The authors found that participants took longer to read the passage when they IM during reading in comparison to the remaining experimental conditions. Bowman and colleagues' study had some methodological shortcomings, such as the use of multiple-choice questions for measuring comprehension and the fact that the IM before reading group received some instructions that differed from the other groups, as Bailer and Tomitch (2016) highlighted in their review of studies of multitasking. Bowman et al. (2009) concluded that multitasking demands more time for achieving an academic task, a similar finding to Fox et al.'s study.

Lin and colleagues (2011) investigated the effect of watching videos on reading comprehension of university students. Of a total of 130 participants, 29 read expository

texts while some videos were playing in the background (background condition), while 36 simultaneously attended to reading and watching, since they would be tested for comprehension later (test condition). The remaining 65 participants completed both experiments. Two different videos were used, one comedy video and one news video, followed by six MC questions. Despite the use of MC questions, the authors devised the questions as “basic knowledge […] intermediate level […] and in-depth analysis level questions based on Bloom’s Taxonomy” (LIN; LEE; ROBERTSON, 2011, p. 189), which seems to resemble Pearson and Johnson’s Taxonomy for comprehension questions.

Results of Lin and colleagues’ study have shown that, on the background condition (with the news video), participants performed better in reading comprehension than in video comprehension. On the test condition, under the same type of video, participants performed better in video comprehension than in reading comprehension. As for the comedy video, both in the background and test condition, participants performed better in reading comprehension than in video comprehension, leading the researchers to conclude that “different types of video content did affect students’ reading comprehension differently, especially under the test environment” (LIN; LEE; ROBERTSON, 2011, p. 192). On the other hand, the participants who watched both videos, those in the background condition had greater comprehension scores[29] in relation to those in the test condition when watching the news. There were no significant differences in the comedy video between conditions (LIN; LEE; ROBERTSON, 2011 for a detailed account). The fact that the news video interfered with reading comprehension led the researchers to infer that emotion plays a role in multitasking performance, considering that the content of the news video was an accident where people died and were injured.

Tran and colleagues (2013) examined the effects of multitasking on reading expository texts in three experiments which simulated several media multitasking situations. In the first experiment half of the participants (of a total of 35 college students) concurrently read a text and communicated online, while the other half did the same in a

[29] These comprehension scores entail a combination of “reading and video comprehension scores between the News Video and the Comedy Video under background and test environments” (LIN; LEE; ROBERTSON, 2011, p. 195).

sequential manner. After that, participants responded to multiple-choice questions on the text (primary task) and on the social messages (secondary task). The results of this experiment showed that, in both concurrent and sequential multitasking, participants did not significantly differ in comprehension. In fact, the authors noticed some limitations in their first experiment, such as participants' lack of interest in the secondary task, due to the experimental nature of it[30], leading them to carry out a second experiment to fill in the gap.

In the second experiment, researchers “examined the immediate effect of online communication when reading expository text on reading comprehension and the recall of content a week later” (TRAN; CARRILLO; SUBRAHMANYAM, 2013, p. 7). Besides, individual differences were controlled by ensuring that all participants performed the easy and difficult learning tasks, which were manipulated by the researchers. Ninety college students participated in the study that consisted in reading two texts (easy and difficult texts[31]) in a sequential and concurrent manner. Reading comprehension was assessed at the end of each reading using a multiple-choice test, which in fact, was also used to measure recall. To be more specific, “for the content recall test, the first and second authors generated multiple-choice questions about the details and themes presented in the passage” (TRAN; CARRILLO; SUBRAHMANYAM, 2013, p. 8). In fact, measuring recall with multiple-choice questions seems equivocal, given the fact that multiple-choice questions are considered a recognition test which is less demanding than a task that involves retrieval of information from memory (CARLISLE, 1999; TOMITCH, 2003). It was hypothesized that (1) “increasing cognitive load by manipulating learning task difficulty and multitasking would disrupt reading comprehension and content recall” (p. 10) and (2) frequent multitaskers would have lower scores on reading comprehension and content recall (TRAN et al., 2013). Results have partially supported the first hypothesis and have not supported the second. However, the manipulation of text difficulty (what the authors

[30] The authors explain that “the content of the social messages was somewhat superficial, and most answers were short, and the resulting conversation was limited” (TRAN; CARRILLO; SUBRAHMANYAM, 2013, p. 7).

[31] Text difficulty was measured in terms of percentage of errors in previous versions of the SAT (TRAN; CARRILLO; SUBRAHMANYAM, 2013).

called an increase in cognitive load) consisted of data provided by SAT developers, “which detailed the percentage of test-takers who correctly answered each reading comprehension question for a given passage” (TRAN; CARRILLO; SUBRAHMANYAM, 2013, p. 8). However, according to Rupp et al. (2006), multiple-choice questions such as the ones used in SAT are more of a problem-solving task than creating a mental representation of the text and by relying on the microstructure of the text to answer the MC questions, readers may not deliver a macrostructure of the text which contains the main idea (RUPP; FERNE; CHOI, 2006).

In experiment 3, researchers added a filler task to make sure that both conditions were similar. Forty college students took part in this experiment, which was quite similar to the previous one, except for the filler task (TRAN; CARRILLO; SUBRAHMANYAM, 2013). Again, results showed that multitasking did not disrupt reading comprehension. Overall, the researchers concluded that their hypothesis that “simultaneously engaging in a secondary online communication task would impair performance in a primary academic learning type task was not supported” (p. 12). In fact, their findings have suggested that the level of difficulty of the secondary task might have influenced the primary task.

Also, Fante and colleagues (2013) investigated the extent to which IM would affect reading comprehension and reading efficiency[32] in a population of undergraduate students from a North American public university. The authors hypothesized that (1) the great amount of instant messaging (IM) would disrupt comprehension; (2) text difficulty would disrupt comprehension in a multitasking condition and (3) multitasking would lead to a time increase for completing the tasks, namely, efficiency. The study consisted of four conditions, split into two criteria, text difficulty (easy and difficult) and multitasking (IM or no-IM). The forty participants of the study were randomly assigned to one of the conditions. The participants assigned to the experimental groups (IM while reading either the difficult or easy text) were instructed to respond to messages while reading a text, but not while answering the ten MC comprehension questions. The control groups (participants reading either the easy or difficult text) had only to read and answer the

[32] The authors hypothesized that performance efficiency concerned the length of time taken to complete the task (FANTE; JACOBI; SEXTON, 2013).

questions. The results have shown that IM did not affect reading comprehension nor did interact with text difficulty, however, text difficulty affected comprehension “regardless of the IM condition” (FANTE; JACOBI; SEXTON, 2013, p. 294). The authors also found that IM affected reading times, regarding text difficulty.

Under the premise that students multitask while studying, Pashler and colleagues (2013) carried out three experiments to investigate the effects of multitasking. For the purpose of this study, I will only approach the experiment which dealt with reading (experiment 1)[33]. Previous studies have found increased reading times in multitasking environments (BOWMAN et al., 2010; FANTE; JACOBI; SEXTON, 2013; FOX; ROSEN; CRAWFORD, 2009). With that in mind, Pashler et al. (2013) investigated the relationship (if any) between increased time in multitasking and performance on the proposed tasks of their experiment. One hundred and nine undergraduate students participated in the experiment which had three conditions: 1) reading-only (control); 2) reading and texting with interruptions at the end of paragraphs (multitasking- paragraph break); 3) reading and texting with random interruptions. A pop-up window appeared on a computer screen while reading an expository text so that participants had to engage in a conversation. Reading comprehension was measured via 25 questions (18 true/false and 7 multiple-choice). Similar to previous studies, reading time increased in the multitasking condition, and the only significant difference was found between the control condition and multitasking with random interruptions, that is, those moments when the participant was reading and the experimenter decided to text message the participant (PASHLER; KANG; IP, 2013). Regarding comprehension, the researchers did not find any significant difference among conditions.

Cho and colleagues (2015) investigated the conditions in which multitasking is detrimental to reading comprehension in two experiments. In the first experiment, participants underwent all the conditions (also known as within-subject design): (1) control; (2) trivia questions; and (3) math problems. The participants read expository texts and answered comprehension questions comprised of factual and conceptual

[33] Experiments 2 and 3 dealt with listening comprehension of a narrative text (PASHLER; KANG; IP, 2013 for details).

knowledge[34], which differed from previous studies which relied only on multiple-choice tests. The procedure consisted of participants (36 university students) reading paragraphs while they were presented with trivia questions[35] and math problems (CHO; ALTARRIBA; POPIEL, 2015). The results from this experiment revealed that multitasking did not impair reading comprehension in any of the conditions. Interestingly, the authors found that the interruptions allowed readers to completely disengage from the reading comprehension, thus not placing any load on working memory, which according to the authors was a limitation approached in the second experiment.

The second experiment consisted of having participants (thirty university students) remember a string of numbers, read a passage and then recall the set of numbers. The experimental conditions were 1) control; 2) remembering two digits – low cognitive load; and 3) remembering five digits – high cognitive load (CHO; ALTARRIBA; POPIEL, 2015). The results showed that participants had more difficulty remembering the numbers, and comprehension and also suffered from the cognitive load placed by the tasks. However, WMC was not considered a variable to be investigated in their study, opening the gap to be investigated.

All in all, the studies reviewed so far leave some issues to be investigated. The first one, as has been repeatedly mentioned along this section, regards the instrument for assessing participants' comprehension. In the field of reading research, there is plenty of arguments on the shortcomings of using multiple-choice questions, such as 1) the overreliance on the textbase, which is not enough for constructing the situation model of the text read; 2) the risk of participants' solely depending on prior knowledge for answering MC questions; 3) the fact that participants are overly exposed to wrong answers which might cause confusion. The second issue left unanswered by the studies reviewed here is whether working memory capacity predicts individuals' performance in multitasking. Cho and colleagues (2015) acknowledged that WMC plays an important role in

[34] Factual knowledge is equivalent to textually explicit information while conceptual knowledge is equivalent to scriptally implicit information (PEARSON; JOHNSON, 1978).
[35] Trivia questions consisted of general knowledge questions, such as "what is the largest desert on earth?". The questions were taken from Nelson and Narens norms (PIETSCHNIG; VORACEK; FORMANN, 2010)(TAUBER et al., 2013 as cited in CHO, ALTARRIBA, POPIEL, 2015).

multitasking, however, they did not include it as a variable in their study. With this in mind, the present investigation addressed such limitations by using free recall and comprehension questions for assessing participants' comprehension and by including participants' working memory capacity measures as a dependent variable, as shall be detailed in the method chapter. Next, I will provide an overview of reading and listening to music, which are the variables investigated here.

### 2.3.3. Reading and listening to music

The study of the effects of music on cognitive tasks is not new. Back in 1993, Rauscher and colleagues advocated for a "Mozart Effect", which consisted of improvements in spatial reasoning ability (as measured by IQ tests) due to listening to Mozart for ten minutes daily. The so-called Mozart Effect led many researchers to investigate this issue, but meta-analyses showed that the improvements were due to arousal caused by the enjoyment of music (CHABRIS, 1999; STEELE; BASS; CROOK, 1999). More recently, a group of researchers in the Faculty of Psychology of the University of Vienna in Austria conducted a meta-analytic review on the issue and found little evidence for the Mozart Effect (PIETSCHNIG; VORACEK; FORMANN, 2010).

Likewise, in the field of education, the interest in the effects of background sounds on reading outcomes dates back to 1917-18, as described by Vasilev, Kirkby and Angele (2018). By background sounds, we refer to speech, noise, and music. In fact, a series of studies have been conducted on the effects of speech (SALAMÉ; BADDELEY, 1982), noise (SALAMÉ; BADDELEY, 1987), and music (SALAMÉ; BADDELEY, 1989) on the serial recall of verbal material. Speech seems to affect recall, while white and pink noise[36], on the other hand, produced diverging results, leading the authors to question whether

[36] Salamé and Baddeley did not bring a definition for white noise, but according to Castro (2013), white noise consists of "random noise that has a flat spectral density" meaning the noise has equal amplitude or intensity, along an audible frequency range (20 to 20,000 hertz). Pink noise, on the other hand, is defined by Salamé and Baddeley (1989, p. 116) as "sound pressure is held constant across all the constituent octaves", that is, it is more intense at lower frequencies, creating, therefore, a deep sound.

vocal music (or lyrical[37] music) would be equated to speech and instrumental music to white/pink noise. Therefore, Salamé and Baddeley (1989) set out to explore the differences that instrumental and vocal music would make in the serial recall of verbally presented digits. In summary, the authors found that lyrical music was more disruptive in relation to instrumental music and silence. Salamé and Baddeley (1989) suggested, therefore, that background music, especially lyrical music, would disturb working memory, affecting therefore other complex cognitive tasks.

More recently, researchers have had several interests regarding multitasking involving music, such as eye movements while reading and listening to music (JOHANSSON et al., 2012; ZHANG et al., 2018); motivations for listening to music while performing another task (KONONOVA; YUAN, 2017); the role of listening to familiar music in the limbic and reward systems of the brain (PEREIRA et al., 2011); and the effects of liked[38] music on reading performance (JOHANSSON et al., 2012; PERHAM; CURRIE, 2014).

Johansson and colleagues (2012) set out to investigate whether reading comprehension was impaired by different listening conditions, to say, (1) listening to preferred music; (2) listening to non-preferred music; (3) under a café noise; and (4) in silence, and how comprehension was affected by these conditions. Johansson and colleagues (2012) had twenty-four university students, whose native language was Swedish, undergo the four conditions. After reading the texts, participants answered the MC comprehension questions from a standardized test (Swedish Scholastic Assessment Test), and for all conditions, the comprehension section was performed in silence. Since their study used eye-tracking technology, participants had to read the text on a computer screen, which resembles digital reading.

[37] Lyrical music in this study refers to songs with lyrics, so it should not be confused with the music genre. Despite some dictionaries having presented lyrics as only related to the latter, several studies have used lyrical music to refer to songs with lyrics (to mention ANDERSON; FULLER, 2010; PERHAM; CURRIE, 2014).

[38] Some authors use liked music while other use preferred music to refer to music participants enjoy; therefore, the terms are used interchangeably.

The researchers expected that the eye-tracking experiment would show longer fixations; more regressions and more second-pass reading[39], which, in fact, did not happen (JOHANSSON et al., 2012). As for the comprehension section, interestingly, they found that participants performed more poorly in listening to non-liked music in relation to the silent condition, while liked music and background noise of a café did not show significant differences. The authors had hypothesized that liked music would enhance comprehension, which did not, but on the other hand, it did not impair as the non-liked music condition did. It is worth mentioning that the researchers only controlled the sound level of the auditory stimuli, lacking the control of other properties, such as tempo, genre, instrumental or vocal, posing some limitations in the generalization of their results.

In fact, Kämpfe et al. (2010) concluded, from their meta-analytic review of the effects of music, that "the tempo of background music strongly affects the tempo of the behavior of different kinds" (p.440). In other words, the characteristics of music, such as tempo, loudness, and whether it is instrumental or lyrical influence while reading. Fast and loud music, for instance, has been shown to disturb reading (THOMPSON; SCHELLENBERG; LETNIC, 2012). Kämpfe et al. (2010) also observed that the type of music might affect reading differently, whether it is instrumental or vocal, and whether pop or classical. All in all, music properties seem to play a role in the degree that comprehension is affected.

Johansson et al. (2011) acknowledged that individual differences were not the main variable in their study, however, they controlled for working memory capacity by using the Operational Span (OSPAN), which views working memory as a general construct. The Reading Span Test (RST), on the other hand, is a task-specific test which is highly correlated with reading comprehension (DANEMAN; CARPENTER, 1980; TOMITCH, 2020 for a review). Nevertheless, a study which used both the OSPAN (domain-general test) and RST (task-specific test) found correlations between both tests

[39] Rayner (1998) explains that, in eye-tracking experiments, Fixations refer to the amount of time the eyes fixate on a word that it is considered actual processing; Regressions refer to "right-to-left movements along the line or movements back to previously read lines" (RAYNER, 1998, p. 375) which means that readers might be having reading difficulties; and Second-Pass Reading consists of "the sum of fixations during re-reading", which is common in reading for studying purposes (JOHANSSON et al., 2012, p. 343).

with reading performance (BAILER; TOMITCH; D'ELY, 2013). All in all, Johansson et al. (2011) reported that WMC neither significantly correlated with the eye-movement data nor with the reading comprehension scores. They concluded that this lack of correlation is a result of participants having high working memory spans.

Johansson's study is the closest we have proposed to do here, nevertheless, some limitations need to be acknowledged in terms of working memory. First, their study did not find correlations between WMC and reading scores, as measured by OSPAN (JOHANSSON et al., 2012). This finding contradicts evidence that reading comprehension is conditional on working memory capacity as measured both by the RST and OSPAN (BAILER, 2011), which points to a need for further investigation on the relationship between WMC and reading in a multitasking environment. Second, as previously mentioned, Johansson and colleagues (2011) recognized that individual differences in working memory capacity was not the most important variable of their study, and it was only considered because "individual differences in working-memory capacity might, therefore, be important for reading comprehension performance in the presence of background noise (JOHANSSON et al., 2012, p. 341). They explained that WMC was considered in their post hoc analyses[40] with responses from personality tests (given that introverts and extroverts respond differently to music), and with participants' answers to a questionnaire on their music and study habits.

Listening to music while performing a primary task seems to have some compensatory effect, as research has shown. For instance, Kononova and Yuan (2017) found that 72% of North American college students (n=524) seem to listen to music in search of efficiency, enjoyment, and relaxation. Another study used fMRI to investigate whether the reward and limbic systems of the brain would be activated when listening to familiar music (PEREIRA et al., 2011, p. 3). Fourteen adults were asked to judge whether the pop/rock songs they heard were familiar or unfamiliar and whether they liked or not the songs. After that, during fMRI scanning, they were asked to relax and enjoy the music.

[40] Post hoc analyses are used "in order to find out which levels are statistically different from one another" (LARSON-HALL, 2010, p. 398).

The researchers found that familiarity triggered more brain activation in limbic, paralimbic, and reward structures of the brain, supporting, thus, their hypothesis that music familiarity is emotionally engaging (PEREIRA et al., 2011). With these results in mind, it is possible to raise the question of whether music familiarity plays a role in reading comprehension. They did not find, however, differences in activation for liked and disliked music.

This issue has been addressed by Perham and Currie (2014), who had thirty undergraduate students from South Wales University carry out reading comprehension tasks in several conditions, to say, silent, instrumental music, liked lyrical music, and disliked lyrical music (PERHAM; CURRIE, 2014). Participants read four passages and answered multiple-choice comprehension questions while listening to music using headphones. The researchers reported that both liked and disliked music were as disruptive for participants, while no significant differences were found between the silent and instrumental music conditions. Similar to Pereira et al. (2011) and Johansson et al. (2011) no difference was found between liked and disliked music.

Perham and Currie's study differed from previous ones in two interesting aspects: first, music was not in the background, participants listened to music in their headphones, which is a common practice when reading in public places. Second, participants listened to music while reading and answering the comprehension questions. To the best of our knowledge, it is not known how Brazilians would respond to such multitasking environment, which will be investigated in this study.

The aforementioned studies seem to agree that listening to music is detrimental to reading comprehension, both for adults (KÄMPFE; SEDLMEIER; RENKEWITZ, 2011) and teenagers (ANDERSON; FULLER, 2010). However, it is not clear whether individual differences and musical preference play a role. To be more precise, Johansson and colleagues (2011) did not find a correlation between working memory spans and reading comprehension, contradicting the extensive literature on WMC and reading outcomes (DANEMAN; CARPENTER, 1980; TOMITCH, 2020). Regarding musical preference, the literature presents mixed results. For instance, Perham and Currie found that both liked and disliked music equally impaired reading comprehension, while Johansson et al. found that disliked music was the most disturbing condition. However, there seems to be some

evidence that music works as a compensatory mechanism (KONONOVA; YUAN, 2017; PEREIRA et al., 2011). The main focus of this study is not to investigate these issues, but participants will have a chance to select the song to be used in their experimental session, as will be described in the method section.

Last, a very recent meta-analysis investigated the general effect of auditory distraction (background noise, speech, and music) on reading performance (VASILEV; KIRKBY; ANGELE, 2018). The study also calculated the probability that sound input is detrimental to reading performance. Results confirmed the detrimental effects of noise, speech, and music for reading comprehension[41]. The authors add that "the magnitude of the effects was small, but highly reliable, meaning that there was a very high probability that these should be detrimental to reading comprehension" (VASILEV; KIRKBY; ANGELE, 2018, p. 580). An interesting finding is that lyrical music was more disturbing than non-lyrical music. In fact, this finding has direct implications for theories of auditory distraction, as shall be reviewed shortly.

Our present study differs from Vasilev and colleagues in two important aspects. First, their control condition consisted of reading in silence, while our control condition consists of reading a hypertext while listening to non-lyrical music (more specifically, binaural beats), and our experimental condition consists of reading a hypertext while listening to lyrical music. Based on the review of literature, we understand that listening to music is detrimental to reading comprehension of linear texts, however, we are interested in investigating whether these effects are replicable for digital reading. Second, their participants were native speakers of the language in which they were reading, while in our study, participants are Brazilian Bilinguals (Portuguese/English pair).

The theoretical background of Vasilev et al.'s (2018) study brings an important review of theories of auditory distraction, as briefly summarized (based on VASILEV et al., 2019; VASILEV; KIRKBY; ANGELE, 2018). The first account is the *phonological-interference hypothesis*, based on Baddeley and Hitch's (1974) working memory model, more specifically in the *phonological loop*, the component which stores acoustic

[41] Since Vasilev and colleagues' study is a meta-analysis, the instruments for measuring reading performance were not mentioned.

information via vocal or sub-vocal rehearsal. The authors explain that background speech is filtered in by the *phonological loop*, in which not only sounds are processed but “visually presented items are also converted into a phonological code that is then fed into the store” (VASILEV et al., 2019, p. 1485), causing, thus, interference “with the storing and retrieval of visual information” (p. 1485), which results in distraction. This view claims “that any speech sound (intelligible or not) would interfere with reading. Acoustical noise, on the other hand, would not cause interference because it does not gain access to the phonological loop” (VASILEV et al., 2019, p. 1485). They explain that the phonological loop works as a filter for sounds, letting in speech sounds and out the non-speech sounds, which implicates that “any speech sound (intelligible or not) would interfere with reading” (VASILEV et al., 2019, p. 1485).

The *phonological-interference hypothesis* was then tested by Martin, Wogalter, and Forlano (1988) (as cited in VASILEV; KIRKBY; ANGELE, 2018; VASILEV et al., 2019), who found that intelligible speech was more detrimental to reading comprehension than unintelligible speech, which, according to them, happened due to semantic interference. The *semantic-interference hypothesis* posited that “the semantic properties of the irrelevant speech can interfere with building the semantic representations of the text that is being read” (VASILEV; KIRKBY; ANGELE, 2018, p. 571).

The third theory of auditory distraction is the *changing-state hypothesis* (HUGHES; JONES, 2001; JONES; MACKEN, 1993; JONES; MADDEN; MILES, 1992 apud VASILEV; KIRKBY; ANGELE, 2018, p. 571), which postulates that acoustic variations present in background sounds are responsible for distraction. Put another way, “interference is caused by background sounds that exhibit considerable acoustic variation but not by steady-state, aperiodic sounds that do not have such variation” (VASILEV; KIRKBY; ANGELE, 2018, p. 571). The authors explain that the changing state of sounds can interfere with the storing lexical information while reading and parsing processes, which are necessary for at least lower-level comprehension processes.

Last, the *duplex theory* argues that sounds may be distracting when interfering with the task at hand – *interference-by-process* – or when deviating attention from the task at hand – *attentional capture* (HUGHES, 2014, p. 30). In a reading task, for instance,

*interference-by-process* might occur when “the semantic processing of meaningful speech would interfere with the task because reading also requires semantic processing to extract the meaning of the text” (VASILEV; KIRKBY; ANGELE, 2018, p. 571). As opposed to that, *attentional capture* might happen when “an infrequent and usually unexpected change or deviation in auditory stimulation following a repetitive or continuous auditory input […] tends to trigger an attentional capture mechanism, an involuntary redirecting or orienting of the attentional focus toward the deviant event” (HUGHES; VACHON; JONES, 2007, p. 1051), such as when one is reading and is suddenly surprised by a loud noise coming from outside, for instance.

In the realm of this study, it is assumed that non-lyrical music – binaural beats – is not as distracting as lyrical music, considering that binaural beats feature steady intensity (GARCIA-ARGIBAY; SANTED; REALES, 2019), as predicted by the *changing state-hypothesis* (VASILEV; KIRKBY; ANGELE, 2018), while lyrical music contains spoken words (sung) conveying semantic information, as predicted by the *semantic-interference* account and the *interference-by-process* hypothesis. In the next chapter, the method for fulfilling the study objectives is described.

# 3. METHOD

This chapter describes the method used to investigate individual differences in multitasking[42]. The method section is subdivided into objectives, hypotheses, participants, design, research ethics, instruments and procedures for data collection, and last, the procedures adopted for data analysis.

## 3.1. OBJECTIVES

The general objective is to investigate whether working memory capacity predicts proficient bilinguals' performance in reading comprehension of a hypertext in a multitasking setting – listening to non-lyrical music (control) or lyrical music (experimental). The specific objectives are:

1) To investigate whether working memory capacity, by means of the Self-Administrable Reading Span Test (OLIVEIRA; WOELFER; TOMITCH, 2021) and Condition (i.e. listening to non-lyrical or lyrical music) predict literal comprehension of a hypertext, by means of comprehension questions (PEARSON; JOHNSON, 1978);

2) To investigate whether working memory capacity, by means of the Self-Administrable Reading Span Test (OLIVEIRA; WOELFER; TOMITCH, 2021) and Condition (i.e. listening to non-lyrical or lyrical music) predict inferential comprehension of a hypertext, by means of comprehension questions (PEARSON; JOHNSON, 1978);

3) To investigate whether working memory capacity, by means of the Self-Administrable Reading Span Test (OLIVEIRA; WOELFER; TOMITCH, 2021)

[42] From this point on, multitasking will be used to refer to listening to music while reading. Multitasking performance, therefore, refers to scores obtained in reading comprehension while listening to music.

and Condition (i.e. listening to non-lyrical or lyrical music) predict reading comprehension of a hypertext, as measured by written free recall (OLIVEIRA; TOMITCH, 2021; RONDON; TOMITCH, 2020).

4) To explore the extent to which linguistic experience (how English was learned, age of onset and age of fluency, contributing factors to learning English, and the frequency of activities in English) and self-rated proficiency, by means of the QuExPli (SCHOLL; FINGER, 2013; SCHOLL; FINGER; FONTES, 2017) predict multitasking performance.

## 3.2. HYPOTHESES

Considering that working memory is limited in terms of resources (BADDELEY, 2012; JUST; CARPENTER, 1992), literal comprehension demands fewer resources than inferential comprehension (ALPTEKIN; ERÇETIN, 2009; GAGNÉ; YEKOVICH; YEKOVICH, 1993; JUST; CARPENTER, 1992), and that lyrical music might be more distracting than non-lyrical music (VASILEV; KIRKBY; ANGELE, 2018), two hypotheses, related to objectives 1 and 2 have been formulated:

- Hypothesis 1: literal comprehension is neither predicted by working memory capacity nor Condition – listening to lyrical music, as compared to non-lyrical music. In other words, no differences in participants' literal comprehension of the hypertext are expected, regardless of their WMC span and the Condition they were assigned.

- Hypothesis 2: inferential comprehension is both predicted by working memory capacity and Condition – listening to lyrical music, as compared to non-lyrical music. In other words, participants' inferential comprehension of the hypertext is expected to be superior in participants with higher WM span in relation to their lower-span counterparts in the experimental condition.

Considering that working memory capacity predicts reading outcomes in an additional language (IN'NAMI; HIJIKATA; KOIZUMI, 2021; TOMITCH, 2020) and the demands of multitasking on working memory capacity (CLINTON-LISELL, 2021; JOHANSSON et al., 2012; JUST; CARPENTER, 1992), a third hypothesis was formulated:

- Hypothesis 3: Participants with higher working memory capacity, as measured by the Self-Applicable Reading Span Test (OLIVEIRA; WOELFER; TOMITCH, 2021), are better multitaskers. In other words, they will recall more information from the text, by means of written free recall (OLIVEIRA; TOMITCH, 2021; RONDON; TOMITCH, 2020) obtained after reading a hypertext whilst listening to lyrical music.

Considering the dissertation that bilingualism is a dynamic construct that reflects a spectrum of linguistic experiences which, in turn, uniquely shape cognition (ANTONIOU, 2019; BACKER; BORTFELD, 2021; DELUCA et al., 2019) in addition to consistent previous findings on cognitive effects of bilingualism, more specifically, bilingual advantages in multitasking due to enhanced cognitive functions (BIALYSTOK, 2011; POARCH; BIALYSTOK, 2015; SÖRMAN et al., 2017), a fourth hypothesis, of exploratory nature, is put forward:

- Hypothesis 4: We expect to find evidence that both linguistic experience and self-rated L2 proficiency will predict multitasking performance in terms of recall of text ideas, by means of free written recall (OLIVEIRA; TOMITCH, 2021; RONDON; TOMITCH, 2020), and in terms of literal and inferential comprehension, by means of comprehension questions (PEARSON; JOHNSON, 1978), and for both groups (control and experimental), with an indication of advantage in multitasking for participants with a more varied linguistic experience and higher proficiency levels.

## 3.3. PARTICIPANTS

Participants of this study were proficient bilinguals from several regions of Brazil. The most expressive population were undergraduate students from *Letras-Inglês* of Universidade Federal de Santa Catarina, English Graduate students from UFSC, and undergraduate students from *Letras* Program from Universidade Federal do Rio Grande do Sul. Invitations were made through a social network *(Instagram)* and e-mail (Appendix G and H, respectively). In addition to these two forms of invitations, this researcher attended to an online class at both UFSC and UFRGS to reinforce the invitation, which then resulted in the most expressive population of this study.

Sample size calculations showed that sixty-seven participants were needed for this study. Sixty-five participants between the ages of 19 and 62 years (M = 28.87; SD = 8.20) participated in the study and data from all of them were included in the final analysis.

The pilot study was conducted with a group of teachers who attended to *Formação Continuada em Inglês para Professores/as de Inglês*, offered by this researcher at *Instituto Federal de Santa Catarina – Câmpus São Lourenço do Oeste* in 2020. Five participants whose ages ranged from 20 to 37 years (M = 29.4; SD= 7.02) agreed to participate in the pilot study. Invitations were made via e-mail. Data from participants in the pilot study were not included in the final analysis.

As mentioned, the participants of this study were highly educated bilinguals (mostly language undergraduate or graduate students), whose age of onset in English did not significantly differ between those in the control group (M = 10.15; SE = 0.72) and those in the experimental group (M = 10.44 SE = 0.83). Similarly, their mean age of fluency in English did not significantly differ between the control group (M = 17.76; SE = 0.85) and the experimental group (M = 19.97 SE = 0.94).

In terms of self-reported L2 proficiency, considering the four skills altogether, participants in both groups did not significantly differ, e.g., control group (Median[43] = 5.0;

[43] As the L2 proficiency was self-rated using a Likert Scale, it seems appropriate to use Median and Interquartile Ranges (IQR). The Median regards “the point at which 50% of the scores are higher and 50% of the scores are lower” (LARSON-HALL, 2016, p. 478), and the IQR concerns “The 25th to 75th percentile of the data (p.478).

IQR = 4-6; M = 5.06; SE = 0.10) and experimental group (Median = 5.5; IQR = 5-6; M = 5.33; SE: 0.07). Considering the four skills separately, Table 3 presents in detail, as follows:

Table 1 - Self-rated Proficiency scores

| Condition | Skill | Median | Q1-Q3 | Mean | SE |
|---|---|---|---|---|---|
| Control | Listening | 5 | 5-6 | 5.19 | 0.18 |
| | Reading | 6 | 5-6 | 5.29 | 0.17 |
| | Speaking | 5 | 4-6 | 4.90 | 0.23 |
| | Writing | 5 | 4-6 | 4.87 | 0.23 |
| Experimental | Listening | 6 | 5-6 | 5.44 | 0.11 |
| | Reading | 6 | 5-6 | 5.53 | 0.11 |
| | Speaking | 5.5 | 5-6 | 5.24 | 0.16 |
| | Writing | 5 | 5-6 | 5.12 | 0.16 |

Source: the author[44]

## 3.4. DESIGN

This is a cross-sectional experimental study using a quantitative method. A between-subject design was adopted comprising the two conditions: (1) Reading a hypertext while listening to non-lyrical music (Control); (2) Reading hypertext while listening to lyrical music (Experimental).

## 3.5. RESEARCH ETHICS

This project was submitted to the Ethics Review Board (*Comitê de Ética em Pesquisas com Seres Humanos da Universidade Federal de Santa Catarina – CEPSH/UFSC*), in compliance with Resolutions 466/12 and 510/16 and has been approved under protocol 4.688.798 of May 4th, 2021. Consent was given by participants selecting the box stating acceptance of terms for data collection and use. Having accepted

[44] The tables and graphs containing data were elaborated by NEL's technical support and assembled by the author. Since they are the authors' property, the source will me regarded as the author of this dissertation.

to participate in this study, participants received a signed copy of the consent form on their e-mail and were instructed to print screen the page of the experiment which contained the consent information. According to *Ofício Circular nº 2/2021/CONEP/SECNS/MS de 24 de fevereiro de 2021*, the consent was considered by the total execution of the tasks contained in this study. The consent form is available in Appendix A.

## 3.6. INSTRUMENTS FOR DATA COLLECTION

The instruments used for collecting data are detailed below, to enumerate, (1) the consent form, for ethical reasons; (2) Language Experience and Proficiency Questionnaire for research with bilinguals (3) a Self-Administrable Reading Span Test for assessing working memory capacity; (4) one expository text for both control and experimental conditions for the primary task of the multitasking experiment; (5) two songs for the control condition and two songs for the experimental condition for the secondary task of the multitasking experiment; (6) the comprehension measures, composed of a written free recall and six comprehension questions; and (7) a retrospective questionnaire.

Given the pandemic of COVID-19, the experimental session was carried out remotely, using an online platform developed by a fellow researcher who is a member of *Núcleo de Estudos em Leitura da UFSC,* Professor at Universidade do Estado da Bahia and a JavaScript Developer. The platform, developed in JavaScript, is called Lapsi – *Laboratório de Psicolinguística* – and will soon be available for researchers in the field of Psycholinguistics, Applied Linguistics and related areas at http://lapsi.davi.solutions/. Since this study is the first to use this platform, it was pre-piloted among fellow researchers in order to verify whether the experiment was running correctly. In particular, it was verified (1) whether data was being correctly stored in the platform database; and (2) whether the answers participants gave were the same as the ones stored in the database (participants recorded their screen whilst taking the experiment). The pre-pilot also showed that some final words of the Self-Applicable Reading Span Test were too similar, and therefore had to be changed. Next, I will describe in detail the instruments for data collection.

### 3.6.1. Language Experience and Proficiency Questionnaire

Considering that the population of this study is composed of adult bilinguals (aged +18), and bilingualism is deemed as a spectrum of language experiences with deterministic factors such as the age of acquisition, context of use and proficiency (ANTONIOU, 2019; BACKER; BORTFELD, 2021; DELUCA et al., 2019; SCHOLL; FINGER; FONTES, 2017), in this study, participants answered a *Language Experience and Proficiency Questionnaire* (*QuExPli - Questionário de Experiência e Proficiência Linguística*) in Brazilian Portuguese, elaborated by Scholl and Finger (2013) and adapted to this study. The questionnaire consists of (1) participants' personal information; (2) English language background; (3) factors that contributed to learning English; and (4) self-rated proficiency. This questionnaire has been recently used in a study which aimed at investigating which language experience factors correlated with the self-reported proficiency of 535 Brazilian university students (SCHOLL; FINGER; FONTES, 2017). The findings showed that "age, time of immersion, and current use of the language are associated to participants' self-reported proficiency" (SCHOLL; FINGER; FONTES, 2017, p. 689). In addition to that, participants' (N = 112) scores on self-rated proficiency, obtained from the *QuExPli*, were correlated with their scores on TOEFL ITP, revealing accuracy in participants' proficiency reports (SCHOLL; FONTES; FINGER, 2021). The questionnaire was adapted to fit the remote experiment and is available in Appendix B.

### 3.6.2. Self-Applicable Reading Span Test

Readers with greater working memory capacity are considered better readers (TOMITCH, 2020). The Reading Span Test (RST), devised by Daneman and Carpenter (1980), is a reliable measure of individuals' working memory capacity, and it has been widely used in reading research over the years (OLIVEIRA; WOELFER; TOMITCH, 2021; TOMITCH, 2020). The original test consists of participants reading sixty sentences out loud and trying to recall the last word of each sentence in the order they were originally presented. The sentences are organized into three sets of two, three, four, five and six

sentences per time (DANEMAN; CARPENTER, 1980; TOMITCH, 2003). Working memory capacity is thus determined by the level at which the participant fails to recall the last word and/or by the total number of recalled words (OLIVEIRA; WOELFER; TOMITCH, 2021). Oliveira and colleagues report the limitations of the original RST, such as the retest effects – caused by the repeated use of the same sentences – and simultaneous application of the test – given that participants have to read the sentences out loud. With that in mind, they developed a Self-Administrable version of the Reading Span Test (OLIVEIRA; WOELFER; TOMITCH, 2021).

Given the limitations of the original RST and the remote nature of this study – due to the pandemic of COVID-19 – we adopted the Self-Administrable version of the Reading Span Test developed and piloted by Oliveira, Woelfer and Tomitch (2021). This test was set up on the same platform where the study was hosted (LAPSI). This version of the test contains 180 sentences (see Appendix C) from a corpus composed of news (see OLIVEIRA; WOELFER; TOMITCH, 2021 for a detailed account). From these 180 sentences, only 60 are selected every time the experiment is run. The sentences range from 9 to 15 words and are presented in five different levels having three sets in each level. For instance, level 1 contains two sentences per set and level 5 contains six sentences per set. At the end of each sentence, two buttons are presented containing the end word of the sentence, in which, only one word correctly fits the sentence. This procedure is adopted to certify participants are not memorizing only the last words of the test and to replace the reading out-loud procedure of the original test. Oliveira and colleagues (2021) explain that, given the fact that the test was programmed to select words from the 180 sentences, both words given as options – the end words that fit the sentence - might be appropriate for the sentence context. In case this happens, participants were instructed to select the word they believe is the most appropriate to complete the sentence and recall that word. After reading the sentences and selecting the appropriate end-word, participants had to remember the words they had selected and write them in the order they appeared. Following Tomitch (2003, 2020) and Linck (2014), the test was administered in Brazilian Portuguese to avoid additional language proficiency confounding the results. Next, we provide a description of the reading task.

### 3.6.3. Primary task – Reading

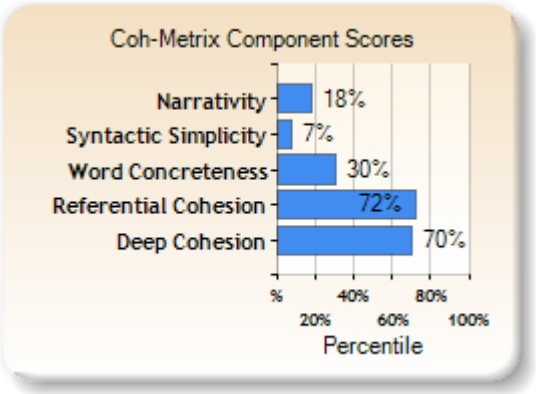
The text used on this study was controlled in terms of (1) type – expository text; (2) source; (3) length; (4) font-size; (5) readability. The text entitled 'Let's talk about English as a Lingua Franca (ELF): a cycle of project-based task' was chosen considering that the population of this study is composed of proficient language students and/or professionals, and this is a relevant and current topic in the field of Applied Linguistics. The text was extracted from a biannual publication aimed at sharing successful initiatives in language teaching and learning which is called '*Revista Bem Legal*' (http://www.ufrgs.br/revistabemlegal) – *CAPES Qualis B5*. The original text has four sections, but only the one entitled 'English as a Lingua Franca: implications for language policies and pedagogical practices' was used to control for length.

For both conditions, the text was displayed in Times New Roman, Font size 12, to facilitate readability (DARROCH et al., 2005). However, given the nature of this remote experiment, the size of the screen of each participant may vary.

Two measures of readability were used in this study: the Flesch-Kincaid metrics and Text Ease and Readability Assessor, both provided by Coh-Metrix (http://cohmetrix.com/). The former is considered a traditional measure which uses word and sentence length to determine text ease or difficulty, in which "the output of the *Flesch Reading Ease* formula is a number from 0 to 100, with a higher score indicating easier reading" (GRAESSER et al., 2004, p. 7). The original version of the text used in this study (available at http://www.ufrgs.br/revistabemlegal/vol-7-2017-2/x-pdf-english-lingua-franca) indicated a Flesch Kincaid Grade Level of 21, which classifies it at a difficult text. The Text Ease and Readability Assessor is a more sophisticated measure of text characteristics at multiple levels of text and discourse (GRAESSER et al., 2014; GRAESSER; MCNAMARA; KULIKOWICH, 2011). The multiple levels comprise (1) Narrativity, which has to with the narrative genre; (2) Syntactic simplicity, related to syntactic complexity and its role in working memory; (3) Word concreteness, related to concrete versus abstract words and their relation with constructing meaning from text; (4) Referential cohesion, related to the overlap of words and ideas across sentences and

whole text in the formation of the *textbase*; and (5) Deep Cohesion, related signaling devices that inform causal, intentional, and temporal cohesion that act in the formation of the situation model (GRAESSER et al., 2014). The initial analysis of the original text used in this study is shown in the Figure 6 below, followed by the automated analysis of this multilevel text and discourse analysis:

Figure 6 - Initial Component Scores

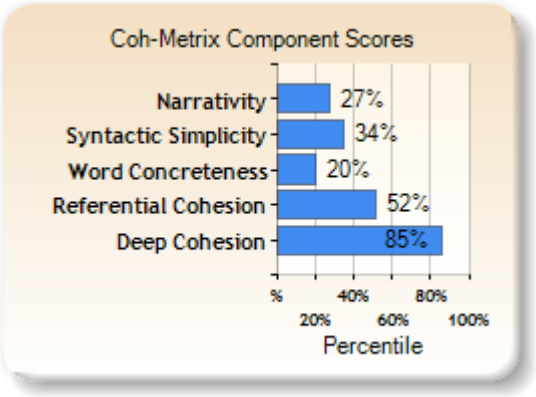



Source: http://129.219.222.70:8084/Grid/Coh-MetrixMytext.aspx

> This text is low in narrativity which indicates that it is less story-like. Less story-like texts are usually more difficult to comprehend. Its low syntactic simplicity means that it has complex sentence structures. Complex syntax is more difficult to process. It has average word concreteness. It has an average amount of referential cohesion. It has an average amount of deep cohesion (COH-METRIX, 2021).

Therefore, the text was manipulated to increase readability. Since the text is about English as a Lingua Franca (ELF) an expert on the topic, also a PPGI Ph.D. student, was consulted. The changes made include (1) shortening of paragraph and sentence length; (2) homogenization of terms to refer to ELF, considering that the authors called it conception, view, and perspective interchangeably, therefore, ELF is considered as a ‘perspective’ in the text; (3) simplification of verbal tenses into simple forms (e.g. simple past); (4) and deletion of some abstract concepts for novice readers on the topic. The output of the text used in this study is as follows, and the final text can be found in Appendix D.

Figure 7 - Final component scores




Source: http://129.219.222.70:8084/Grid/Coh-MetrixMytext.aspx

> This text is average in narrativity. It is average in syntactic simplicity. It has low word concreteness suggesting a high volume of word abstractness and low imageability. Thus, it may be more difficult to understand. It has an average amount of referential cohesion. It is high in deep cohesion suggesting more explicit causal relationships as needed by the text. Because of this, it may be easier to comprehend on unfamiliar topics. (COH-METRIX, 2021).

For the experimental condition, the properties of nonlinear hypertexts followed Procailo's (2017) study in terms of text presentation. To be more precise, Procailo (2017) controlled for the number of hyperlinked information her participants could have access to, meaning they could only access a maximum of seven links per text, given the assumption that the flow of reading and attention would be disrupted given the number of hyperlinks (DESTEFANO; LEFEVRE, 2007). In order to resemble a real web page, aspects such as the color of the links changing from blue to gray were added (PROCAILO, 2017). The hyperlinked information was determined by raters, reading experts who read the text and pointed out concepts that needed further elaboration. Based on their notes, seven concepts of the text were chosen to compose the pop-up information, that is, concepts that are not deepened in the text were added as hyperlinked information, and participants were told that the hyperlinks contained a detailed account on some of the issues brought by the text.

Hyperlinked text information can be presented on a new page (PROCAILO, 2017), or on a pop-up window (DELGADO et al., 2020). Procailo (2017), for instance, presented the main arguments in the main text and the supporting details in the

hyperlinked text, and the reader would be directed to a different page when clicking on the link. Delgado et al. (2020), on the other hand, presented conflicting information in the hyperlinked text, and a pop-up balloon appeared when clicking on the link, therefore, readers did not leave the original text. Researchers seem to agree that the construction of a mental representation during reading might be affected by navigating from page to page (DELGADO et al., 2020; SALMERÓN et al., 2018; VAN DEN BROEK; KENDEOU, 2015). Having that in mind, in this study, the hyperlinked information was presented as a pop-up window containing additional information on the text, granted that navigation on hyperlinked information should be determined by the reader's goal (PIROLLI, 2007).

### 3.6.4. Secondary task – Listening to music

Each participant chose the song for their reading task, both in the control and experimental conditions. Prior to that, there were two clickable buttons, one for each song, in which participants were instructed to listen to a 30-second excerpt of each song. After that, participants were directed to select which song they liked the most and would listen to while reading a text. The rationale for this has to do with the mixed results in terms of musical preference in comprehension, as reviewed in the review of literature in subsection 2.3.2. It is expected, therefore, that it somehow resembles the real-life task of selecting a song of their preference for reading.

For the control condition, participants were able to choose between two songs, retrieved from a playlist for studying – *Binaural Beats: Focus* – available on Spotify and containing 244.568 followers[45]. Binaural Beats were chosen, instead of classical music, for having a less distracting nature. Put another way, some classical music feature acoustic variations that result in distraction, that is, "non-lyrical music should be more distracting than acoustical noise (e.g., white or pink noise) because the former exhibits more acoustic variation than the latter" (VASILEV; KIRKBY; ANGELE, 2018, p. 572). With

[45] This figure is from March 27, 2021.

all that in mind, participants in the control group could choose either ‘Alpha Thoughts 107 Hz – 114 Hz’ (101 *bpms*) or ‘Binaural Alpha Sinus’ (120 *bpms*).

Tempo was manipulated using the software *MixMeister BPM Analyzer*, and ranged from 108 to 120 bpm, which is considered *moderato* in terms of tempo (FERNÁNDEZ-SOTOS; FERNÁNDEZ-CABALLERO; LATORRE, 2016). The rationale derives from the finding that slow and soft music does not seem to impair comprehension as opposed to fast and loud music (THOMPSON; SCHELLENBERG; LETNIC, 2012). Since both pieces do not contain lyrics, it is expected that participants inhibit the piece since they do not have linguistic features to compete for resources.

For the experimental condition, participants were also able to choose between two songs, which were extracted from the playlist containing the most-streamed pop songs at the time of data collection - *Today’s Top Hits* – do Spotify (27.433.179 followers). Participants could either choose ‘Levitating’ from Dua Lipa (103 *bpms*) or ‘Save your tears’ from The Weeknd (117 *bpms*). For both conditions, participants were instructed to use an earphone during the experiment and set the volume to feel comfortable during reading.

### 3.6.5. Reading Comprehension measures

Two comprehension measures were adopted in this study: a written free recall task (OLIVEIRA; TOMITCH, 2021; RONDON; TOMITCH, 2020) and comprehension questions based on the Taxonomy devised by Pearson and Johnson (1978), both available in Appendix E. According to these authors, comprehension questions can be devised into textually explicit, textually implicit and scriptally implicit (PEARSON; JOHNSON, 1978). Textually explicit questions have answers that can be easily identified in the text, such as in – “The USA boarders have been closed to European flights due to corona virus” – followed by a question “why have the boarders been closed?”, in which, as it can be seen, the answer is obvious. Textually implicit questions, in contrast, should not have such obvious questions/answers, so that readers should engage in some inferential process. For instance, in the sentence – Trump’s decision to ban European countries flights has been considered ‘unilateral’” – followed by a question “Which country

was benefited from Trump's decision?", in which demands readers to infer that 'unilateral' benefits, in this case, only the USA. Last, in scriptally implicit questions, readers cannot find the answers to the question on the text, since it should be drawn from the reader's background knowledge. For instance, in the sentence – "President Trump bans travel from Europe to the United States due to corona virus" – followed by a question "why did President Trump ban flights from Europe only?", in which readers must know that Europe, especially Italy, has registered a great number of cases of the virus. The question was made based on the text, but the answer relied previous knowledge of the reader.

Participants performed the written free recall first, and then the comprehension questions. The written free recall preceded the comprehension questions in order to prevent the comprehension questions to bias the free recall. The written free recall consisted of having participants write everything they could recall from the text (OLIVEIRA; TOMITCH, 2021; RONDON; TOMITCH, 2020). Participants were instructed to write down complete sentences in a box on the screen and in Brazilian Portuguese, in order to avoid planning writing in English affects text recall.

As Tomitch (1995) observes (based on van DIJK; KINTSCH, 1983), free recall relies on macrostructure formation which is the direct result of how organized information from texts had been organized in chunks in working memory. Consequently, more information should be recalled from readers with higher working memory capacity due to having more resources to build richer and bigger chunks (TOMITCH, 1995). Besides being a well-accepted research tool that "provides purer measures of comprehension" (BERNHART, 1991 apud CHANG, 2006, p. 521), the free recall comes, in this study, to overcome the limitations of multiple-choice questions. Free recall was done in the participants' mother language (Brazilian Portuguese), in order to avoid overload in working memory due to planning in an additional language, also to soften the burden of writing a text in the additional language. After completing the written free recall, participants answered five open-ended comprehension questions on the text, based on the taxonomy explained above. The questions were elaborated and rated by this researcher resulting in three textually explicit questions (1,2, and 3) and two textually implicit (4 and 5), available in Appendix E. For this task, participants had access to the text.

### 3.6.6. Retrospective questionnaire

As briefly mentioned in the design section, this study adopts both quantitative and qualitative methods/procedures. Therefore, a retrospective questionnaire was developed to identify participants' (1) perceptions of the experiment; (2) multitasking profile; and (3) musical experience. Similar to Roscioli (2017), "the answers provided in the retrospective questionnaires helped to better understand the results, allowing data triangulation and providing more internal validity to the research" (p. 193). Participants' responses are presented in the Exploratory section of *Results and Discussion* (chapter 4).

## 3.7. PROCEDURES FOR DATA COLLECTION

The procedures for collecting data consisted of (1) invitation to participate in the study; (2) signing the consent form and briefing; (3) participating the online experiment. As described in the 'Participants' section, proficient Portuguese-English bilinguals from several contexts were invited via social media and/or e-mail (see Appendix G and H). Participants who were invited via e-mail received (1) the general objective of the study; (2) the instructions on how to carry out the experiment; (3) the Consent form (*Termo de Consentimento Livre e Esclarecido*); (4) instructions on how to ask questions (via WhatsApp, e-mail, or even a Google Meet Conference); and (5) the link to the experiment (Appendix H). Participants who demonstrated, via social media, interest in participating in the study received a similar e-mail (Appendix I).

Both e-mail formats (Appendix H and I) contained the same instructions on how to carry out the experiment. The procedures for performing the experiment were displayed in two formats, a written tutorial, and a briefing video tutorial so that participants could choose the best modality according to their preference. Both contained the same information, (see Appendix H or I). Since it was an online experiment, participants were instructed that once they had started it, they would have to finish it, otherwise, answers would be lost. The link to the online experiment was sent out via e-mail (Appendix H and I).

In the first part of the experiment, participants read an introductory message containing the title, the instructions for the Consent section, the estimated time to complete all the tasks, and a ‘thank-you’ message. On the second page, the consent form was presented as approved by the Ethics Committee, followed by two tick boxes, one where participants provided consent and the other where consent was not given. If the former were selected, the experiment continued, but if the latter were selected, the experiment ended. On the third page, participants entered their personal information, since it is part of the language background questionnaire (SCHOLL; FINGER, 2013; SCHOLL; FINGER; FONTES, 2017). For ethical reasons, all information is kept confidential. Still part of the Language Background Questionnaire, participants answered questions concerning their language acquisition, and last, they rated their proficiency in the English language.

Having finished the questionnaire, they took the Self-Administrable Reading Span Test (OLIVEIRA; WOELFER; TOMITCH, 2021). The first session was a training session so that participants could familiarize with the test. Then, the test proceeded as previously described. After that, participants were directed to a new page where they should select which song they would listen to during the experiment. Having chosen the song, the following page contained the text and the song played whilst they read. Participants were instructed to use earphones for this part and listen to the song at a comfortable volume. They had around 15 to 20 minutes to read the text and try to understand the main idea and as much information as possible. On the following page, participants were directed to write (in Brazilian Portuguese) as much information as possible regarding the text read. Then, they had to answer the comprehension questions. Last, participants answered a retrospective questionnaire. In the next section, the procedures for analyzing data are described.

## 3.8. PROCEDURES FOR DATA ANALYSIS

In order to test hypotheses 1, two separate linear models were applied, one for the strict scoring method and another for the lenient scoring method. The models

contained the literal comprehension and WM scores. The same procedure was adopted to test hypothesis 2 but containing the inferential comprehension scores instead.

To test hypothesis 3, six separate models were used. One for the recall scores for main idea and WM in the strict method, and another for the recall scores for main idea and WM in the lenient method. The same procedure was adopted but with the recall scores of secondary ideas and WM scores in both scoring methods and recall scores of details in both scoring methods.

Hypothesis 4 was generated after initial inspection of participants' responses (post hoc hypothesis). The models contained (1) literal comprehension scores with WMC strict and lenient scores; (2) inferential comprehension scores with WMC strict and lenient scores; (3) main idea recall scores in both scoring methods; (4) secondary idea recall scores in both scoring methods; (5) detail recall scores in both scoring methods. In all of them, the issues raised by the *QuExPli* were entered: (1) how English was learned; (2) age of onset; (3) age of fluency; (4) factors that contributed to learning English (5) frequency of factors that contributed to learning English; and (6) self-rated proficiency.

### 3.8.1. Language Background Questionnaire Scoring

This study adopted the procedures listed by previous studies (SCHOLL; FINGER; FONTES, 2017; SCHOLL; FONTES; FINGER, 2021) for the initial inspection of the *QuExPli*. Considering the explanatory nature of the data obtained through this questionnaire, the procedures for data analysis are described in the results section (4.5.1.) as data is reported. This analysis was conducted using the language and statistical environment R (R CORE TEAM, 2020).

### 3.8.2. RST Scoring

In this study, both the lenient and the strict scoring methods were used. The strict method – or higher-level measure – considers the reading span from the ability to recall at least two out of three sets (DANEMAN; CARPENTER, 1980; TOMITCH, 2003). In

previous versions of the test, failing to recall three sets would result in the test being terminated (DANEMAN; CARPENTER, 1980; TOMITCH, 2003). However, given that this study used the Self-Applicable Reading Span Test (OLIVEIRA et al., 2021), participants proceeded until the end of the test, and their reading span was considered the point at which they were able to recall at least two out of three sets.

Several studies have used the strict scoring method (TOMITCH, 2003; WOELFER; TOMITCH, 2019), whose rationale relies on the assumption that attentional resources are tapped by having participants simultaneously process incoming information at the same time they recall the last words of previously displayed sentences (DANEMAN; CARPENTER, 1980). Similar to Tomitch (2003) the point at which the participant was able to recall at least two sets is taken as the reading span. In addition to that, half a point was given to participants who reached one set at the next level. For instance, if a participant scored two sets at the three-sentence level and one set at the four-sentence level, then his/her working memory span would be 3,5.

Previous studies mention they considered the exact words in the exact order participants recalled as a means to score in the RST (DANEMAN; CARPENTER, 1980; TOMITCH, 2003; WOELFER; TOMITCH, 2019). Notably, “participants need to recall the exact words (plurals/class, etc.) in the exact order to score” (ROSCIOLI, 2017, p. 90). Initially, the same criterium was considered, but data had shown that a great number of participants recalled the correct words and followed the order they appeared but failed in aspects such as number (singular/plural) and gender (masculine/feminine). For instance, in the sentence “*para o professor, a aproximação americana também poderia ser motivada por interesses [econômicos]”,* three participants recalled the word “econômico”, in the singular form instead of the plural as in the original sentence. For this reason, this study disregarded gender and number features of the words in the strict scoring method, following, therefore, the same procedure adopted by Rondon (2019).

In the lenient scoring method – or *total words measure* – participants complete the full set of tests, and the total number of words recalled in all sets is considered (FRIEDMAN; MIYAKE, 2005). Participants get a point per word recalled. Whilst in the strict scoring method participants must recall the words in the exact order they appeared,

the lenient scoring method considers the total number of words irrespective of their order in the set. In addition to that, differences in word number and gender are also disregarded, following Rondon (2019).

The distinction lower-higher spans is made by considering “the upper and lower third of the frequency distribution of total words recalled by each” (LINDERHOLM; VAN DEN BROEK, 2002, p. 779). In other words, participants who scored at or below 31 are considered lower-span readers, while participants who scored at or above 35 are considered higher-span readers (LINDERHOLM; VAN DEN BROEK, 2002). These authors advocate that more continuous scoring methods such as the lenient method present higher reliability[46] and more normal distribution[47] of data in relation to strict methods (FRIEDMAN; MIYAKE, 2005). The rationale for using both methods relies on the belief that there may be differences among highly correlated scoring methods (ROSCIOLI, 2017; ROSCIOLI; TOMITCH, 2022). Several studies on reading and working memory capacity have used both methods (BAILER, 2011; RONDON, 2019; ROSCIOLI, 2017).

### 3.8.3. Scoring of comprehension measures

The first comprehension measure used in this study was a written free recall, which was analyzed in terms of a hierarchy of idea units. An idea unit (IU) is considered here as “a segment in […] written discourse that carries a message that is semantically meaningful and complete” (PAÑOS, 2015, p. 15). However, as the author acknowledges, using only semantic criteria for establishing an IU might be troublesome, therefore, syntactic features must be taken into account (see PAÑOS, 2015 for a full discussion on the operationalization of propositional complexity into IUs). In addition to semantics, the syntax was also taken into account, following Baretta’s (1998) syntactic criteria “where each ‘idea unit’ corresponded either to (1) a clause, characterized by the presence of a verb or (2) single phrases, formed by a group of words which contains an idea”

[46] Reliability refers to the consistency of a research instrument (i.e., a test), in the sense that the same score would be obtained if a person retook the test (LARSON; HALL, 2016).
[47] Normal distribution refers to the probability function of how a variable is distributed. In normally distributed data, most observations cluster around the mean, meaning less standard deviation in data.

(BARETTA, 1998, p. 40). Moreover, the IUs were classified into main ideas (MI), supporting ideas (S) and details by five independent raters who received a booklet containing (1) a framework for rating the IUs; (2) the original text used in the experiment and (3) the text split into IUs. It is important to mention classifying the ideas accordingly enables this researcher “to distinguish important ideas from mere detail, and it predicts how a text is comprehended and remembered” (KINTSCH, 2013, p. 809). Regarding the aforementioned framework, we have borrowed ideas from Tomitch (2012) and Kintsch (1998), which resulted in the following:

Table 2 - Framework for rating the Idea Units

| **MAIN IDEA (MI)** |
|---|
| ▪ What is the thesis statement?<br>▪ What is the controlling idea in the text?<br>▪ What is the main point the writer is trying to make? |
| **SECONDARY IDEAS (S)** |
| ▪ What are the supporting arguments for the main point?<br>▪ What evidence is presented to support the main point? |
| **DETAILS (D)** |
| ▪ Is this idea relevant for the main idea or is a minor detail? *(MI should not be affected by deletion of IUs containing details)* |

Source: elaborated by the author (based on KINTSCH, 1998; TOMITCH, 2012)

Interrater reliability – the degree to which raters agree on the classification of ideas – was obtained using Fleiss’ kappa, which is used for measuring nominal scale agreement for more than two raters (FLEISS, 1971; HALLGREN, 2012). The result was K = 0,13 (p > 0,001), indicating slight agreement according to Landis and Koch (1977). Moreover, there was disagreement among the raters regarding six IUs. An online meeting set according to their availability was scheduled to reach a consensus. Only three out of the five raters participated in this meeting. After presenting each of the six IUs in the context of their paragraph, the raters had to choose, between the previously most voted options. Each rater wrote their choice on a piece of paper/device and simultaneously showed the researcher what they had written. The criterium for selection was that two out of three

raters agreed on the choice made. The result from inter-rater reliability was K = 0,27 (p < 0,001), indicating fair agreement (LANDIS; KOCH, 1977).

The text used in this experiment was divided into 57 idea units by this researcher and categorized by raters as aforementioned, resulting in ten IUs classified as main ideas, thirty as supporting ideas and seventeen IUs as details (see Appendix L). Results of interrater reliability within IUs and the interpretation according to Landis and Koch (1977) are depicted in Table 3, below:

Table 3 - Interrater reliability across idea units

| Idea categorization | Results | Landis and Koch (1977) |
|---|---|---|
| **Main idea (MI)** | K = 0,42 (p < 0,001) | Moderate agreement |
| **Supporting idea (S)** | K = 0,143 (p = 0,001) | Slight agreement |
| **Detail (D)** | K = 0,295 (p < 0,001) | Fair agreement |

Source: the author

For the purpose of this study, the number of idea units recalled by each participant was considered taking into account whether the participant literally recalled the idea unit and/or a paraphrase of the idea unit was recalled, similar to previous studies (BARETTA, 1998; TOMITCH, 2003).

The second comprehension measure was open-ended comprehension questions. This study adopted the method used by Roscioli (2017), in which three raters[48] corrected participants' answers to the comprehension questions by assigning 1 point if the answer was correct and 0,5 if the answer was partially correct. The average of the scores assigned by the raters was calculated and used for the statistical analysis.

## 3.9. THE PILOT STUDY

For the pilot study, a group of English teachers from *Formação Continuada em Inglês para Professores/as de Inglês*, offered by this researcher at *Instituto Federal de*

[48] The raters from the comprehension questions were not the same of those who rated the idea units of the text.

*Santa Catarina – Câmpus São Lourenço do Oeste* in 2020 was invited to participate. The sample for the pilot study should approximately reach 10% of the intended sample of the actual study (BAILER; TOMITCH; D'ELY, 2011; CANHOTA, 2008). Considering that sample size calculations have suggested a sample of 67 participants, six participants should be appropriate. Thirteen people were invited to participate, of which six accepted and took part in this pilot study. Data from one participant was not saved in the server, therefore, data from five participants were considered for the pilot study, whose mean age was 28.6 (SD = 7.05).

Some aspects were observed during the collection of the pilot study. First, regarding data that was lost, two main assumptions can be made: (1) the participant did not finish the experiment (she simply closed the window), or (2) the version of the Windows was outdated (Windows 7). However, we are not certain of the real reason which caused data loss. Second, when participants received the invitation via e-mail, most of them replied asking about the due date for participation. Therefore, for the actual study, a deadline of seven days was set in case the participant asked. More time was granted if needed.

Another aspect observed during the interpretation of data from the pilot study regards the Self-Applicable Reading Span Test, in which participants were instructed to read each sentence and select the best word to fit the context and recall the word in the following section. In case both end-words were appropriate for the context, participants were instructed to select one and recall the word they had selected. However, the spreadsheets containing participants' responses did not contain the sentence that appeared on the screen, preventing the researcher to verify whether the participant's response was indeed correct. With that in mind, for the actual study, the output of the test was updated to properly save the sentence that appeared for the participant. Last, we noticed that data from the comprehension questions was not saved by the platform, which was later fixed for the main study.

# 4. RESULTS AND DISCUSSION

This section is organized according to each of the hypotheses of this study, which includes the results (and descriptive statistics which are also available in Appendix M) and discussion. Then, the post hoc exploratory analyses are presented and discussed. Beforehand, a section briefly explaining some statistical concepts used in this study is presented.

## 4.1. STATISTICAL CONCEPTS

This section is devoted to briefly explaining some statistical concepts to novice readers of statistical reporting. First, some basic concepts of regression models will be provided, followed by an explanation of the rationale for using such models. Then, some key constructs pertaining to regression models are presented.

The statistical test used in this study is a *multiple linear regression model*, which aims at attempting to predict the effects of the *independent (*also *predictor or explanatory*) variables on the *dependent (*or *response)* variable (LARSON-HALL, 2016). Following Garcia (2021), which provides an up-to-date manual on data visualization and analysis in our field, in this study, the terms *predictor* and *response variables* will be used to refer to *independent* and *dependent* variables, respectively. The use of these terms is very common in regression models since *predictor* variables “are trying to explain parts of the variance of the *response* variable” (LARSON-HALL, 2016, p. 475).

This study used a multiple linear regression model for two reasons: first, they are robust models which are consequently better at explaining the variability of linguistic data; and second, given the number of variables investigated. To be more precise, the explanation of language phenomena calls for statistical tests that account for language complexity, therefore, “regression models are one of the most robust options over hypothesis testing because they emphasize the effect size and allow the development of

more complex models" (LIMA JR; GARCIA, 2021, p. 10, my translation[49]). In addition to that, we are particularly interested in investigating whether working memory capacity and condition (control and experimental) – **predict** literal and inferential comprehension of a hypertext – our *response variable.* Put another way, while in simple linear models, the predictor variable tries to explain the response variable, in multiple linear models, several factors (*predictors*) attempt to explain the *response* variable. Garcia (2021) points out that "realistic models have multiple predictors because we typically assume that several factors are driving a particular effect" (p. 123).

In linear regression models, the relationship between the *predictor variable* and *response variable* is *linear,* and the inclination of the fitted line in the plot is represented by a parameter called the slope (*β*) (GARCIA, 2021). In addition to that, the effect size can be observed in terms of the inclination of the slope, meaning that "the more inclined the line, the larger the effect size of the explanatory variable on the response variable" (GARCIA, 2021, p. 114). The intercept, on the other hand, is the parameter that indicates "where the line crosses zero on the x-axis" (GARCIA, 2021, p. 114)[50].

Another important construct is the *coefficient of determination* ($R^2$), which tells us "how much of the variance in one variable is accounted for by the other variable" (LARSON-HALL, 2016, p. 208). In other words, the line which represents the relationship between variables is drawn along the plotted points, so the "$R^2$ is a measurement of how tightly these points fit the regression line" (LARSON-HALL, 2016, p. 209), meaning that the closer the points are to the regression line, the smaller the deviance of the predicted values to the actual data. Garcia (2021) explains that in linguistics, perfect fits do not exist, especially when we are dealing with multiple variables. For instance, for the fit $R^2 = 0.15$, this means that the *predictor variables* can explain 15% of variance of the *response variable*, which is "not bad considering how intricate linguistic patterns are" (GARCIA, 2021, p. 112).

---

[49] Original: "Modelos de regressão são uma opção mais robusta em relação a testes de hipótese por colocarem a ênfase no tamanho do efeito e por permitirem a elaboração de modelos mais complexos" (GARCIA, 2021, p. 10).

[50] See Larson-Hall (2010, p. 177) for an example of the mathematical formula of a line in linear regression models.

The last construct regards the Confidence Interval (CI), which is an estimate that the effects obtained in the sample represent the population of the study (GARCIA, 2021; LARSON-HALL, 2016). To be more specific, the *sample* represents the participants of the experiment whose results shall be generalizable to the *population* (adult proficient bilinguals in this study). Since it is impossible to collect data with all adult proficient bilinguals, a sample was investigated and the sample mean was found (e.g., scores on the experimental tasks), but what about the population mean? According to Larson-Hall (2016), **"95% CI will tell us a range of plausible values where we could expect to find the true mean of the population, with 95% confidence"** (p. 86). Last, in this study the alpha level (significance level) was set at 0.05. Let us move now to the hypotheses of this study followed by the results and discussion.

## 4.2. HYPOTHESIS 1

The first hypothesis of this study assumed that literal comprehension would be neither predicted by working memory capacity nor Condition, that is, listening to lyrical music during reading in the experimental condition and listening to non-lyrical music while reading in the control condition.

### 4.2.1. Results

No statistically significant effects were observed for WMC, Condition, nor Interaction, irrespective of the scoring method used. Thus, the data support Hypothesis 1. A linear model shows that neither WMC, as measured in the lenient method, nor Condition affected literal comprehension of a hypertext (Table 4).

Our model also shows that there is no statistically significant interaction between our predictor variables – WMC and Condition – and literal comprehension scores (Table 4). The line for the control condition seems to be slightly more inclined in relation to the line in the experimental condition, which might suggest that controls outperformed experimentals in literal comprehension. Similarly, mean scores of literal comprehension

reveal a slight difference between controls (M = 0.65; SE = 0.04) and experimentals (M = 0.66; SE = 0.04). However, no statistical significance was obtained (Table 4).

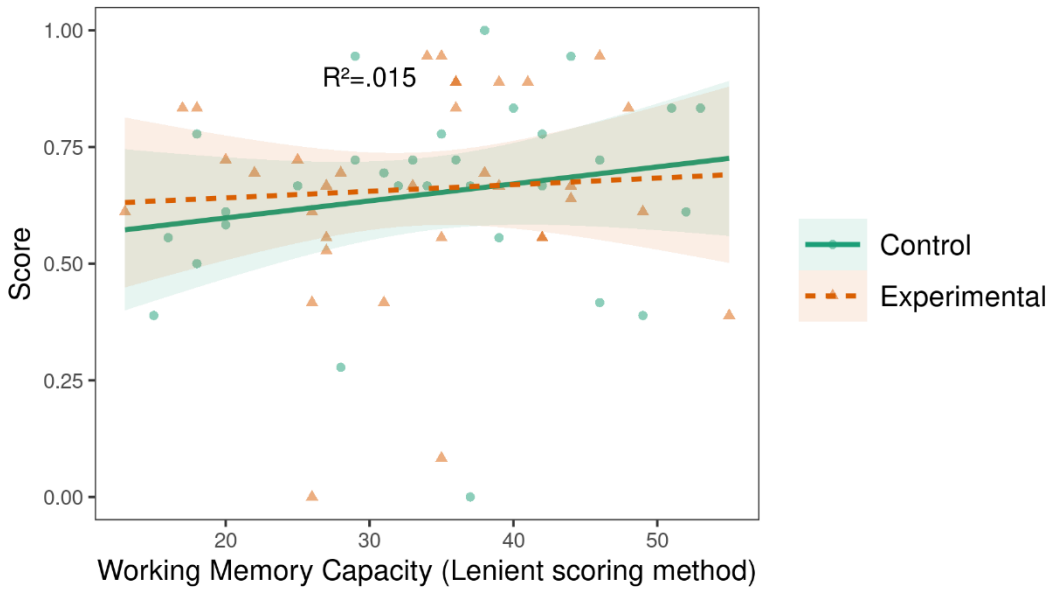
The shadowed area in the graph in Figure 8 shows that both groups share the same area, suggesting, among other things, no Interaction between variables. The $R^2$ = 0.15 indicates that WMC and Condition explain 15% of variance in literal comprehension scores. In other words, this figure represents the percent of variance explained by the model. Considering the percentage of variance explained by the model with the non-significant statistical results obtained, the model seems to adequately suggest that neither WMC nor Condition predicts literal comprehension of a hypertext.

Table 4 - Estimates of WMC (Lenient method) and Condition as predictors of literal comprehension.

| Names | β | p | 95% CI |
|---|---|---|---|
| Intercept | 0.48 | 0.02 | [0.09, 0.87] |
| WMC (Lenient) | 0.01 | 0.38 | [-0.01, 0.02] |
| Condition | 0.13 | 0.62 | [-0.39, 0.65] |
| Interaction | -0.01 | 0.66 | [-0.02, 0.01] |

Source: the author

Figure 8 - Literal comprehension predicted by WMC (Lenient method) and Condition




Source: elaborated by the author

Our model has also shown that neither WMC, as measured in the strict method, nor Condition affected literal comprehension (Table 5). In addition to that, no statistically significant Interaction was found between our predictors and literal comprehension scores.

Figure 9 displays a slight positive slope for the control condition, however, the *β* value is too small[51] to account for a robust effect size of the predictors (WMC and Condition) on literal comprehension. The negative slope of the experimental condition (Figure 9) does not have statistical significance to suggest an Interaction between variables. The $R^2 = 0.009$ indicates that our predictors could account for a minimal 9% of variability among data.

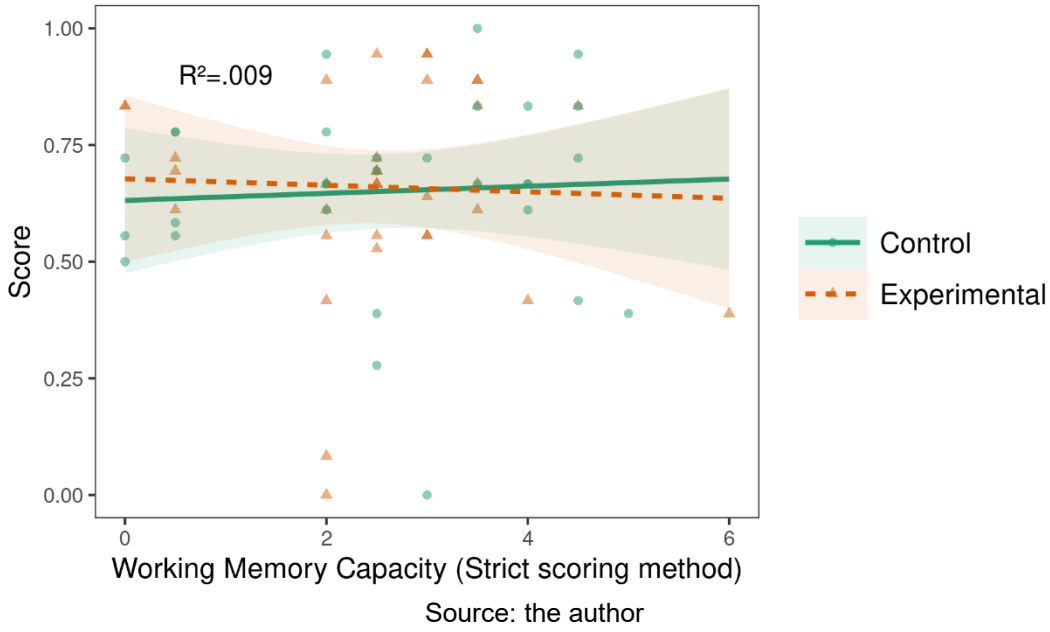
Table 5 - Estimates of WMC (Strict method) and Condition as predictors of literal comprehension.

| Names | β | p | 95% CI |
|---|---|---|---|
| Intercept | 0.60 | 0.00 | [0.37, 0.83] |
| WMC (Strict) | 0.02 | 0.64 | [-0.05, 0.08] |
| Condition | 0.11 | 0.48 | [-0.19, 0.4] |
| Interaction | -0.03 | 0.48 | [-0.11, 0.06] |

Source: the author

Figure 9 - Literal comprehension predicted by WMC (Strict method) and Condition

[51] The larger the *β* value, which goes from 0 to 1, the larger the effect size (GARCIA, 2021).




Source: the author

### 4.2.2. Discussion

The statistically nonsignificant effect obtained from the linear models for WMC, Condition, and Interaction can be interpreted as evidence that literal comprehension demands little resources from readers' working memory in the case of the participants of the present study.

The lack of effect of WMC on literal comprehension lends support to the *total capacity explanation* of individual differences which assumes that "capacity limitations affect performance only if the resource demands of the task exceed the available supply" (JUST; CARPENTER, 1992, p. 145). In other words, literal comprehension might not have deployed all available working memory resources, especially considering participants' higher levels of proficiency (see Participants section), which is intimately related to grammatical knowledge used in syntactic parsing and vocabulary knowledge needed for lexical access (GAGNÉ; YEKOVICH; YEKOVICH, 1993; GRABE, 2009). Additionally, these results seem to be in line with Alptekin and Erçetin's (2010) findings that literal comprehension heavily relied on language proficiency, decoding, and syntactic parsing. Another possible explanation is that lower-level comprehension processes do not

consume working memory resources, as speculated by Hannon (2012). The author found evidence for her model, the CC-R model (described in chapter 2, section 2.1.2.) that did not simulate “a path from word processing to working memory” (HANNON, 2012, p. 141), which led her to conclude that lower-level processes do not demand from working memory. Besides, the bilingual readers in this study are all proficient in the language and probably have automatized the lower levels of decoding and literal comprehension.

These findings might bring additional evidence to suggest that lower-level processes and higher-level processes function separately, as evidenced by previous studies (ALPTEKIN; ERÇETIN, 2011; HANNON, 2012). In detail, Alptekin and Erçetin (2011) proposed that “higher-order and lower-order reading operations reflect independent cognitive systems at work” (p. 257), based on their findings that domain knowledge did not contribute to literal comprehension. Similarly, Hannon (2012) assumed that lower-level and higher-level processes function independently in adult readers, based on evidence from a structural equation model that tested the potential relationship among lower- and higher-level processes and working memory as sources of individual differences in reading comprehension altogether (HANNON, 2012). However, the assumption that lower-level and higher-level processes work independently is both speculative (e.g. ALPTEKIN; ERÇETIN, 2011) and preliminary (e.g. HANNON, 2012); therefore, it deserves further investigation.

The absence of statistically significant results for condition shows that either binaural beats or pop songs with lyrics did not affect the participants’ literal comprehension. However, the fact that multitasking may not affect literal comprehension might not be seen as optimistic, given the fact that comprehension that relies on the microstructure only will be shallow (KINTSCH; RAWSON, 2005). As discussed above, the construction of a coherent mental representation of the text read relies on both micro- and macrostructure (inferences) (KINTSCH, 2013).

## 4.3. HYPOTHESIS 2

The second hypothesis assumed that inferential comprehension would be both predicted by working memory capacity and Condition, that is, listening to lyrical music in the experimental group and listening to non-lyrical music in the control group.

### 4.3.1. Results

With the lenient scoring method, only a statistically significant effect of WMC was observed (Table 6a). However, with the strict scoring method, the three predictors (WMC, Condition, and Interaction) were found to have statistically significant effects (Table 6b). Thus, Hypothesis 2 was supported by the data only if considering the strict method. It is worth noticing, however, that the $R^2$ of the model with the strict scoring method is lower than the $R^2$ of the model with the lenient scoring method ($R^2$ = .116; $R^2$ = .123, respectively), which means that the lenient scoring method results in a linear model that is slightly better at explaining the variability in the data.

Table 6 - Estimates of WMC (a) Lenient method and (b) Strict method and Condition as predictors of Inferential Comprehension

(a)

| Names | β | p | 95% CI |
|---|---|---|---|
| Intercept | 0.05 | 0.81 | [-0.34, 0.44] |
| WMC | 0.01 | 0.01 | [0.01, 0.03] |
| Condition | 0.45 | 0.09 | [-0.07, 0.97] |
| Interaction | -0.01 | 0.12 | [-0.03, 0.03] |

(b)

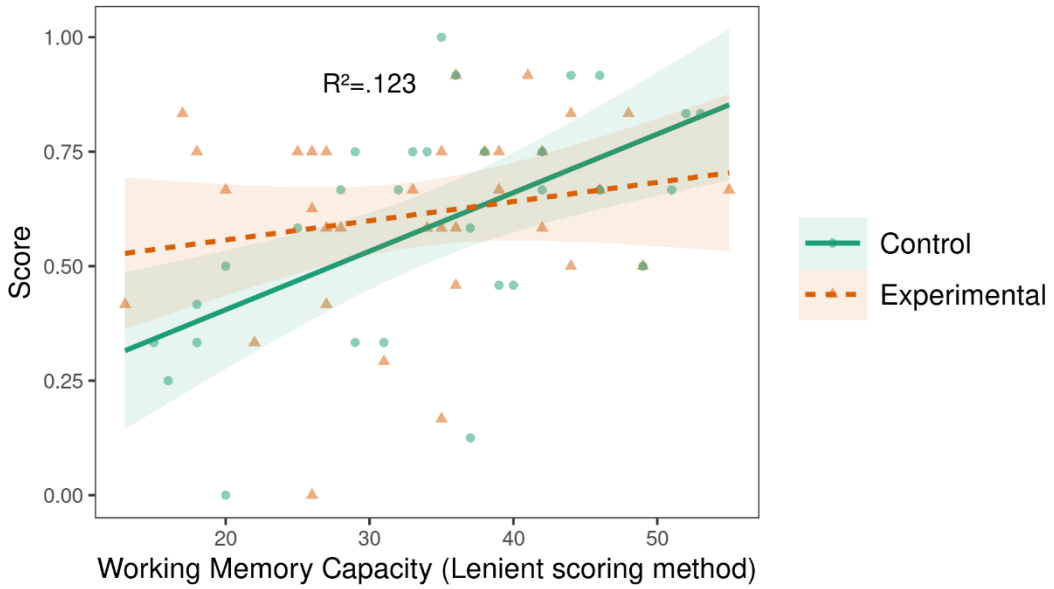
| Names | β | p | 95% CI |
|---|---|---|---|
| Intercept | 0.29 | 0.02 | [0.06, 0.52] |
| WMC | 0.08 | 0.01 | [0.03, 0.14] |
| Condition | 0.37 | 0.02 | [0.08, 0.67] |
| Interaction | -0.09 | 0.02 | [-0.18,-0.02] |

Source: the author.

Our linear model shows that inferential comprehension is predicted by working memory capacity as measured by the lenient method (Table 6a). Both lines in the plot (Figure 10) indicate that the higher WMC, the better comprehension scores in inferential comprehension are. Nevertheless, no significant differences between the control group (M = 0.59; SE = 0.05) and the experimental group (M = 0.61; SE = 0.04) in inferential comprehension were found. Figure 10 demonstrates the solid line (control group) crossing

the dashed line (experimental group), which at first sight might suggest an Interaction between those variables. However, no significant statistical result was obtained for the Interaction (Table 6a). Therefore, it seems that only WMC, as measured in the lenient method, seems to predict inferential comprehension.

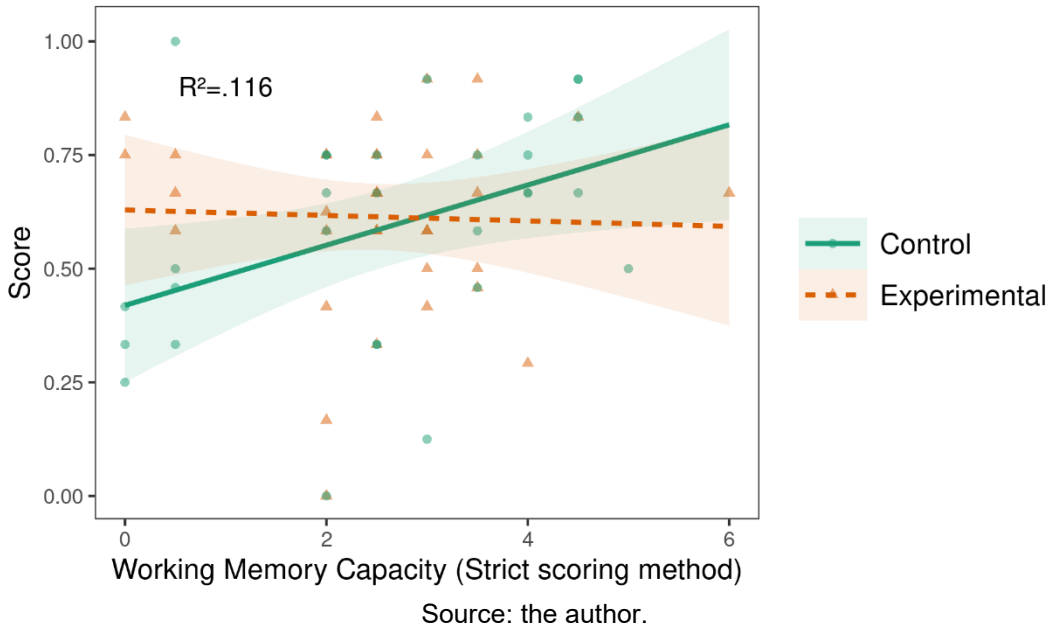
Figure 10 - Inferential comprehension predicted by WMC (Lenient method) and Condition




Source: the author.

According to Figure 11, the slope of the solid line (control) seems to be more inclined than the slope of the dashed line (experimental), suggesting that the effect of WMC on score is stronger for the control group. Similarly, the negative estimate for the Interaction (Table 6b) suggests that the effect of WMC is weaker for participants in the experimental group. Mean scores on WMC tests seem to corroborate such claim for both controls (M = 3.65; SE = 0.24) and experimentals (M = 3.24; SE = 0.24). Nevertheless, participants in the experimental group performed slightly better in inferential comprehension (M = 0.61; SE = 0.01) in relation to the control group (M = 0.59; SE = 0.05). Despite this, our model suggests that both WMC and Condition predicted inferential comprehension, as shown in the trends in Figure 11.

Figure 11 - Inferential comprehension predicted by WMC (Strict method) and Condition




Source: the author.

### 4.3.2. Discussion

The results of this study find support both in the *domain-general* and the *domain-specific* views of working memory (LOGIE; CAMOS; COWAN, 2021b; WEN, 2015; WEN; LI, 2019), following the emerging trend to integrate several models of working memory (LOGIE; BELLETIER; DOHERTY, 2021; WEN; LI, 2019; WEN; SCHWIETER, 2022). More specifically, the results can be explained by the *Working Memory and Executive Attention* perspective (ENGLE, 2018; MASHBURN; TSUKAHARA; ENGLE, 2021); and the Multicomponent Model (BADDELEY, 2012, 2015, 2017b).

The significant effects obtained from inferential reading whilst listening to lyrical music were only found in the strict scoring method and converge with the claim that “the ability to do a cognitively demanding task […] while trying to recall the last word of each sentence is believed to require attention, and therefore the strict scoring method would show the limitations of WMC” (ROSCIOLI, 2017, p. 90). This claim seems to be in line with Engle and colleagues’ view of working memory as the system responsible for maintaining goal-relevant information in an active state, which has been evidenced by

complex span tasks, such as the RST (BURGOYNE; ENGLE, 2020; ENGLE, 2018; MASHBURN; TSUKAHARA; ENGLE, 2021). In fact, WMC relies on domain-general executive attention to keep goal-relevant information in an active state preventing distractions. Thus, our results demonstrate that WMC, which is dependent on attentional control, is compromised during multitasking.

Nevertheless, it seems that Baddeley's Multicomponent Model of Working Memory best explains the results obtained, given its modular nature (BADDELEY, 2017b; WEN, 2015). The domain-specific component known as the phonological loop, which is held accountable for storing and manipulating verbal information (BADDELEY, 2012, 2015; LINCK et al., 2014) is believed to be highly deployed while reading and listening to music, given that "speech sounds automatically gain access to phonological loop" (VASILEV; KIRKBY; ANGELE, 2018, p. 571), as evidenced by a series of experiments that explored the effects of background music on phonological short-term memory by having participants recall a series of visually presented verbal items whilst listening to either instrumental or vocal (lyrical) music (see SALAMÉ; BADDELEY, 1989 for a detailed account). Even though reading is more complex than recalling visually presented items, it somehow resembles the process of keeping the order of words and their syntactic relations for constructing the mental representation (VASILEV; KIRKBY; ANGELE, 2018). To be more specific, the linguistic level of comprehension involves word and parsing processes in order to form idea units or propositions (KINTSCH, 1998, 2013; KINTSCH; RAWSON, 2005), thus, "forming these units must also involve establishing and keeping track of the order of words in the sentence, as well as their syntactic relationships" (VASILEV; KIRKBY; ANGELE, 2018, p. 571).

Despite the fact that both the visuospatial sketchpad and episodic buffer have been little investigated, some speculations may be made regarding their role in multitasking. The sketchpad seems to be employed in reading comprehension for maintaining visuospatial information (BADDELEY; LOGIE, 1999), while the episodic buffer is held accountable for passively storing visual and verbal information from the LTM and the environment (BADDELEY, 2015; BADDELEY; HITCH; ALLEN, 2021). The episodic buffer is intimately connected to the central executive, the component that guides goal-

directed attention, and maintains focused attention to avoid distractions. In multitasking, therefore, the components of working memory may be overloaded by both the concurrent streams of information coming from the input of the primary task (reading), and vocal and acoustical information from the secondary task.

All in all, these results seem to provide evidence for the claim that working memory is both *domain-general,* in terms of executive control functioning, and *domain-specific,* concerning phonological and visuospatial materials (see WEN; SCHWIETER, 2022 for a full account). These authors suggest, therefore, that "it may be best to conceive working memory as a multicomponent system that consists of both *domain-specific* storage buffers and domain-general executive control functions […]. Therefore, neither a completely *domain-general* nor a completely *domain-specific* view of working memory holds" (WEN; SCHWIETER, 2022, p. 913).

The statistically significant effects of WMC in both scoring methods (table 6) suggest that WMC played an important role in inferential comprehension in this sample. First, the results of the strict scoring method support the claim that this method may be a reliable tool for assessing the limitations of WMC in attentional control (ROSCIOLI, 2017). Second, the results obtained by means of the lenient scoring method support the claim that this scoring method may provide "better distribution and reliability characteristics because they provide more discrimination in terms of individual differences" (FRIEDMAN; MIYAKE, 2005, p. 582).

## 4.4. HYPOTHESIS 3

The third hypothesis predicted that participants with higher WMC would be better multitaskers in relation to lower WMC counterparts. In other words, it was hypothesized that individuals with higher working memory capacity would be better at recalling main ideas (MI), secondary ideas (S), and details (D) of a hypertext in two conditions: listening to lyrical music in the experimental condition and non-lyrical music in the control condition.

### 4.4.1. Results

On predicting Recall of Main Ideas, no statistically significant effects were observed, irrespective of the scoring method used (Table 7, Figure 12). However, on predicting Recall of Secondary ideas, a statistically significant effect of WMC was observed (Table 8, Figure 13). The same effect was observed in predicting Recall of Details (Table 9, Figure 14). Additionally, a significant Interaction between WMC and Condition was observed while predicting Recall of Details with the strict scoring method.

Hypothesis 3 is supported by the data based on the assumption that the recall of secondary ideas and details is more demanding. In summary, participants with higher WMC could recall more secondary ideas and details than participants with lower WMC. Considering the strict scoring method and specifically the recall of details, higher WMC participants outperformed lower WMC participants in the experimental condition, while the opposite was observed in the control condition.

Given the aforementioned assumption that the recall of secondary ideas and details are more demanding than the recall of main ideas, a complementary analysis was carried out (Table 10) and is further discussed in this section. The assumption only holds if we consider that participants are proficient readers, which would entail that they build a mental representation of texts by emphasizing main ideas and giving less priority to secondary ideas and details. Thus, readers with higher working memory capacity are expected to be able to recall secondary ideas in addition to main ideas and details in addition to secondary and main ideas. In other words, readers are not expected to recall details and secondary ideas without recalling the main ideas, which would invalidate the assumption.

Regarding the recall of main ideas, trend lines in Figure 12 show a slight, yet non-statistically significant, difference between controls and experimentals in the recall of main ideas. Participants' similar performances across groups might have happened due to the fact the number of main ideas explicitly stated is just about the same as those implicit in the text, based on a visual inspection of the idea units of the proportionalized text and the results of the interrater reliability (*moderate agreement* on main ideas, as reported in section 3.8.3). Nevertheless, the complementary analysis discussion shall address the

issue of main ideas recall.

Table 7 - Estimates of WMC (a) Lenient method and (b) Strict method and Condition as predictors of Main Ideas Recall

(a)

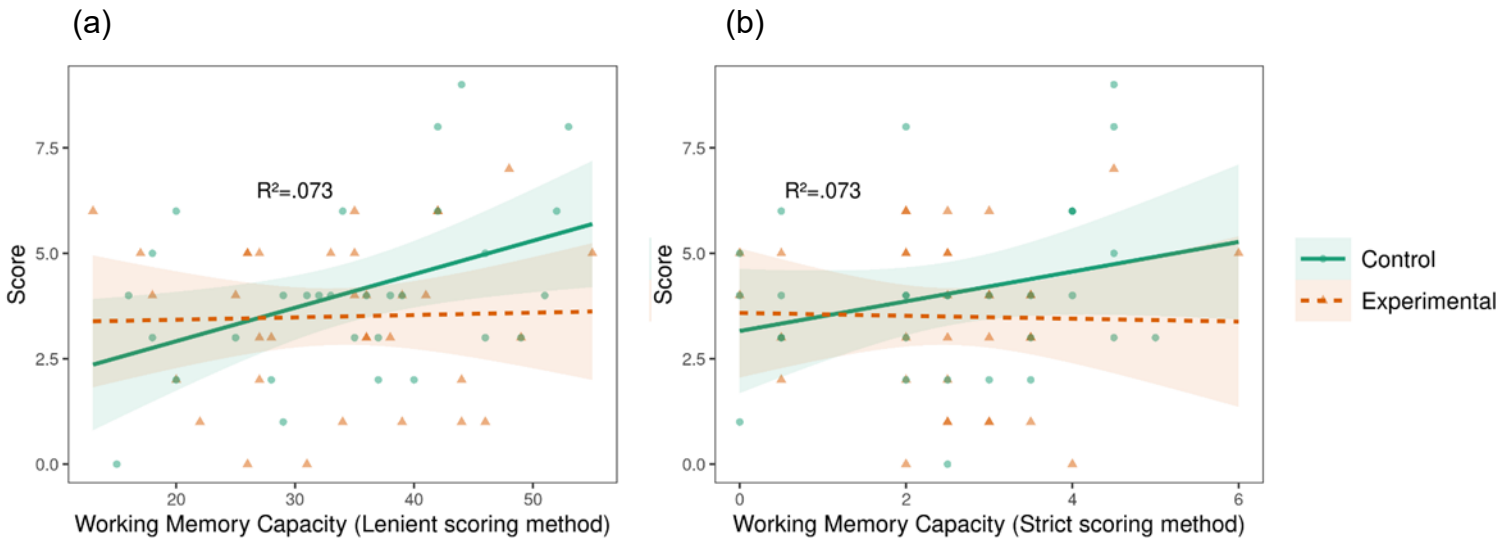
| Names | β | p | 95% CI |
|---|---|---|---|
| Intercept | 1.10 | 0.53 | [-2.4, 4.6] |
| WMC | 0.06 | 0.09 | [-0.02, 0.14] |
| Condition | 1.20 | 0.62 | [-3.5, 5.9] |
| Interaction | -0.04 | 0.48 | [-0.14, 0.07] |

(b)

| Names | β | p | 95% CI |
|---|---|---|---|
| Intercept | 2.30 | 0.03 | [0.23, 4.4] |
| WMC | 0.48 | 0.08 | [-0.05, 1] |
| Condition | 1.60 | 0.24 | [-1.1, 4.2] |
| Interaction | -0.60 | 0.10 | [-1.3, 0.11] |

Source: the author.

Figure 12 - Recall of Main Ideas predicted by WMC (a) Lenient method and (b) Strict method and Condition




Source: the author.

As mentioned, a statistically significant effect of WMC in secondary ideas recall was obtained both in the lenient scoring method (Table 8a) and in the strict scoring method (Table 8b). The graph (Figure 13a) suggests that participants in the control group with higher working memory capacity (lenient scoring method) are better at recalling secondary ideas. Additionally, mean scores reveal that participants in the control group outperformed those in the experimental group in the recall of secondary ideas (controls M = 9.26; SE =

1.05; experimentals M = 6.20; SE = 0.70). However, no statistical significance was obtained for Condition (Table 10).

Figure 13b displays both lines for control and experimental (solid and dashed lines, respectively), which seem to be parallel, suggesting no Interaction between variables, which is confirmed by the lack of statistical significance for Interaction (Table 10). Even though lines cross in Figure 13a, the Interaction is not statistically significant.

Interestingly, the $R^2$ for both scoring methods seems to be a fine predictor of data variability, considering ($R^2$ = .184) for the lenient scoring method and ($R^2$ = .166) for the strict scoring method, which correspond to 18% and 16% of variability in our data, respectively.

Table 8 - Estimates of WMC (a) Lenient method and (b) Strict method and Condition as predictors of Secondary Ideas Recall

(a)

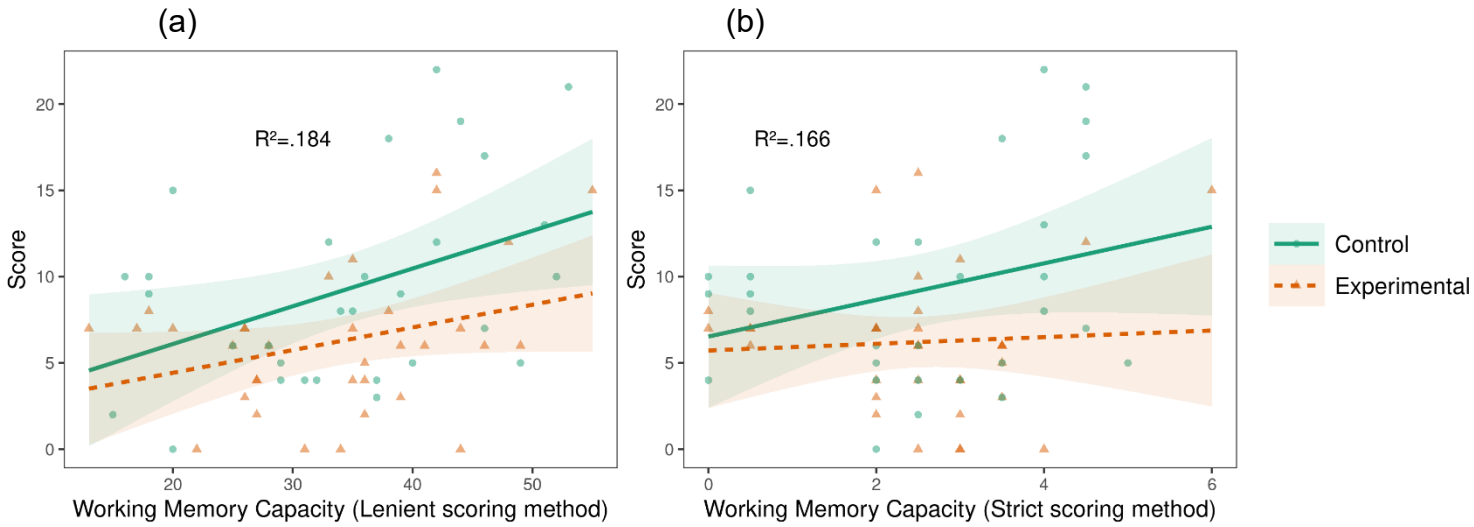
| Names | β | p | 95% CI |
|---|---|---|---|
| Intercept | -0.76 | 0.86 | [-9.4, 7.9] |
| WMC | 0.22 | 0.03 | [0.04, 0.41] |
| Condition | 2.20 | 0.70 | [-9.3, 14] |
| Interaction | -0.11 | 0.39 | [-0.37, 0.15] |

(b)

| Names | β | p | 95% CI |
|---|---|---|---|
| Intercept | 3.5 | 0.19 | [-1.7, 8.6] |
| WMC | 1.6 | 0.02 | [0.27, 2.9] |
| Condition | 2.4 | 0.47 | [-4.2, 9] |
| Interaction | -1.5 | 0.10 | [-3.3, 0.28] |

Source: the author.

Figure 13 - Recall of Secondary Ideas predicted by WMC (a) Lenient method and (b) Strict method and Condition




Source: the author.

Table 12 indicates a statistically significant effect of both lenient and strict scoring methods of WMC on the recall of details. In addition to that, the strict scoring results showed a statistical significance for the Interaction between variables (Table 12b), which can also be observed by the line trends in Figure 14b. Condition, on the other hand, did not seem to predict the recall of details.

Results indicate the significant effects of the Interaction between WMC (strict scoring method) and Condition on the recall of details (Table 12b). Taken that and the ascending line for the control group and the descending line for the experimental group (Figure 14b), the higher the WMC, the better recall in the control condition, as opposed to that, the worse recall in the experimental condition (Figure 14b). Mean scores also reveal that participants in the control group recalled more details (M = 3.83; SE = 0.59) in comparison to their experimental counterparts (M = 1.73; SE = 0.28). Last, the $R^2$ of both scoring methods (Figure 14) indicates that the model explains a good variability in our data, accounting for 25% and 24%.

Table 9 - Estimates of WMC (a) Lenient method and (b) Strict method and Condition as predictors of Details Recall

(a) (b)

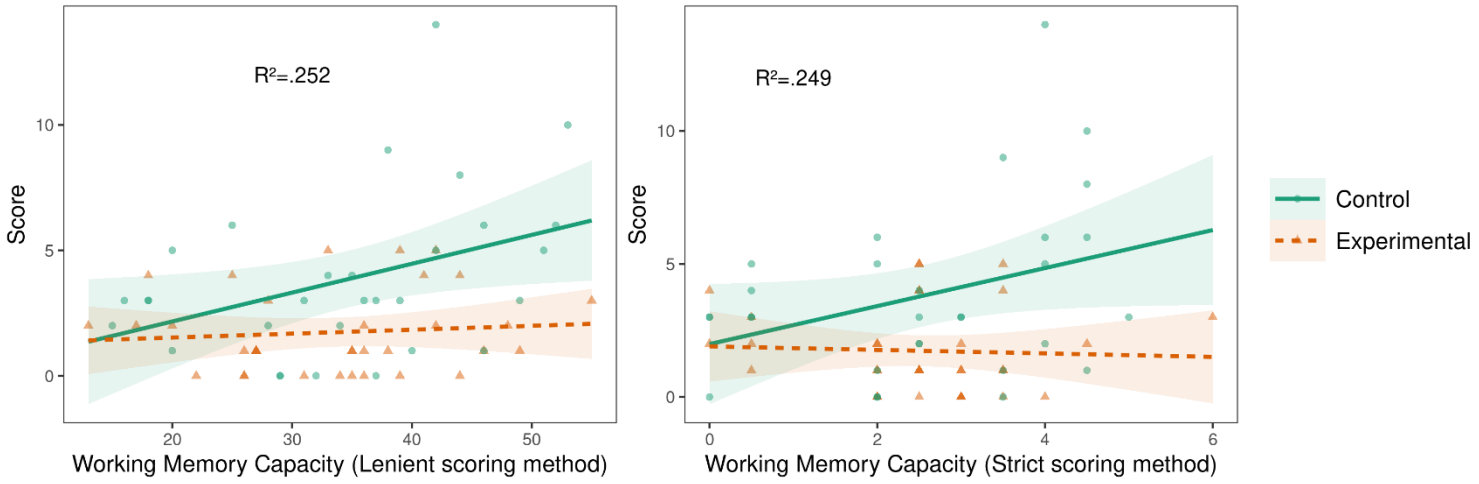
| Names | β | p | 95% CI |
|---|---|---|---|
| Intercept | -2.30 | 0.31 | [-4.5, -0.06] |
| WMC | 0.14 | 0.01 | [0.08, 0.18] |
| Condition | 3.70 | 0.21 | [0.8, 6.7] |
| Interaction | -0.13 | 0.05 | [-0.2, -0.06] |

| Names | β | p | 95% CI |
|---|---|---|---|
| Intercept | 0.49 | 0.70 | [-0.81, 1.8] |
| WMC | 0.92 | 0.01 | [0.58, 1.3] |
| Condition | 1.80 | 0.28 | [0.13, 3.5] |
| Interaction | -1.10 | 0.02 | [-1.5, -0.64] |

Source: the author.

Figure 14 - Recall of Details predicted by WMC (a) Lenient method and (b) Strict method and Condition

(a) (b)




Source: the author.

The results of the complementary analysis are displayed below (Table 10 and Figure 15). Table 10 shows that main ideas had the highest probability of being recalled and details had the lowest probability of being recalled in both conditions. Figure 15 shows that main ideas, secondary ideas, and detail recalls are positively correlated. In other words, participants that recalled more main ideas tended to also recall more secondary ideas and details. Thus, participants recalling only details or secondary ideas without recalling main ideas are rarer than those recalling both. Considering these patterns and the results showing no statistically significant effects of WMC nor Condition in the recall of main ideas but showing statistically significant effects in the Recall of Secondary Ideas and Details, the proposed interpretation is that (1) participants focused on main ideas

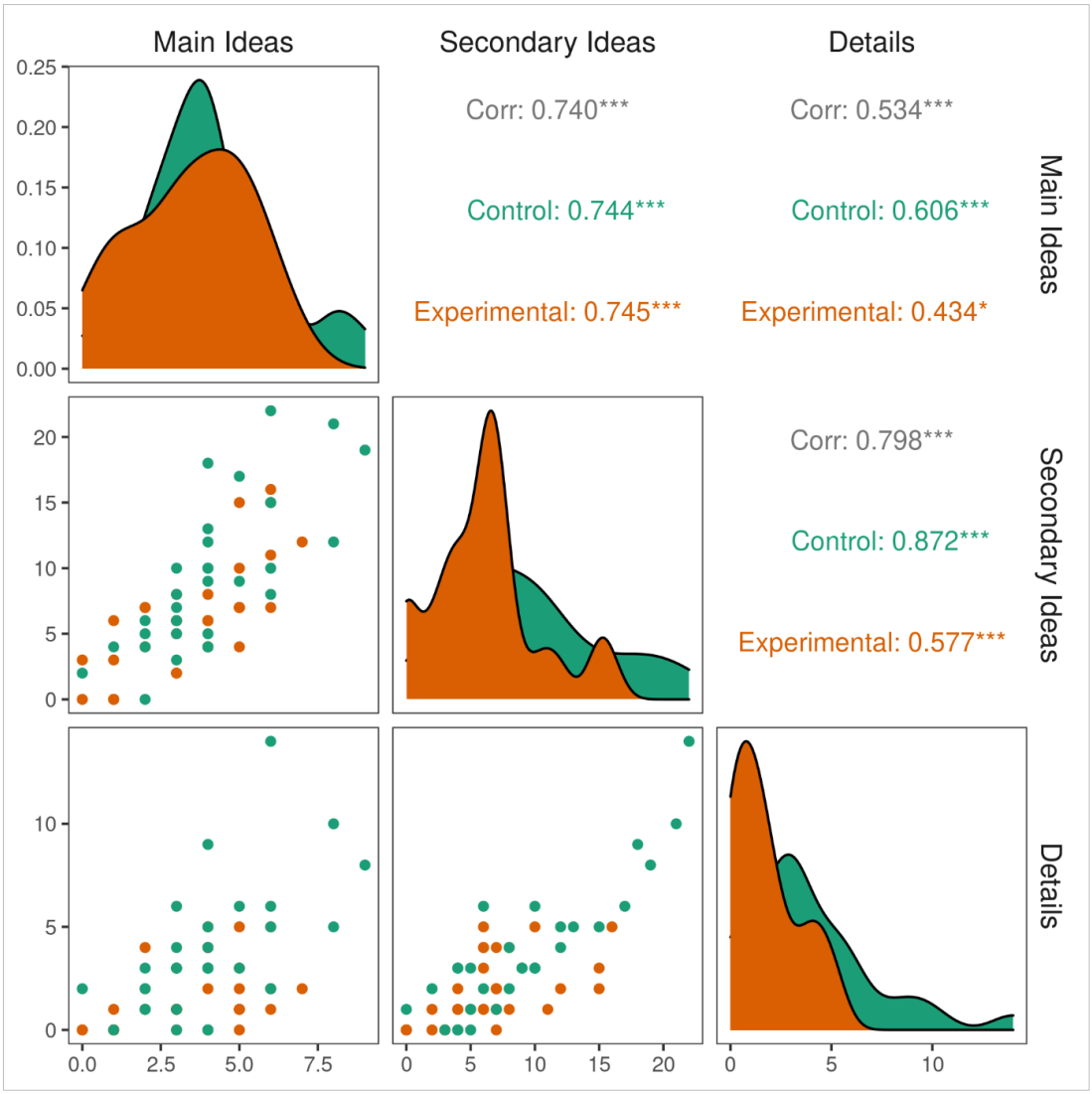
when building their mental representation of texts, thus the absence of effects of WMC in the recall of main ideas can be explained by a lack of high cognitive demand in the addition of main ideas in the mental representation of texts in the population of the study, especially considering the similar number of explicit and implicit stated main ideas; (2) participants with higher working memory capacity were able to recall more secondary ideas and details **in addition to** main ideas and that is why the effects were only observed predicting secondary ideas and details and not predicting main ideas. However, further studies are necessary to better investigate the proposed interpretation.

Table 10 - Mean and proportion of ideas recalled

| Condition | Recall | Mean | SE | Proportion |
|---|---|---|---|---|
| Control | Main Ideas Recall | 4.07 | 0.374 | **0.407** |
| Control | Secondary Ideas Recall | 9.27 | 1.055 | 0.309 |
| Control | Details Recall | 3.83 | 0.589 | 0.225 |
| Experimental | Main Ideas Recall | 3.50 | 0.325 | **0.350** |
| Experimental | Secondary Ideas Recall | 6.21 | 0.709 | 0.207 |
| Experimental | Details Recall | 1.74 | 0.281 | 0.102 |

Source: the author.

Figure 15 - Correlations between ideas recall




Notes: * p < .05, *** p < .001
Source: the author.

### 4.4.2. Discussion

It was hypothesized that WMC would be a good predictor of multitasking performance, enacted by the recall of a hypertext whilst listening to non-lyrical music (control condition) and lyrical music (experimental condition). The hypothesis is supported based on the findings that participants with higher WMC could recall more secondary ideas and details than participants with lower WMC, and they were able to do so better in

the experimental condition, while lower WMC participants were better in the control condition. The absence of significance in the recall of main ideas was further investigated in the complementary analysis which suggested that participants with higher WMC did recall main ideas in addition to secondary ideas and details. Some assumptions can be made regarding these findings.

A first possible explanation for such findings is connected with participants' high levels of proficiency and thus, low cognitive demand. These results seem consistent with previous findings (OLIVEIRA; TOMITCH, 2021; TOMITCH, 1999). Tomitch (1999) demonstrated that more proficient readers (also higher-span readers) recalled more propositions from the text in comparison to less proficient counterparts (also lower-span ones). As opposed to that, Oliveira and Tomitch (2021) found that lower-span participants obtained high scores in text recall, so they explored the possible influence of reading proficiency. The authors found that foreign language reading proficiency correlated with recall scores and therefore suggested that "foreign language reading proficiency is a better predictor of recall than WMC" (OLIVEIRA; TOMITCH, 2021, p. 87). It seems, thus, that identifying and/or constructing main ideas from text may be an automatic process for proficient readers, and consequently might not consume all of working memory resources (ANDERSON, 2000). Additionally, scholars seem to agree that "proficient readers are able to identify or construct the main points of a text" (TOMITCH, 2000, p. 51).

The issue of low cognitive demand is discussed by van Dijk and Kintsch (1983). Macrostructure formation – the representation of the global structure of the text, the gist – demands working memory resources for chunking information from the text. In order to retrieve the chunked information, both *a rich knowledge base* and *rapid and effortlessly storage and retrieval operations* are needed to avoid overloading working memory (VAN DIJK; KINTSCH, 1983). Our results, thus, seem to corroborate van Dijk and Kintsch's ideas.

A second possible explanation has to do with the readers' goal during reading the hypertext used in this experiment. Participants were instructed to read a text and later report the main ideas and all the information they could remember from the text. Thus, participants' reading goal might have directly influenced their outcomes in the recall task.

Similar results were found by Yeari, van den Broek and Oudega (2015), who investigated the effects of reading goals on the recall of central versus peripheral information (analogous to main idea and secondary ideas and details). The authors found that “readers can strategically regulate their overall engagement and selective attention allocation to central and peripheral information in accordance to their reading goals” (YEARI; VAN DEN BROEK, 2015, p. 1092).

## 4.5. HYPOTHESIS 4

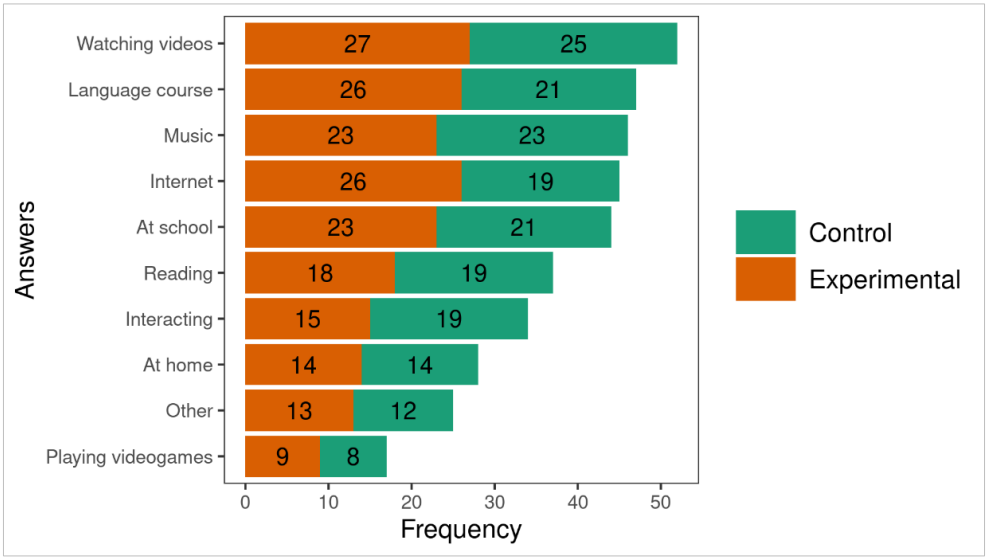
A fourth post hoc exploratory hypothesis predicted that both linguistic experience and self-rated L2 proficiency would predict multitasking performance in terms of recall of text ideas, by means of free written recall (RONDON; TOMITCH, 2020), and in terms of literal and inferential comprehension, by means of comprehension questions (PEARSON; JOHNSON, 1978), and for both groups (control and experimental), with an indication of advantage in multitasking for participants with a more varied linguistic experience and higher proficiency levels.

### 4.5.1. Results

It is important to mention that this post hoc exploratory hypothesis was generated after initial inspection of results, and should, therefore, be further investigated by future studies, a procedure similarly adopted by Oliveira, Woelfer and Tomitch (2021). Taken that, a preliminary analysis of participants’ responses was carried out to inspect group differences (control and experimental) in terms of the aspects raised through the *QuExPli* (SCHOLL; FINGER, 2013; SCHOLL; FINGER; FONTES, 2017), to say, (1) English language background which is devised in *how English was learned; age of onset; age of fluency;* followed by the (2) factors that contributed to learning English and (4) their frequency; and participants’ (4) self-rated proficiency. The inspection is detailed as follows:

The first step of the analysis was the visual inspection of summaries of the answers to the *QuExPli* considering possible differences between groups (control and experimental). To inspect how English was learned, the frequency of each answer was counted (Figure 16). It is important to note that each participant could select more than one answer. To inspect the age of onset and the age of fluency, each age range was converted to its mid-point. For example, the age range 0-3 was converted to 1.5. The mean and standard error of this distribution was then calculated (this procedure is suggested in BELL, 2005, p. 210) (Figures 17a and 17b). To inspect the contributing factors to English learning, the frequency of activities in English, and self-reported proficiency, the mean of the answers in the Likert scale for each category was calculated (Figures 18, 19 and 20).

Figure 16 - How English was learned

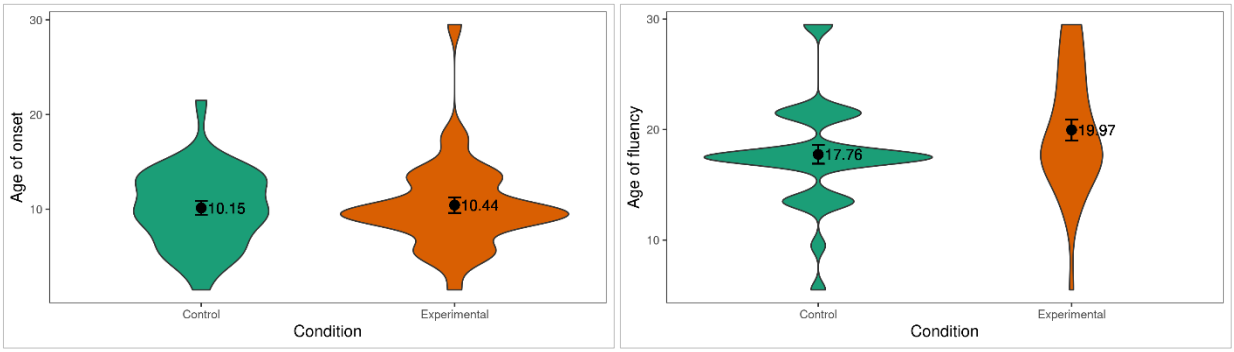



Source: the author.

Figure 16 shows that both groups (Control and Experimental) answered similarly to the question about how English was learned. Regarding the age participants started speaking English, similar results between groups were also obtained (Figure 17a). However, concerning the age of fluency (Figure 17b) results showed a slight difference

between the two groups, with the Experimental group reaching fluency about 2 year later in comparison with the Control group.

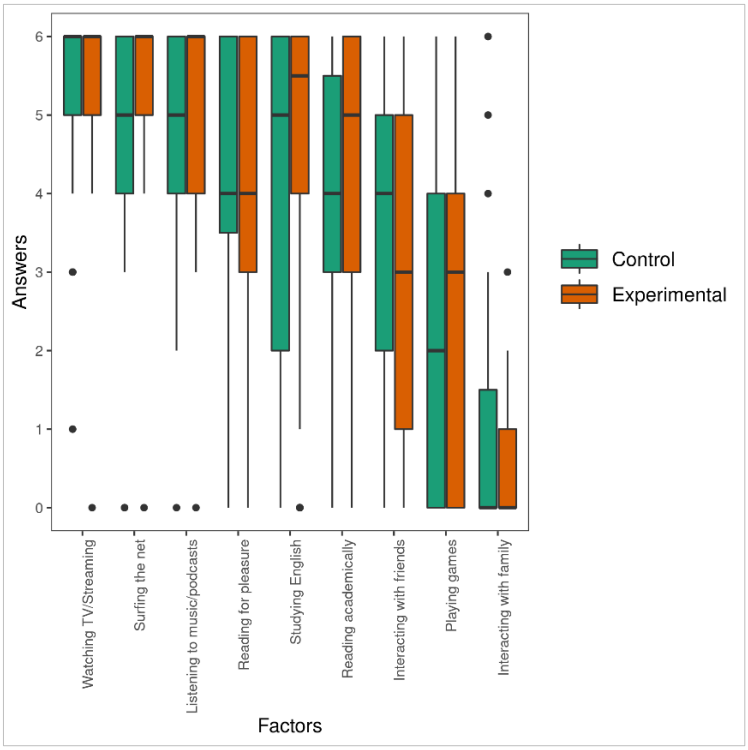
Figure 17 – (a) age of onset (b) age of fluency




Source: the author.

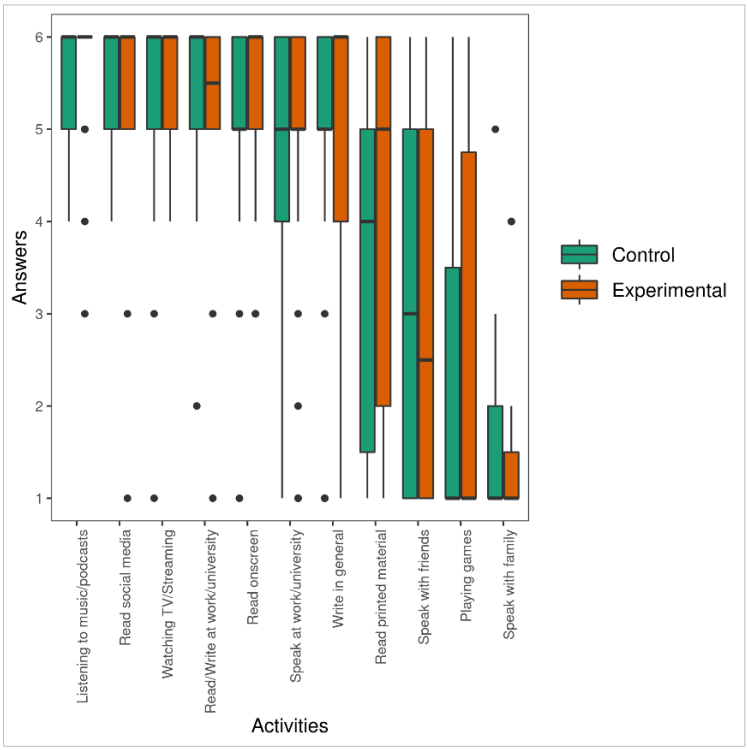
Regarding the factors that contributed to learning English, Figure 18 demonstrates the absence of significant differences between the Control and Experimental groups. Similarly, Figure 19 shows the absence of significant differences between the Control and Experimental groups regarding the reported frequency of activities in English.

Figure 18 - Contributing factors to English learning




Source: the author.

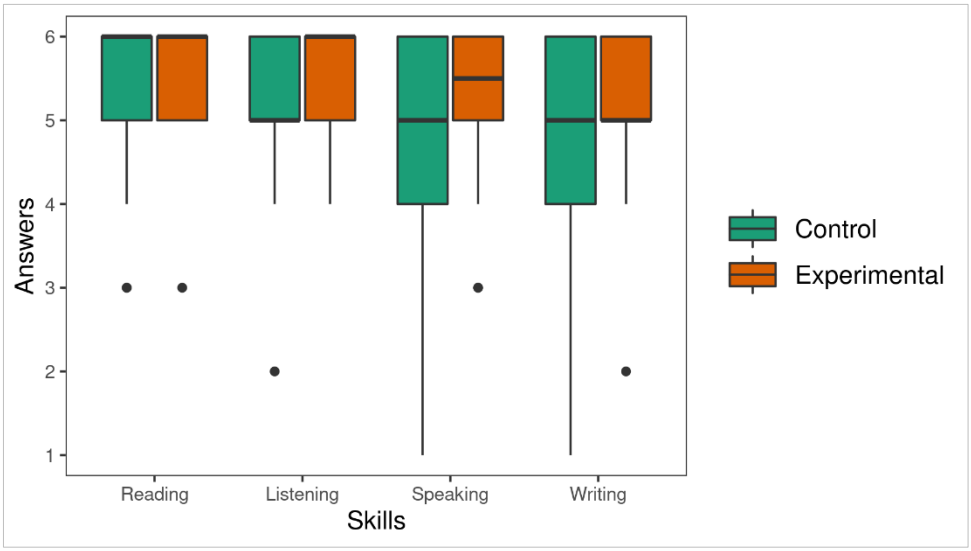
Figure 19 - Frequency of activities in English




Source: the author.

Similar to the previous figures, Figure 20 shows the absence of significant differences between the self-reported proficiency of the groups.

Figure 20 - Proficiency




Source: the author.

The second step of the analysis was the inspection of the correlation coefficients between the answers to each of the categories of the self-reported proficiency and the answers to each of the categories of the questions about the contributing factors to English learning (Appendix N) and the frequency of activities (Appendix O). This step was based on the study by Scholl, Finger e Fontes (2017). To compare the results with the ones reported in Scholl, Pearson's Correlation Coefficient was used (Appendix N and O). However, since Pearson's Coefficient may not be appropriate the measure the association of ordinal variables (e.g., answers to Likert scale questions, see HAUKE; KOSSOWSKI, 2011 for a discussion), Spearman's Rank Correlation Coefficient was also used (Appendix N and O).

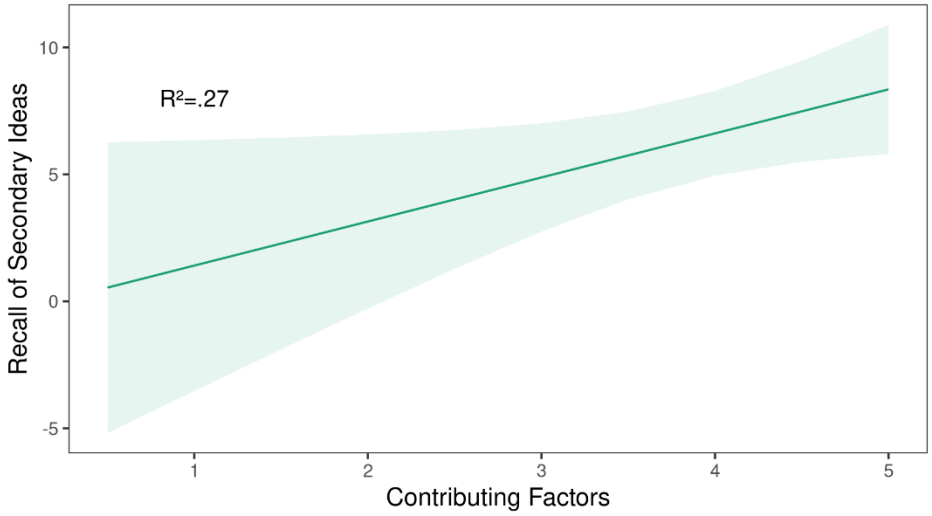
Then, a linear regression analysis was carried out to inspect the exploratory hypothesis of this study, and only the factors of linguistic experience significantly predicted reading comprehension in terms of text recall (secondary ideas, and details). Given its

post-hoc exploratory nature, only the statistically significant results will be reported as follows.

A linear regression analysis showed that among the factors of linguistic experience, the recall of secondary ideas in the lenient scoring method ($\beta = 1.7$; $p = 0.05$; 95% CI = [0.09, 3.4]), and details in the lenient ($\beta = 0.96$; $p = 0.03$; 95% CI = [0.15, 1.8]) and strict method ($\beta = 0.94$; $p = 0.03$; 95% CI = [0.12, 1.8] are predicted by the contributing factors to learning English.

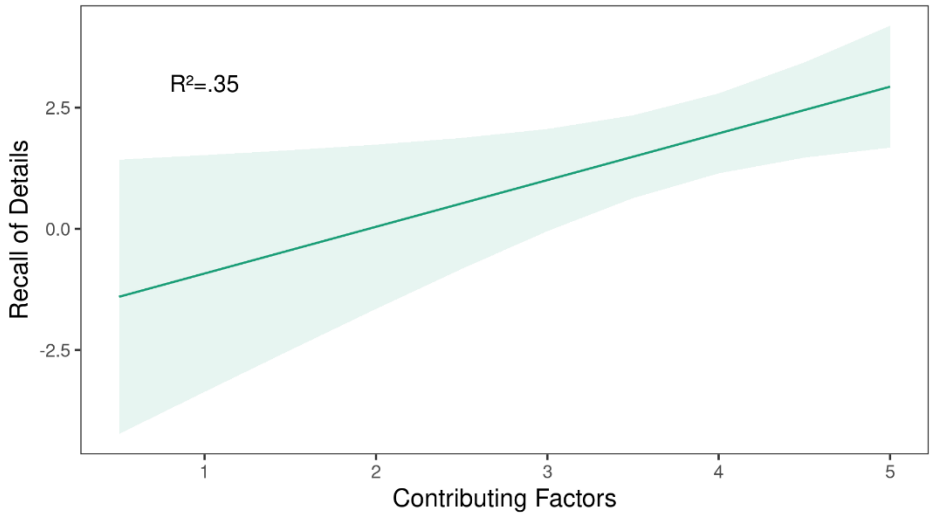
Figures 21, 22 and 23 display the recall of secondary ideas (scored leniently) and details (both scoring methods) predicted by the contributing factors to learning English, to mention, watching TV/Streaming, surfing the net, listening to music/podcasts, reading for pleasure, studying English, reading academically, interacting with friends, playing games and interacting with family (Figure 18 depicts these factors according to groups – control and experimental). Participants answered on a scale from 0 to 6 (0 = nothing; 3 = fairly; 6 = a lot) to what extent each of the nine factors influenced their learning of English. Thus, the positive slope of contributing factors suggests that the more the factors indicated as higher contributors to language learning, the better their recall of secondary ideas and details (figures 21,22, and 23). The $R^2 = .27$ in the recall of secondary ideas suggests that 27% of variability of data can be explained by the model. Similarly, the $R^2 = .35$ in the recall of details in both methods suggests a variability of 35% of data.

Figure 21 - Recall of Secondary Ideas predicted by Contributing Factors to English learning (Model with Lenient WMC Scores)



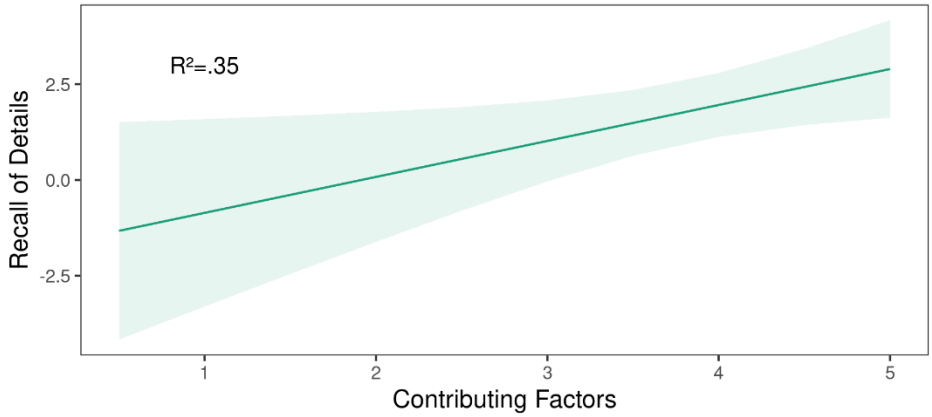

Source: the author.

Figure 22 - Recall of Details predicted by Contributing Factors to English learning (Model with Lenient WMC Scores)




Source: the author.

Figure 23 - Recall of Details predicted by Contributing Factors to English learning (Model with Strict WMC Scores)




Source: the author.

### 4.5.2. Discussion

With these results in mind, it is possible to suggest that the more the factors indicated by participants as higher contributors to their learning the English language, the better their recall of text ideas was. It is important to mention that the preliminary analysis showed that both groups (control and experimental) were balanced in terms of the factors they judged as contributors to English learning (Figure 18).

The section *Contributing Factors for English Learning* of the *QuExPli* (SCHOLL; FINGER, 2013; SCHOLL; FINGER; FONTES, 2017) was adapted from *Language Experience and Proficiency Questionnaire* (LEAP-Q) (MARIAN; BLUMENFELD; KAUSHANSKAYA, 2007). These authors emphasized the role of the environment and context for additional language acquisition and thus their questionnaire “elicits descriptions of acquisition modes in terms of the learning environments and in terms of the extent to which these learning environments contributed to language acquisition” (MARIAN; BLUMENFELD; KAUSHANSKAYA, 2007, p. 943).

Among the factors that contributed to additional language learning, by means of the *QuExPli,* Figure 18 (previous section) demonstrates that ‘Watching TV/Streaming’ was rated the highest among the groups, especially considering the line indicating the

median[52] is placed at the top of the boxplot. Participants also rated ‘Surfing the Net’ as a highly influential factor, followed by ‘listening to music/Podcasts. The factor ‘reading for pleasure’, on the other hand, showed greater interquartile ranges (box length) but was still considered a highly influential factor. The interquartile range was even greater in the ‘studying English’ factor for controls, but the medians do not suggest significant differences. Among the lowest-rated factors, it is possible to mention ‘interacting with friends’, ‘playing games’, and ‘interacting with family’.

Taken that, it seems that multiple factors of linguistic experience similarly contributed to additional language acquisition, thus, benefiting recall of text ideas, as our results have shown. Our results seem to be in consonance with the concept of *variability* in learning (RAVIV; LUPYAN; GREEN, 2022). According to these authors,

> Learning is using past experiences to inform new behaviors and actions. Because all experiences are unique, learning always requires some generalization. An effective way of improving generalization is to expose learners to more variable (and thus often more representative) input. More variability tends to make initial learning more challenging, but eventually leads to more general and robust performance (RAVIV; LUPYAN; GREEN, 2022, p. 1)

In the context of additional language learning, therefore, it seems that the more variable the input, the more robust learning will be. Such claim is consistent with our findings that several factors of participants’ bilingual experience contributed to English learning and thus reflected in a more coherent mental representation of the text read. This ability to transfer acquired knowledge to different contexts (in this case, to text recall) is called *generalization* and differs from simply retention of knowledge (RAVIV; LUPYAN; GREEN, 2022).

The fact that several factors contributed to learning English fits into two categories of variability proposed by Raviv et al., to say, “*numerosity (set size)* such as when learning from more or fewer distinct examples; […] [and] *situational (contextual) diversity* “such as when learning from the same examples under more or less variable environmental

[52] Larson-Hall (2010) explains that “the line drawn in the box marks the median, which is the point at which 50% of scores are above and 50% of scores are below” (p.245).

conditions that do not pertain to the examples themselves" (RAVIV; LUPYAN; GREEN, 2022, p. 5–6). In other words, it seems numerous and distinct inputs in the English language in a variety of contexts might have influenced the acquisition of English as an additional language in our sample.

Equally important is the claim that every experience is unique (RAVIV; LUPYAN; GREEN, 2022), in the same way that the bilingual experience is (BIALYSTOK, 2021; LÓPEZ; LUQUE; PIÑA-WATSON, 2021). To be more specific, bilingualism is a complex and dynamic construct (DELUCA et al., 2019; LUK; BIALYSTOK, 2013) "with individuals varying not only in the number of languages they know and how proficient they are in each, but also in the social contexts in which they use those different languages" (BACKER; BORTFELD, 2021, p. 2). In fact, researchers have long been interested in the impacts of the bilingual experience on the cognitive system and brain structures (see BIALYSTOK, 2021; BIALYSTOK; CRAIK, 2022; LEIVADA et al., 2021 for reviews). For instance, Bialystok (2017) reported how the mind accommodates the bilingual experience, under the argument that "language use is the most intense, sustained, and integrative experience in which humans engage. The intensity reflects the role that language has in all our activities, not only for verbal communication but also for conceptualizing and interpreting ongoing experience" (BIALYSTOK, 2017, p. 2).

Therefore, it seems that the bilingual experience reported by our participants may have impacted their multitasking ability. Nevertheless, it is important to mention that our assumptions are purely speculative, thus, future studies should address the issue of variability in bilingual experience.

The lack of statistically significant results in the self-rated proficiency suggested that traditional proficiency rankings might not always be considered unique ratings of bilingualism profiling. In other words, our study supports the view that bilingualism should not be regarded as a categorical variable containing the binary classification monolingual/bilingual (BIALYSTOK, 2021; DELUCA et al., 2019; LUK; BIALYSTOK, 2013), but it should be regarded a spectrum of linguistic experiences (BACKER; BORTFELD, 2021; LEIVADA et al., 2021). Therefore, issues such as language usage patterns, sociocultural contexts (BACKER; BORTFELD, 2021), ages of acquisition and

fluency, as well as individuals' self-rated proficiency (LUK; BIALYSTOK, 2013; SCHOLL; FINGER, 2013; SCHOLL; FINGER; FONTES, 2017) should be accounted in research with bilinguals.

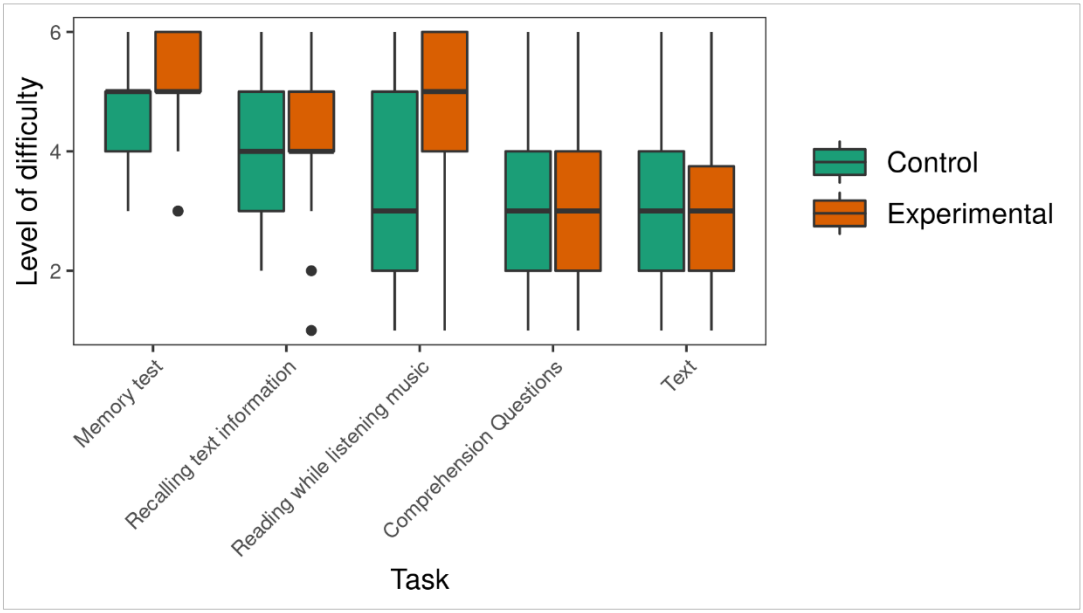
## 4.6. EXPLORATORY ANALYSES

This section reports the results obtained from the retrospective questionnaire, the last task applied in the experimental section. Participants were asked questions concerning (1) the level of difficulty of the tasks involved in the experiment; (2) their multitasking profile, and (3) their background experience with music. The full questionnaire is available in Appendix F.

### 4.6.1. Retrospective Questionnaire: Level of Difficulty of the Tasks

The first part of the questionnaire investigated participants' perceptions on the level of difficulty of the tasks contained in the study. Results are displayed in Figure 24.

Figure 24 - Participants' perceptions on the level of difficulty of the experimental tasks




Source: the author.

Overall, it seems that the participants of this study struggled more with the Self-Applicable RST (memory test in Figure 24), which seems reasonable given that the RST was designed to tap both storage and processing components in WM which compete for the limited capacity of the system (DANEMAN; CARPENTER, 1980). Difficulty in the RST is inherent in studies that used this test, as evidenced by retrospective questionnaires of previous studies (e.g. PROCAILO, 2017; RONDON, 2019). Tomitch (2020) reports that previous researchers noticed that teenage participants struggled with reading the sentences of the RST, which might have happened due to unfamiliarity with the vocabulary used in the sentences. Thus, according to her, "input must be at an 'optimal' level of difficulty so that every sentence is properly processed by the participant" (TOMITCH, 2020, p. 64, my translation)[53]. Nevertheless, this might not have been the case in this study, given that (1) our sample was composed of adults with higher levels of education; and (2) the finding that the Self-Applicable RST, used in this study, is relatively easier in comparison to the original RST (OLIVEIRA; WOELFER; TOMITCH, 2021). Thus, the source of difficulty reported by the participants of this study might be related to the inherent difficulty of the test in terms of (1) time, (2) actually processing the sentence to see if it makes sense; (3) keeping previous last words in memory; (4) recalling the words in the order they appeared, (5) in the same form.

Another interesting finding is that participants in the experimental group, compared to controls, reported more difficulty performing the memory test in the same way that they reported more difficulty in reading while listening to lyrical music. These participants might have felt overwhelmed, especially considering that multitasking does not seem to be usual for them, as our results have shown (Figure 26). As it shall be discussed in the next section, habituation might be an important predictor of multitasking performance (HALLAM; MACDONALD, 2016; KONONOVA; YUAN, 2017).

Recalling text information (Figure 24) was found to be more difficult than the comprehension questions, which again, is expected given that participants did not have access to the text to perform the free recall, but they could re-read the text for the

[53] Original: "o insumo deve estar em um nível 'ótimo' de dificuldade para que cada frase seja efetivamente processada pelo participante" (TOMITCH, 2020, p. 64).

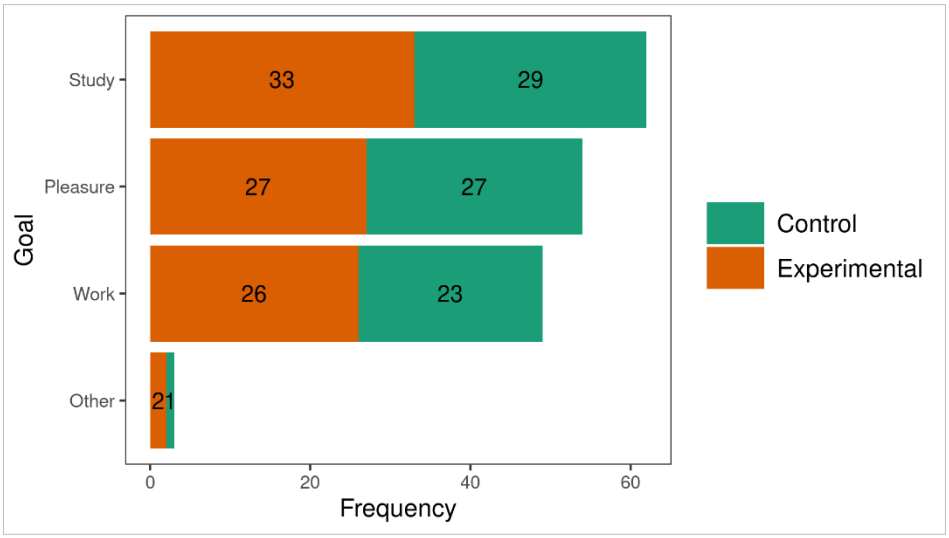
comprehension questions. Free recall tasks are more demanding in the sense that language production is required, that is, ideas must be selected, coordinated, formulated and remembered, as opposed to recognition tasks (e.g. multiple-choice questions or true-false statements) (CARLISLE, 1999).

Figure 24 shows a greater interquartile range (box length) is noticed for controls for recalling text information, differently from the participants in the experimental group. This result might suggest that controls found the task easier than experimentals did. With that in mind, it appears that listening to lyrical music while reading is not only more challenging than listening to non-lyrical music, but also compromises comprehension, as our study and previous ones have shown (e.g. VASILEV; KIRKBY; ANGELE, 2018). The nature of such difficulty might be explained by several models of working memory (BADDELEY, 2012; JUST; CARPENTER, 1992; MASHBURN; TSUKAHARA; ENGLE, 2021 to mention a few) and by a theory of auditory distraction, more specifically, the *interference-by-process* account (HUGHES, 2014; MARSH; HUGHES; JONES, 2009) which claims that processing semantic speech (e.g. lyrics in a song) would conflict with processing semantic content of the text.

### 4.6.2. Retrospective Questionnaire: Multitasking Profile

The second part of the questionnaire explored participants' multitasking profile. Figure 25 displays the results in terms of participants' goals for reading in English.

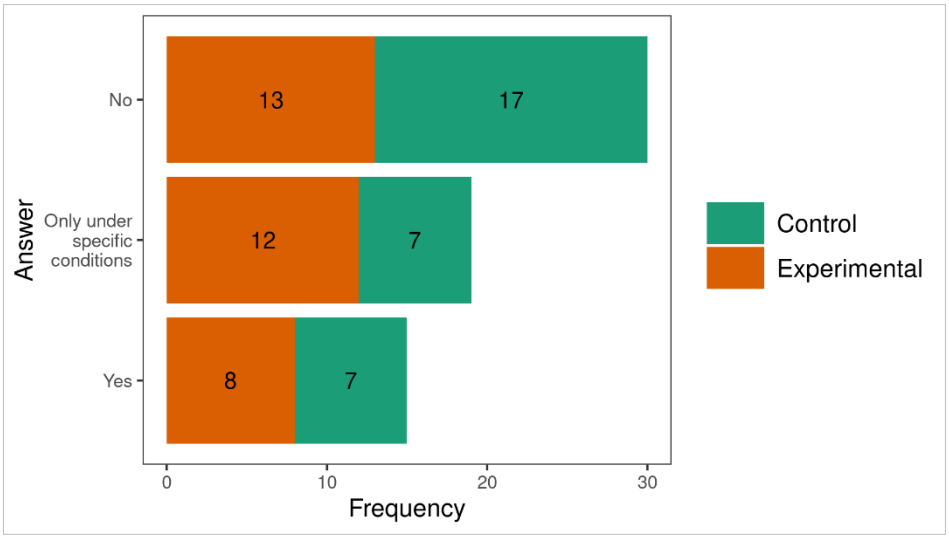
Figure 25 - Participants' Goals for Reading in English




Source: the author.

Participants in the control and experimental groups seem to be balanced in terms of the reading goals investigated. Some participants reported other reasons for reading in English, for instance, for obtaining information (e.g., news), or for interacting on social media. Then, participants were asked whether they normally listened to music whilst reading in English, as displayed in Figure 26. In order to better understand their responses, a follow-up question was added *(Se sim, por quê? Se não, por quê? Se somente em ocasiões específicas, quais?)* whose responses are discussed as follows.

Figure 26 - Participants' habits while reading in English




Source: the author.

The majority of our sample reported not listening to music while reading in English, with controls outweighing experimentals (Figure 26). From the thirty negative responses, 26 participants argued that listening to music diverges their concentration from the reading material. Some responses were selected to illustrate these claims[54]. P54 declared *"eu prefiro não ouvir música ao ler, pois sinto que isso me distrai. Não me sinto 'dentro' da leitura, preciso voltar aos parágrafos já lidos para recuperar informações que perdi".* It seems, thus, that these participants side with the longstanding claim that listening to music disrupts the comprehension of written material (KÄMPFE; SEDLMEIER; RENKEWITZ, 2011; SALAMÉ; BADDELEY, 1989; VASILEV; KIRKBY; ANGELE, 2018).

In addition to that, some participants reported that lyrical music is more disruptive in comparison to instrumental music, such as P18 and P19 who reported, respectively, that *"…ler em inglês ao mesmo em que ouço música inglês torna minha concentração difícil. Quando ouço,* ***prefiro instrumentais****"* and *"****eu não consigo me concentrar em ler e escutar música ao mesmo tempo,*** *principalmente se a música tiver letra. Se a música for só instrumental e muito baixa posso até conseguir mas não é algo que*

[54] Participants will be identified by the letter P (stands for participant) and the number assigned to them. Their responses are in the language they answered the questionnaire (Brazilian Portuguese) and were not translated to keep the original meaning and avoid 'getting lost in translation'.

*costumo fazer".* These results seem to converge with theories of auditory distraction which posit that reading might be disturbed either by simultaneously processing two semantic contents, to say the song lyrics and the verbal information of the text (*the semantic-interference hypothesis* and *interference-by-process hypothesis*) or by the acoustic variation of songs (*the changing-state hypothesis*) (see VASILEV; KIRKBY; ANGELE, 2018 for a full account). Additionally, considering that intelligible lyrical music contains both semantic and phonological information, the *phonological-interference hypothesis* might also play a role in this context since "all types of speech sounds should be equally distracting because they all gain access to the phonological store" (VASILEV; KIRKBY; ANGELE, 2018, p. 572).

As opposed to that, some participants mentioned their preference for reading in silence. To exemplify, P53 and P46 expressed, respectively, that *"...tenho dificuldade de concentração, por isso, preciso de* ***silêncio total*** *quando estou fazendo qualquer tipo de leitura (especialmente em inglês)"* and *"acredito que a música atrapalha minha concentração e capacidade de reter informações. Geralmente, percebo que consigo me concentrar melhor e ser mais produtiva quando estou lendo com* ***total silêncio*** *ao meu redor".* In fact, the superiority of reading in silence has been evidenced by several studies. To mention a few, Johansson et al. (2012) found that reading comprehension was better in silence than while listening to non-preferred music, however, no main effects were observed for eye-movements across conditions (JOHANSSON et al., 2012). As opposed to that, Zhang et al. (2018) found longer reading times, more rereading, and more regressions for music condition in comparison to the silent condition. Comprehension in the silent condition was only marginally different from the music condition (ZHANG et al., 2018). It is worth mentioning that Zhang and colleagues did not place time constraints for participants reading (in both conditions) therefore, their participants might have been able to cope with the task demands and comprehend the text.

Another interesting finding regards the inhibitory control, as reported by P25 "*na maioria das vezes, quando leio para o trabalho ou faculdade preciso de concentração e tranquilidade para fazer um trabalho bem feito. Ao colocar música, no começo parece difícil manter o foco mas após algum tempo* ***sinto que estou ignorando a música*** *e que*

*talvez nem a ouço porque meu foco está em fazer a leitura e compreender o texto"* and P49 who claimed that *"não costumo escutar música enquanto leio porque, se a leitura for de estudo, acabo me distraindo ou simplesmente* ***ignorando-a****, então não teria motivo em escutá-la de qualquer forma".* It seems, thus, that these participants might have more inhibitory control that allows them to deliberately suppress music while reading. Most recently, researchers have pointed out to individual differences in blocking distracting and interfering information – *attention control*[55] (DRAHEIM et al., 2022) which might be good predictors of multitasking ability (REDICK et al., 2016). To put it simply, there might individual differences in the ability to control attention which could be addressed in future studies.

As for those who reported listening to music while reading 'only under specific conditions', participants in the experimental group outweighed those in the control group (Figure 26). Most participants reported using music as a resource to block noises from the environment. For instance, P6 and P7 mentioned, respectively, that *"...****quando o ambiente está barulhento****, eu recorro a músicas. Algumas me ajudam a focar, porque o som se torna um só e não cachorros latindo e crianças berrando ao mesmo tempo, por exemplo" "não consigo me concentrar ouvindo música. A exceção é* ***quando tem outros barulhos*** *ao redor de onde tenho que estudar (como obras ou outras pessoas falando alto), nesse caso coloco música instrumental".* Similarly, P35 listens to music *"apenas quando estou estressada ou quando quero* ***bloquear ruídos externos*** *durante a leitura".* In fact, the effects of background speech and noise have long been investigated (e.g. VASILEV; KIRKBY; ANGELE, 2018), whose findings revealed that both background speech and noise are detrimental to reading comprehension. The authors found that speech is more disturbing as compared to noise and music. Despite the deleterious effect of music on reading comprehension, participants of this study seem to use music to mask unwanted auditory sounds that cause distraction. An alternative view claims that "when

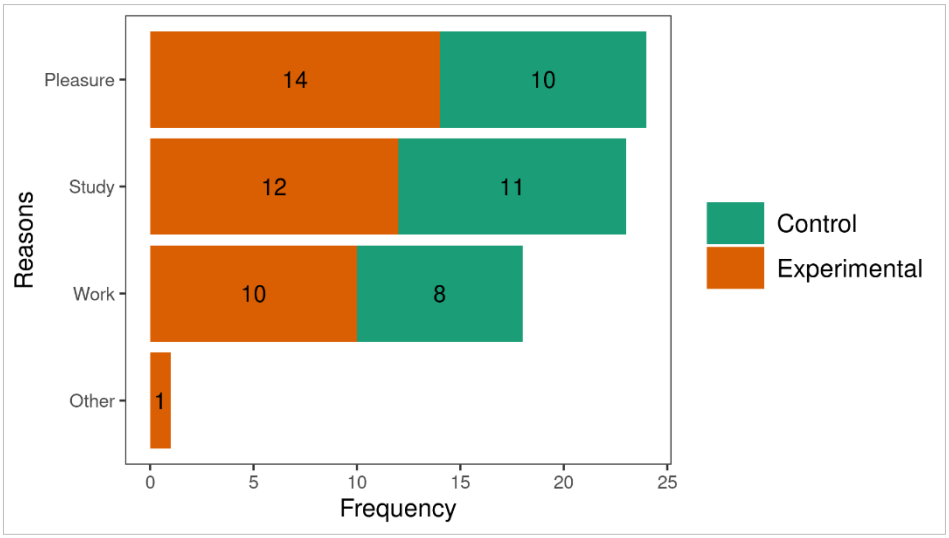
[55] As pointed out in the review of literature, researchers initially believed that WM was highly involved in attention control (ENGLE; KANE; TUHOLSKI, 1999), however, nowadays they believe that WM is related to maintenance of information to avoid distraction (MASHBURN; TSUKAHARA; ENGLE, 2021), while attention control is involved "the management of goal-directed behavior"' (DRAHEIM et al., 2022).

music is used out of habit or to filter out ambient noise, the listener exercises volitional control to limit attention to music"(DAVID et al., 2015, p. 1667).

For those who affirmatively reported listening to music while reading, the results showed that participants in both groups were balanced in their responses (Figure 26). In addition to that, most participants reported listening to music while reading 'for concentration' and tend to prefer non-lyrical pieces. To illustrate that, both P2 and P42 mentioned a preference for 'lo-fi music', i.e.,*"eu costumo escutar* ***um gênero instrumental de lo-fi****. Desta forma eu consigo me concentrar por muito mais horas"* and *"costumo ouvir música o tempo todo para me concentrar, sem ela eu dificilmente consigo realizar alguma leitura ou tarefa sem me perder, mas não costumo ouvir músicas com letras ou algo do tipo. Na maior parte das vezes,* ***ouço músicas instrumentais ou 'lo-fi****".* Lo-fi (low-fidelity) music is characterized by the imperfect aesthetic of music with a slow tempo and the occasional absence of lyrics (SUPPER, 2018; WINSTON; SAYWOOD, 2019). Although scarce, some studies have investigated the effects of lo-fi music on reading comprehension (ANGGRAITA et al., 2021; FLORES, 2021), whose findings showed no effects of lo-fi beats on comprehension. Despite these results, it seems that our participants might have chosen such music genre due to its slow tempo and "soothing instrumental music from instruments such as piano, acoustic guitar, ukulele, violin, bongos, among many others" (FLORES, 2021, p. 88) which might help them concentrate. Nevertheless, more studies are needed to investigate the effects of lo-fi music on comprehension.

Participants who affirmatively reported listening to music while reading were also asked about the specific reading situations to which they listened to music (e.g., reading for pleasure, study, work, or others). The results are displayed in Figure 27, as follows, and they seem to be balanced in terms of reading situations.

Figure 27 - Reading Situations for Reading while Listening to Music



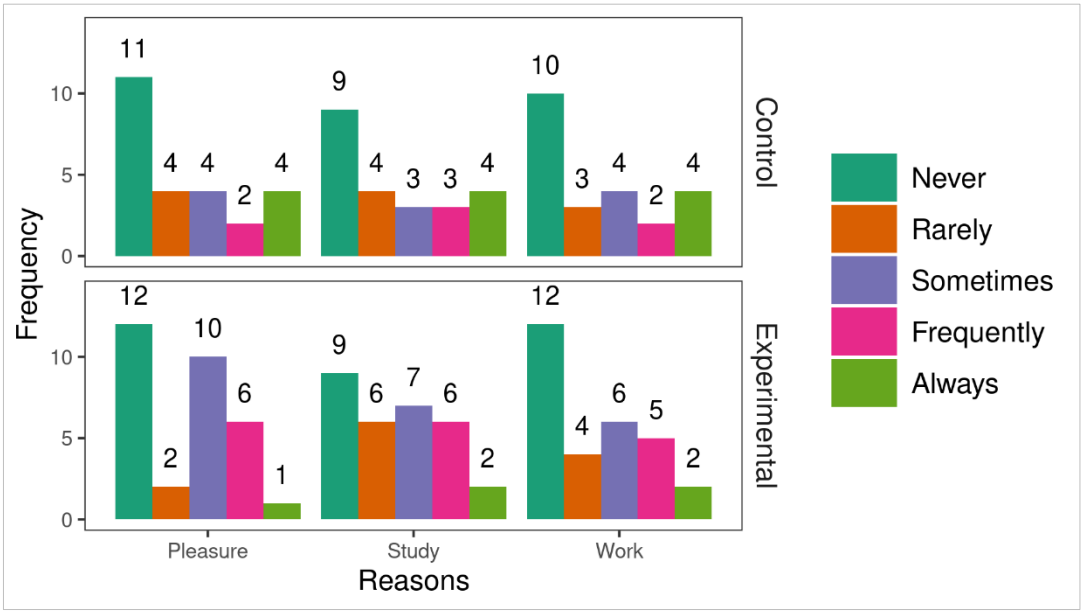

Source: the author.

A more in-depth analysis shows that most participants listen to music while reading for pleasure, which seems to be a reading situation that is not as cognitively demanding as reading for work and/or study. However, the difference is subtle, followed by reading for study purposes and work. Kononova and Yuan (2017) found that relaxation, entertainment, and efficiency were the main motivators for college students (*N* = 524) to multitask while studying and/or working. It seems, thus, that for more cognitively demanding reading situations, such as studying and working, participants of this study rely on music as a compensatory mechanism for a laborious task.

Kononova and Yuan (2017) also investigated to what extent college students' motivation predicted multitasking frequency and found that habit and efficiency were the main predictors. The authors explained that "the more respondents perceived listening to music while studying as a habit and the more they desired their work to be efficient, the more often they engaged with this medium during work- or study-related activities" (KONONOVA; YUAN, 2017, p. 192). Similarly, "the extent to which learners are used to working with music playing in the background" (HALLAM; MACDONALD, 2016, p. 781) might impact task performance. With that in mind, we also asked our participants the

frequency they listen to music while reading under specific situations (pleasure, study, and work). Results are displayed in Figure 28, below.

Figure 28 - Frequency according to Reading Situation



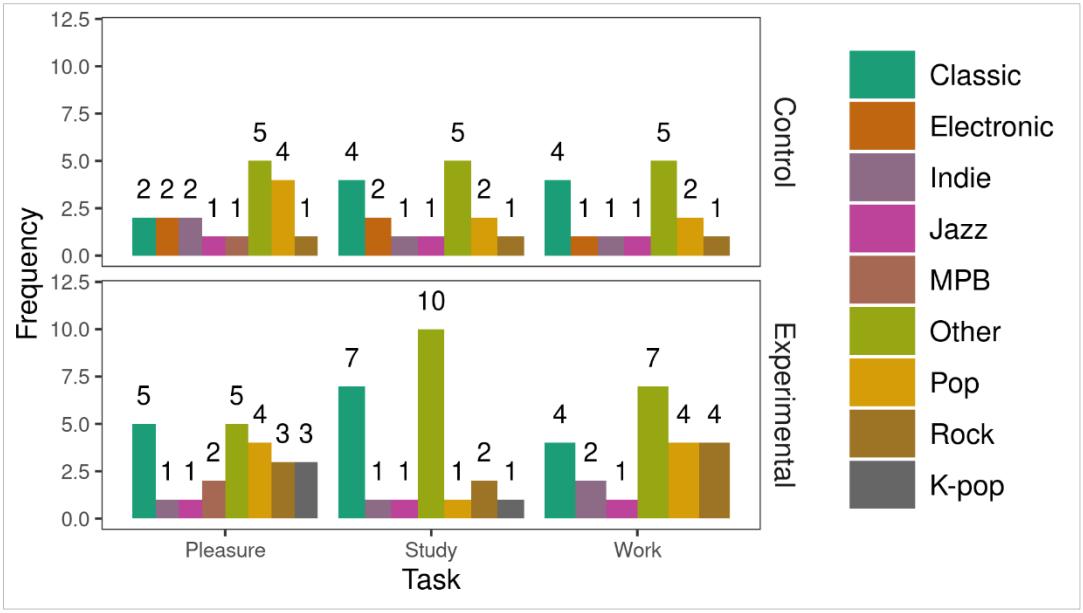

Source: the author.

Overall, most participants reported **never** listening to music while reading for pleasure (N = 23), followed by work (N = 22) and study (N = 18). Similarly, they reported **rarely** listening to music while reading for pleasure (N = 6), study (N = 10), and work (N = 7). In sum, almost half of our sample reported that it is not habitual (ranging from never to rarely) for them to listen to music while reading for work (N = 29), study (N = 28) and pleasure (N = 26), which might have impacted on their outcomes in the comprehension tasks, especially for the experimental group. However, a statistical analysis would be needed to make a stronger claim.

In what follows, participants reported that they **sometimes** listen to music while reading for pleasure (N = 14), for study (N = 10), and work (N = 10). The most frequent music listeners do it while reading for work and study purposes. More specifically, they **frequently** do it while reading for pleasure (N = 8), study (N = 9), and work (N = 7). As for those who **always** listen to music, they mostly do it while reading for work (N = 6) and study (N = 6), followed by pleasure (N = 5). These results are consistent with the evidence

from previous studies on the reward mechanisms music has on work/study tasks (JÄNCKE, 2019; KONONOVA; YUAN, 2017; PEREIRA et al., 2011). More specifically, Kononova and Yuan (2017) found that searching for better efficiency predicted university students' multitasking frequency with music in the sense that “the extent of music listening during a demanding task is driven by the desire to stimulate oneself during a task for better results” (p. 194). Similarly, Pereira et al. (2011) found that emotional centers of the brain (limbic, paralimbic, and reward areas) were associated with song familiarity, suggesting, thus, an emotional engagement with music. Participants were then asked about their preferred music genres according to the task (pleasure, work, and study). Results are displayed in Figure 29, below.

Figure 29 – Music Genre according to Task




Source: the author.

Participants’ responses were balanced across groups (control and experimental) and music genres. For pleasure, pop music was the most frequent choice (N = 8), followed by classical music (N = 7). Some participants (N = 10) responded ‘other’, varying from lo-fi music and instrumental in general. For study purposes, classical music was highly frequent (N = 10) and ‘other’ (N = 15), which varied mostly from lo-fi music (N = 4) and instrumental (N = 4). Interestingly, some (N= 3) reported ‘silence’ as their preference. As

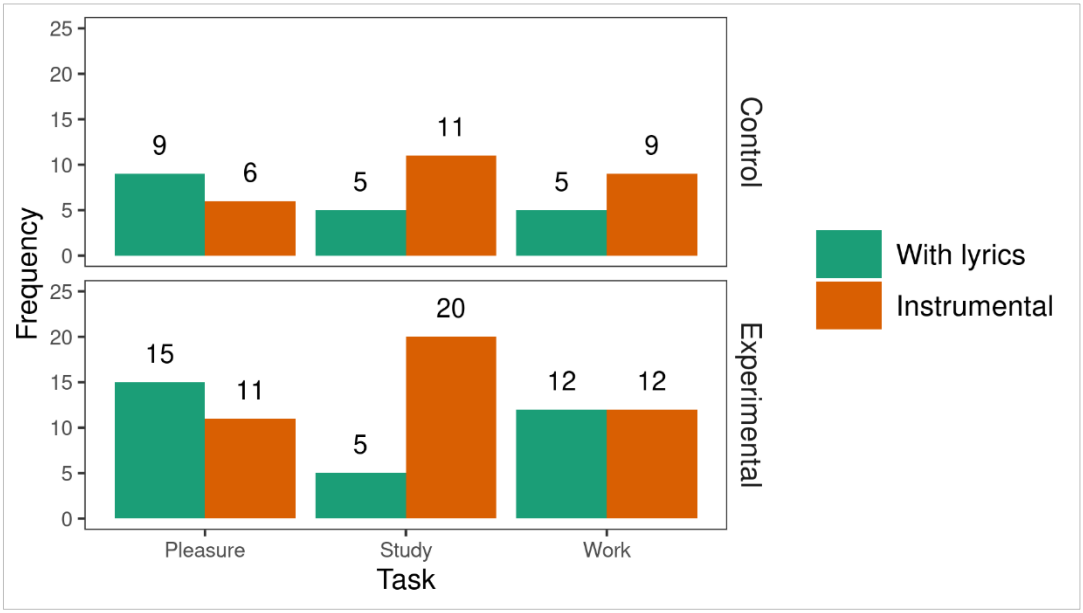
for work, classical music was highly frequent (N = 8) in addition to ‘other’, whose answers varied among lo-fi, instrumental, chill-out songs, nursery rhymes, and even silence.

Figure 29 demonstrates a great variety of music genres participants of this study most frequently listen to while reading, converging, thus, with the *subjective aspects of music perception,* that is, people responding to music differently according to musical preferences, “cultural factors (aspects of our environment including tonality and the way that musical associations are culturally shaped and learned), and associative factors (personal and subjective meanings we place on a particular piece of music depending on our musical experiences)” (HALLAM; MACDONALD, 2016, p. 780). With that in mind, participants of this study might have had different reactions towards the songs used in our experimental section (pop songs for the experimental group and binaural beats for the control group), which might have influenced their comprehension outcomes. Hallam and MacDonald (2016) note that “the complex and interacting nature of the factors which influence responses means that it is difficult to predict the exact effects of any particular piece of music on any individual although there do seem to be some general trends” (p. 780).

Taken from the results in Figure 29, it seems that for pleasure reading, participants prefer more upbeat songs, such as pop. However, non-lyrical music (ranging from lo-fi, instrumental, and classical) was highly frequent as well. Similarly, participants seem to prefer non-lyrical pieces both for studying and work. These results can be explained in the light of a recent systematic review of literature on the effects of background music on learning (DE LA MORA VELASCO; HIRUMI, 2020), which reported that several genres were used in research, however, a general preference for classical and pop music was observed. These researchers noted that, from a sample of 30 studies, those with classical music had the most positive effects (N = 3) while those with pop music had the most negative effects on learning (N = 3) (DE LA MORA VELASCO; HIRUMI, 2020). They explain that a general preference for classical music in the studies they reviewed might have been influenced by the “well-known, yet controversial *Mozart effect* (RAUSCHER et al. 1993) that suggests classical music played before performing cognitive tasks benefits performance” (DE LA MORA VELASCO; HIRUMI, 2020, p. 2832).

Although it is a plausible explanation, previous studies might have used classical/instrumental music given that participants reported a general preference for such genre. Our results might indicate a general preference for non-lyrical music regardless of the reading situation/purpose. In what follows, participants were asked whether they preferred lyrical or non-lyrical music according to the reading situation (for pleasure, work, and study).

Figure 30 - Lyrical or non-lyrical music preference according to reading situation

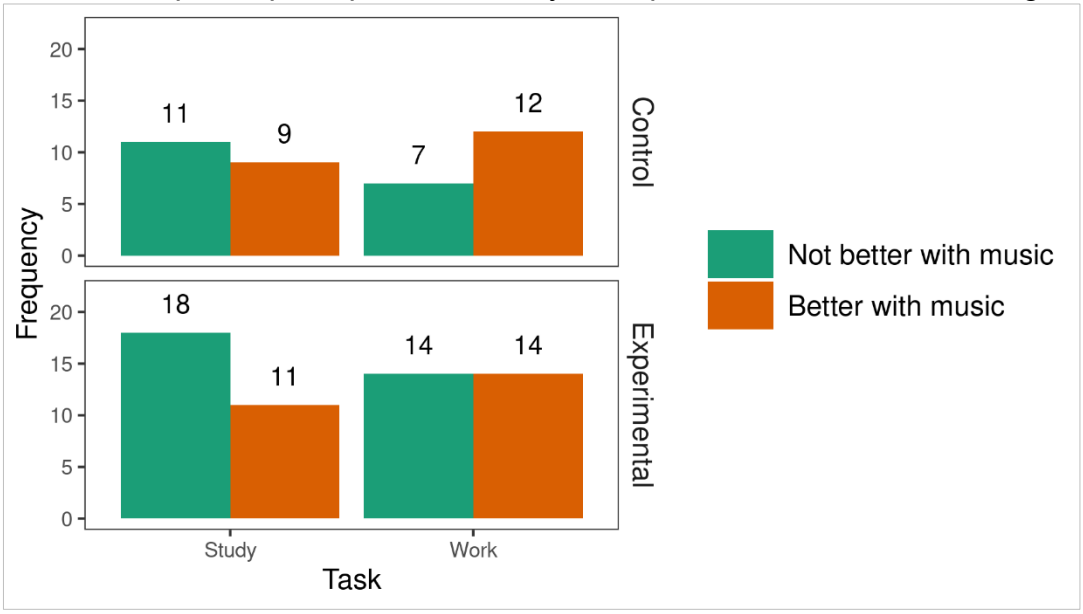



Source: the author.

Participants seem to prefer listening to lyrical music when reading for pleasure (N = 24), for work (N = 17), and ultimately for studying (N = 10). On the other hand, they seem to prefer instrumental music while reading for study purposes (N = 31), followed by reading for work (N = 21), and pleasure (N = 10). These results seem to align with the previous question, which suggested a preference for non-lyrical music for study and work, and pop music (usually containing lyrics) for pleasure reading. Overall, the results seem to be balanced in terms of groups (control and experimental), regardless of a greater preference of participants in the experimental group for instrumental music for study purposes. This general preference, thus, might have impacted the results obtained in the reading tasks for the experimental group, especially considering that habituation might be

a moderator factor when reading while listening to music (HALLAM; MACDONALD, 2016; KONONOVA; YUAN, 2017). Last, participants reported whether they believed they studied/worked better when they listened to music simultaneously, as shown in Figure 31.

Figure 31 – Participants' perceptions on study/work performance when listening to music




Source: the author.

Overall, the results in Figure 31 demonstrate that participants' perceptions regarding the role of music in their study and work performance were quite balanced. More specifically, participants of both groups perceived music as a distractor for study (N = 29) and work (N = 21), while some participants believe that music improves study (N = 20) and work (N = 26).

Analyzing the groups separately, some trends were observed. Precisely, experimentals (N= 32) more often believe that music distracts both study and work-related tasks in comparison to controls (N = 18), in the same way that experimentals (N = 25) more often believe that music improves both study and work-related tasks as compared to controls (N = 21). The fact that twice as many participants in the experimental group found that music has a detrimental effect on study/work tasks might have directly impacted their performance on the experimental tasks of this study, especially considering individual factors as moderators for multitasking with music (DE LA MORA VELASCO; HIRUMI,

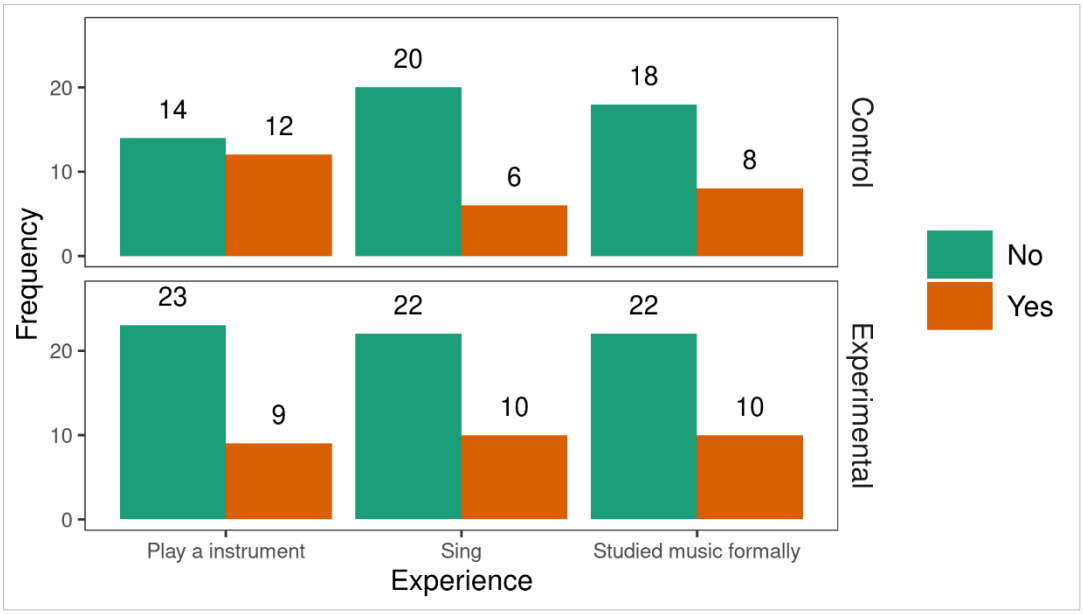
2020; HALLAM; MACDONALD, 2016). More specifically, the frequency to which individuals listen to music while studying/reading, musical taste, and familiarity might be determinants of the impact of music on cognitively demanding tasks such as reading.

A slight difference was observed when analyzing both groups and tasks (study/work) separately, in which participants in the experimental group (N = 18) believe that music listening is detrimental to study tasks, as opposed to those (N = 11) who believe that music is beneficial for studying. As for the control group, a slight difference was observed between those who believe study better with music (N = 9) as opposed to those who find that study better with no music (N = 11). The fact that most participants believe that music negatively influences studying might converge with the claim that "that peoples' personal beliefs about conditions which facilitate reading do not correspond to the actual effects" (JOHANSSON et al., 2012, p. 350), especially considering the results obtained in this study – Condition predicted inferential comprehension, recall of main ideas, secondary ideas and details – suggesting that participants' belief that music improves efficiency did not correspond to the results obtained in this study.

### 4.6.3. Retrospective Questionnaire: Musical Background

The last set of questions explored participants' musical background, that is, whether they had already studied music formally, played any instrument, and sung, as displayed in Figure 32.

Figure 32 - Participants' Musical Background




Source: the author.

Overall, most participants of this study do not present a musical background, characterized by ‘playing an instrument’ (N = 37), ‘singing’ (N = 42), and ‘studying music formally’ (N = 40). As opposed to that, a smaller number of participants reported some background experience with music, which is sorted by ‘playing an instrument’ (N = 21), ‘singing’ (N = 16), and ‘studying music formally’ (N = 10). Analyzing both groups separately (control and experimental), small differences were observed, as demonstrated in Figure 32. Results in the experimental group, which is sorted by ‘playing an instrument’ (N = 9), ‘singing’ (N = 10), and ‘studying music formally’ (N = 10), do not seem to account for a great amount of the total sample. Similar results were obtained in the control group, characterized by ‘playing an instrument’ (N = 12), ‘singing’ (N = 6), and ‘studying music formally’ (N = 8).

Participants with musical expertise perceive music differently from non-musicians. Taken that, it seems difficult to make any assertion regarding participants’ musical expertise and the possible impact on their performance on the experimental tasks, especially considering that our questionnaire is limited to tracing participants’ experience with musical instruments, singing, and music training. Future studies could address participants’ musical background in more depth, approaching social, cultural, and

individual factors inherent in music experience, as pointed out by Hallam and MacDonald (2016) in their claim that “musical skill develops through opportunities for musical engagement in childhood, adolescence, and early adulthood, the influence of family, school, and wider cultural factors being crucial in the individual’s developing musicality” (p. 777).

However, we might speculate, based on the data in Figure 32 and previous literature in the field, that musicians’ perception of music differed from non-musician in the experimental tasks. More specifically, musicians possess some sort of enhanced auditory processing, that is, *fine-grained auditory skills* (KRAUS; CHANDRASEKARAN, 2010), which are characterized by the similarities that music and speech share, both at the acoustic level, using “pitch, timing and timbre cues to convey information” and at the cognitive level, demanding working memory processes similarly to “to integrate discrete acoustic events into a coherent perceptual stream according to specific syntactic rules” (p. 600). Thus, “years of active engagement with the fine-grained acoustics of music and the concomitant development of ‘sound to meaning’ connections may result in enhanced processing in the speech and language domains” (KRAUS; CHANDRASEKARAN, 2010, p. 600). Therefore, future studies could take these features into account, as previously suggested. Next, we present a summary of the main findings, the limitations of this study, and suggestions for future studies.

# 5. FINAL REMARKS, LIMITATIONS, SUGGESTIONS FOR FURTHER RESEARCH AND PEDAGOGICAL IMPLICATIONS

## 5.1. FINAL REMARKS

The main objective of this study was to investigate whether working memory capacity predicted multitasking performance of proficient bilinguals in reading comprehension of a hypertext in a multitasking context devised by two conditions: listening to non-lyrical music as the control condition and lyrical music as the experimental condition. More specifically, it aimed at investigating whether working memory capacity and Condition predict (1) literal comprehension and (2) inferential comprehension of a hypertext; and (3) whether working memory capacity and Condition predict recall of hypertext information.

Considering that this study was carried out in a sample of proficient bilinguals, the participants self-rated their proficiency and provided information on their language background, in agreement with the literature that considers bilingualism as a dynamic and complex construct determined by individual experiences with the language (DELUCA et al., 2019; SCHOLL; FONTES; FINGER, 2021). Participants' self-rated proficiency and their responses to the factors of linguistic experience were included in the exploratory analysis of this study in two ways: (1) to inspect whether language proficiency influenced the experimental outcomes, and (2) to explore whether self-reported proficiency and the factors of linguistic experience predicted multitasking performance. In addition to that, a retrospective questionnaire was used to help understand the results of the experimental section and to investigate participants' multitasking habits and musical background that might have impacted their outcomes. The main findings are discussed as follows:

Firstly, the hypothesis that literal comprehension would not be affected by working memory capacity and condition was supported, in agreement with Just and Carpenter's (1992) total capacity approach which posits that the limitations of WMC are only noticed once the task is demanding enough to surpass the supply of resources. Put simply, literal comprehension might not have consumed participants' WMC, especially considering that

they were all proficient bilinguals, as the exploratory analysis demonstrated as well. This finding agrees with the literature that literal comprehension is dependent on language proficiency (ALPTEKIN; ERÇETIN, 2011; GAGNÉ; YEKOVICH; YEKOVICH, 1993). Additionally, the retrospective questionnaire responses showed that both groups (control and experimental) were balanced in terms of difficulty ratings of comprehension tasks.

Secondly, the hypothesis that inferential comprehension would be affected by working memory capacity and Condition was supported considering the strict scoring method only, which aligns with the claim the limitations of WMC are evident given the attentional demand required to recall the last word of each sentence in the exact order it appeared during the RST (ENGLE, 2018; MASHBURN; TSUKAHARA; ENGLE, 2021; ROSCIOLI, 2017). In addition to that, our results converge with the claim that inferential comprehension is more demanding for WM resources (ALPTEKIN; ERÇETIN, 2009; JUST; CARPENTER, 1992).

Thirdly, the hypothesis that participants with higher working memory capacity would be better multitaskers was supported by considering participants' recall of a hypertext. Participants with higher WMC recalled more main ideas, secondary ideas, and details. Nevertheless, the recall of main ideas was only observed when a post hoc analysis was carried out. The absence of significance in the recall of main ideas can be explained by low cognitive demand as a result of high proficiency levels, and thus automatization of the process of main idea construction.

Finally, the post hoc exploratory hypothesis that that both linguistic experience and self-rated L2 proficiency would predict multitasking performance was supported only considering the factors of linguistic experience predicting the recall of text ideas, more specifically the recall of secondary ideas in the lenient scoring method and details in both methods. In addition to providing information on participants' proficiency, the exploratory section of this study provided further evidence that bilingualism is a spectrum of linguistic experiences (BACKER; BORTFELD, 2021; LEIVADA et al., 2021). With this in mind, the results provide evidence that variability (RAVIV; LUPYAN; GREEN, 2022) in learning an additional language might have outcomes in performance, in this case, the more variable the input learners received, the more ideas they recalled from the text.

The retrospective questionnaire also provided some important findings, especially related to participants' habituation with multitasking. More specifically, our results showed that (1) most participants (controls and experimentals) are not used to listening to music while reading in English, regardless of the reading purpose (pleasure, work, and/or study); (2) when they do, they aim to block noises from the environment, especially participants in the experimental group; (3) those who are habituated to listening to music while reading prefer instrumental pieces and use them as an aid to concentration or as a reward for a laborious task. All in all, these results provide evidence for subjective aspects of music perception (HALLAM; MACDONALD, 2016) which claims that individuals respond differently to music, according to their musical taste and personal characteristics.

In addition to the results obtained by the regression models, the retrospective questionnaire also provided some evidence for the claim that multitasking is detrimental to reading comprehension. More specifically, (1) almost half of our participants consider music distracting while they are reading; (2) lyrical music is deemed more distracting than non-lyrical music; (3) participants seem to prefer non-lyrical music for study purposes. These findings converge with the meta-analytic review that found that lyrical music is one of the major auditory distractions for reading comprehension (VASILEV; KIRKBY; ANGELE, 2018). Next, the limitations of the study and suggestions for further research are discussed.

## 5.2. LIMITATIONS OF THE STUDY AND SUGGESTIONS FOR FURTHER RESEARCH

The first limitation of this study is the absence of control for background knowledge participants had on the topic of the text used in the experimental section (English as a Lingua Franca). Departing from the view of working memory adopted by Cowan, information retained in long-term memory is crucial for activation of attention in working memory. Therefore, it seems paramount to assess participants' previous knowledge on the topic of the text.

The second limitation of this study relies on the discussion brought by Hambrick and colleagues (2021) on the *task impurity problem* of complex span tasks such as the reading span test used in this study. According to them, cognitive tasks not only measure the constructs of interest, but also measure other constructs. In the RST, for instance, it is well known that participants may feel anxious during the test, which translates into the test measuring also anxiety at a certain point (HAMBRICK; BURGOYNE; ARAUJO, 2021). These authors claim that studies that measure WMC only fail to consider that other variables might be determinant for complex cognition performance, such as the environment. They argue that WMC "cannot reasonably be expected to explain all, nearly all, or even most of the variance in the real-world outcomes that it is believed to underpin" (HAMBRICK; BURGOYNE; ARAUJO, 2021, p. 215). Thus, it is fundamental to consider "the role of the environment in performance in tasks and situations that are assumed to involve the working memory system" (p. 215) taking that features of the environment might be captured by these tasks and, thus, impact on performance outcomes. A similar argument has been used recently used to refute the argument some researchers in the field of Bilingualism have used to claim that the bilingual experience alone would lead to better executive functioning. To be more precise, Valian (2015) ascertains that it is not the bilingual experience alone that brings cognitive benefits, but "consistent exposure to cognitive challenges leads to better executive function" (VALIAN, 2015, p. 18), such as higher levels of education, socioeconomic status, motivation, among others. With this in mind, this study is limited in the sense that it only considered working memory capacity as a variable for performance in multitasking. Future studies could collect more information regarding participants' socioeconomic status and sociolinguistic information, as shall be discussed further in this section.

The third limitation regards the generalization of inferential comprehension. In this study, we followed Gagné and colleagues' (1993) grouping of inferential comprehension into their subcomponents *of integration, elaboration and summarization*. Nevertheless, each subcomponent was not investigated independently, as some studies have done (PROCAILO; TOMITCH, 2020; ROSCIOLI; TOMITCH, 2022; YEARI, 2017). To exemplify, Procailo and Tomitch had two independent raters categorize inferences according to a

framework proposed by Linderholm and van den Broek (2002)[56]. Our study considered inferential comprehension those comprehension questions our raters considered as *textually implicit* questions, according to the Taxonomy proposed by Pearson and Johnson (1978). For future studies, we suggest adopting a more comprehensive inference categorization, such as the ones used in the aforementioned studies.

The fourth limitation of this study concerns digital reading, more specifically, hypertext reading. We included glossed information in pop-windows in the text used in this study, as described in the section '3.5.3 - 3.5.3. Primary task – Reading'. We failed to analyze whether participants included the information contained in the glossary in their recall of the text, to be able to explore whether their mental representation would be enriched by the concepts of the pop-up windows.

A fifth limitation regards the lack of a control group reading in print to compare with reading onscreen. As already mentioned, such limitation was due to the health crisis the world faced during 2020-2021, so our experiment had to be carried out remotely to respect the social distancing of the COVID-19 pandemic. All in all, our study is limited in portraying a clearer picture of how onscreen reading might place more demands in the cognitive system, as claimed by Destefano and LeFevre (2007).

Although not deemed as a limitation of this study, but out of its scope, future studies could explore the strategic behavior of digital reading in a multitasking situation. Cho and Afflerbach (2017) advocate that strategic behavior may demand attentional resources differently, according to the goals for reading. Resource consuming strategic behavior, for instance, might compete for working memory resources in hypertext reading in a multitasking situation.

Another suggestion for future studies is investigating the variability in bilingual experiences that might lead to improvements in real-world tasks, such as the discussion brought in section 4.5.2 concerning the post hoc exploratory hypothesis. First, the

[56] The aforementioned framework categorizes inferences into "associations, evaluative comments, elaborative inferences, predictive inferences, reinstatement inferences, metacognitive comments, paraphrases, […] text repetitions,[…] summarizations (main idea of the paragraph) and misunderstandings (PROCAILO; TOMITCH, 2020, p. 331–332).

hypothesis that both linguistic experience and self-rated L2 proficiency would predict multitasking performance was generated based on initial inspection of participants' responses to the QuExPli, a procedure similarly adopted by Oliveira, Woelfer and Tomitch (2021). In the aforementioned study, the authors explained that their study aimed at not only testing hypotheses previously elaborated, but also generate hypotheses to be tested by future studies (OLIVEIRA; WOELFER; TOMITCH, 2021). In the same vein, we suggest that future studies address the hypothesis that bilinguals have some advantage in multitasking given that bilingualism is a complex and multifaceted construct that encompasses not only language proficiency but also the social context of language use (BACKER; BORTFELD, 2021; BIALYSTOK, 2017; LÓPEZ; LUQUE; PIÑA-WATSON, 2021). Secondly, taken that, the section of que QuExPli that addressed the issues of linguistic experience was limited to asking where our bilingual participants had learned English and to what extent those factors contributed to their learning (see QuExPli in Appendix B). For instance, recent studies have investigated the sociolinguistic context of bilinguals (WIGDOROWITZ; PÉREZ; TSIMPLI, 2020, 2022), taken that "one's linguistic experience is fundamentally linked to their sociolinguistic context – the language environment within which speakers have spent most of their lives" (WIGDOROWITZ; PÉREZ; TSIMPLI, 2020, p. 2). These authors developed a holistic measure of contextual and individual linguistic diversity (available here).

Last, future studies could also address the effects of lo-fi music on reading comprehension, considering the scarcity of studies on this music genre (ANGGRAITA et al., 2021; FLORES, 2021). Next, the pedagogical implications of our findings are discussed.

## 5.3. PEDAGOGICAL IMPLICATIONS

Listening to music while reading seems to be a personal preference, as evidenced by the retrospective data. Therefore, some implications of this work might be more relevant to bilingual readers and language learners in general, while others might be more directed to language teachers, as normally done.

This study has also shown that individual differences in working memory capacity predict reading comprehension, corroborating previous evidence. Optimistic and somewhat ambitious authors argue that measuring working memory among language learners in educational settings is possible (MOTA; BUCHWEITZ; MASCARELLO, 2018 for a detailed account), however, we tend to agree with Woelfer and Tomitch (2019) that applying working memory tests outside controlled conditions might be a delicate issue, in the sense that "students would have to be informed the test scores and differences among scores could be misinterpreted since they quantify an aspect of memory labeled *capacity"* (p.652), and therefore, prior to administration "should be carefully discussed by educators" (WOELFER; TOMITCH, 2019, p. 652). With that in mind, caution is needed when advising teachers to carry out WM tests in educational settings. For that reason, as optimistic as it might be, our implications do not include any recommendation for language teachers to apply WM tests, instead, we shall be limited to discussing the implications of engaging in multiple tasks simultaneously and their costs to the limited capacity of working memory (BADDELEY, 2012; JUST; CARPENTER, 1992).

Our study has revealed that inferential comprehension of a hypertext is predicted by both Condition (reading while listening to non-lyrical music as opposed to reading while listening to lyrical music) and working memory capacity. In other words, listening to lyrical music disrupts inferential comprehension of a hypertext, that is to say, the ability to make inferences for the construction of a coherent mental representation of the text might be compromised when songs that contain lyrics (a language task) dispute the limited cognitive resources with reading (which is also a language task). A coherent mental representation is only possible when the reader engages in inferential processes (VAN DEN BROEK; KENDEOU, 2015). Van den Broek and Kendeou (2015) explain that "the spark of understanding takes place when the presented information, the consumer's background knowledge, and his or her inferential processes come together and meaningful connections emerge in the mind of the comprehender" (p. 106-107). In order for that to happen, several cognitive processes might be orchestrated, and central to our argument is their claim that "units of information are most likely to become directly connected when they are activated or attended simultaneously" (VAN DEN BROEK;

KENDEOU, 2015, p. 107). Put simply, the semantic relations among text units are more likely to become successful when attended/activated at the same time, but one's working memory constrains this process. It seems, thus, that inferential processes are complex enough to constrain working memory, and the additional processing burden of processing music with lyrics might compromise reading comprehension. As an alternative, we encourage readers to choose songs without lyrics in order to avoid interference with reading comprehension.

Another process that is constrained by working memory capacity is main idea construction (TORRES, 2003), deemed as a complex process (TOMITCH, 2000). More specifically, signaled and undersignalled main ideas in the text might influence comprehension (BUDD; WHITNEY; TURLEY, 1995; TORRES, 2003). For instance, when the main idea is explicitly stated in the text, the reader must only 'recognize' it and find matches with the remaining ideas of the text. As opposed to that, for undersignalled main ideas, "readers must construct one while reading, test it for adequacy, and be prepared to modify it if new information arises that does not support the readers' initial interpretation" (BUDD; WHITNEY; TURLEY, 1995, p. 737). With that in mind, considering that (1) our study is mixed in terms of signaled and undersignalled main ideas; (2) a slight difference in the mean scores in the recall of text ideas between participants in the control group as opposed to those in the experimental group; we would advise language users/learners to choose non-lyrical pieces while reading, so that working memory is not overwhelmed either by the nature of main ideas or the semantic interference posed by lyrics.

In spite of the fact that we do not have direct evidence of differences in multitasking while reading on paper vs. reading onscreen, we can presuppose, based on the literature that onscreen reading is more cognitively demanding, in the sense that readers must (1) decide whether or not reading should be interrupted to access hyperlinked information (DESTEFANO; LEFEVRE, 2007; KAMIL; CHOU, 2009); (2) integrate information obtained in the hyperlinked information with text information (KAMIL; CHOU, 2009; SALMERÓN et al., 2018), and (3) evaluate whether information gathered is relevant and reliable (SALMERÓN et al., 2018), especially at obscure times we have been living regarding the ubiquity of fake news. Salmerón and colleagues (2018) explain that

previous studies seem to have investigated navigation, integration, and evaluation skills in isolation, but during reading, readers might have to coordinate these skills simultaneously, therefore, listening to music (especially with lyrics) might compromise reading skills in the aforementioned context.

This study has also shown that factors associated with linguistic experience might play a role in multitasking. More specifically, we found that the factors that contributed to English learning (e.g., watching TV/Streaming, surfing the net, listening to music/podcasts, reading for pleasure, studying English, reading academically, interacting with friends, playing games and interacting with family) predicted the recall of text ideas. Therefore, we discussed these findings in the light of the *variability* construct (RAVIV; LUPYAN; GREEN, 2022), which argues that experiences are unique and generalization is needed, so variability in input leads to robust learning, according to the authors. The practical implications of our findings are that both language teachers and learners must seek a wide variety of input opportunities in language learning and/or use in different contexts/situations.

Last, and perhaps one of the most important implications of this study regards emotions in language processing. The attention to the important role of emotions in engaging in multitasking arose from the retrospective data, since some participants reported listening to music while performing a laborious task, indicating that in such cases music functioned reward mechanism. There is growing evidence on the role of music in emotions (FERNÁNDEZ-SOTOS; FERNÁNDEZ-CABALLERO; LATORRE, 2016; JUSLIN; SLOBODA, 2010; LIU et al., 2018; PEREIRA et al., 2011), and learning (IMMORDINO-YANG; DAMASIO, 2007; IMMORDINO-YANG; GOTLIEB, 2020).

In fact, the influential work by Mary Helen Immordino-Yang, in the field of Educational Psychology, has provided a broader understanding of the influence of emotions in learning. More specifically, “the aspects of cognition that are recruited most heavily in education, including learning, attention, memory, decision making, motivation, and social functioning, are both profoundly affected by emotion and in fact subsumed within the processes of emotion” (IMMORDINO-YANG; DAMASIO, 2007, p. 7). In addition to that, emotions can stimulate thinking “by helping people attend to, evaluate and react

to stimuli, situations, and happenings, and then to integrate what they have attended to and evaluated into their knowledge structures and memory in a coordinated way going forward" (IMMORDINO-YANG; GOTLIEB, 2020, p. 248). With that in mind, the implementation of music in study tasks might be a feasible alternative. Findings from our study provide evidence that non-lyrical music might not be detrimental to comprehension, therefore, future interventional studies could implement non-lyrical music in their reading lessons.

## REFERENCES

AAGAARD, J. Multitasking as distraction: A conceptual analysis of media multitasking research. **Theory & Psychology**, v. 29, n. 1, p. 87–99, fev. 2019.

AEBERSOLD, J.; FIELD, M. L. **From reader to reading teacher: issues and strategies for second language classrooms**. Cambridge ; New York: Cambridge University Press, 1997.

ALPTEKIN, C.; ERÇETIN, G. Assessing the relationship of working memory to L2 reading: Does the nature of comprehension process and reading span task make a difference? **System**, v. 37, n. 4, p. 627–639, dez. 2009.

ALPTEKIN, C.; ERÇETIN, G. The role of L1 and L2 working memory in literal and inferential comprehension in L2 reading. **Journal of Research in Reading**, v. 33, n. 2, p. 206–219, maio 2010.

ALPTEKIN, C.; ERÇETIN, G. Effects of Working Memory Capacity and Content Familiarity on Literal and Inferential Comprehension in L2 Reading. **TESOL Quarterly**, v. 45, n. 2, p. 235–266, 1 jun. 2011.

ANDERSON, J. R. **Learning and memory: An integrated approach, 2nd ed.** Hoboken, NJ, US: John Wiley & Sons Inc, 2000. p. xviii, 487

ANDERSON, S. A.; FULLER, G. B. Effect of music on reading comprehension of junior high school students. **School Psychology Quarterly**, v. 25, n. 3, p. 178–187, set. 2010.

ANGGRAITA, A. D. et al. The Effect of Low-Fidelity Music (lo-fi) on Reading Comprehension in Indonesian College Students at Jabodetabek. **Jurnal Ilmiah Psikologi MIND SET**, v. 12, n. 01, p. 10–20, 12 maio 2021.

ANTONIOU, M. The Advantages of Bilingualism Debate. **Annual Review of Linguistics**, v. 5, n. 1, p. 395–415, 14 jan. 2019.

BACKER, K. C.; BORTFELD, H. Characterizing Bilingual Effects on Cognition: The Search for Meaningful Individual Differences. **Brain Sciences**, v. 11, n. 1, p. 81, 9 jan. 2021.

BADDELEY, A. **Exploring working memory: selected works of Alan Baddeley**. 1. ed. London: Routledge, 2017a.

BADDELEY, A. D. Working Memory: Theories, Models, and Controversies. **Annual Review of Psychology**, v. 63, n. 1, p. 1–29, 10 jan. 2012.

BADDELEY, A. D. Working Memory in Second Language Learning. Em: WEN, Z.; BORGES MOTA, M.; MCNEILL, A. (Eds.). **Working Memory in Second Language Acquisition and Processing**. Bristol, UK: Multilingual Matters, 2015. p. 17–28.

BADDELEY, A. D. Modularity, working memory and language acquisition. **Second Language Research**, v. 33, n. 3, p. 299–311, 1 jul. 2017b.

BADDELEY, A. D. **Exploring Working Memory: Selected works of Alan Baddeley**. United Kingdom: Routledge, 2018.

BADDELEY, A. D.; GATHERCOLE, S.; PAPAGNO, C. The phonological loop as a language learning device. **Psychological Review**, v. 105, n. 1, p. 158–173, 1998.

BADDELEY, A. D.; HITCH, G. Working Memory. **Psychology of Learning and Motivation**, v. 8, p. 47–89, 1974.

BADDELEY, A. D.; HITCH, G.; ALLEN, R. A Multicomponent Model of Working Memory. Em: LOGIE, R. H.; CAMOS, V.; COWAN, N. (Eds.). **Working Memory: State of the Science**. Oxford, UK: Oxford University Press, 2021. p. 10–43.

BADDELEY, A. D.; HITCH, G. J. The phonological loop as a buffer store: An update. **Cortex**, v. 112, p. 91–106, mar. 2019.

BADDELEY, A. D.; LOGIE, R. H. Working Memory: The Multiple-Component Model. Em: MIYAKE, A.; SHAH, P. (Eds.). **Models of Working Memory: Mechanisms of Active Maintenance and Executive Control**. 1. ed. New York, NY, US: Cambridge University Press, 1999. p. 28–61.

BAILER, C. **Working memory capacity and attention to form and meaning in EFL reading**. MA Thesis—Florianópolis: Universidade Federal de Santa Catarina, 2011.

BAILER, C.; TOMITCH, L. M. B. Estudos comportamentais e de neuroimagem sobre multitarefa: uma revisão de literatura. **Alfa: Revista de Linguística (São José do Rio Preto)**, v. 60, n. 2, p. 403–425, ago. 2016.

BAILER, C.; TOMITCH, L. M. B.; D'ELY, R. C. S. F. O planejamento como processo dinâmico: a importância do estudo piloto para uma pesquisa experimental em Linguística Aplicada. **Intercâmbio**, v. 24, 2011.

BAILER, C.; TOMITCH, L. M. B.; D'ELY, R. C. S. F. Capacidade de memória de trabalho e atenção à forma e significado em leitura de inglês como língua estrangeira. **Letras de Hoje**, v. 48, n. 1, p. 139–147, 11 abr. 2013.

BARETTA, L. **The Performance of Proficient EFL Readers when Reading to Recall and to Summarize Expository Texts**. MA Thesis—Florianópolis: Universidade Federal de Santa Catarina, 1998.

BARON, N. S. Digital Reading. Em: MOJE, E. B. et al. (Eds.). **Handbook of Reading Research, Volume V**. 1. ed. [s.l.] Routledge, 2020. p. 116–136.

BELL, J. **Doing your research project: a guide for first-time researchers in education, health and social science**. 4th ed ed. Maidenhead, Berkshire, England: Open University Press, 2005.

BHATIA, E. T. K. et al. **The Handbook of Bilingualism and Multilingualism**. 2. ed. Oxford, United Kingdom: Blackwell Publishing, 2012.

BIALYSTOK, E. Coordination of executive functions in monolingual and bilingual children. **Journal of Experimental Child Psychology**, v. 110, n. 3, p. 461–468, nov. 2011.

BIALYSTOK, E. The bilingual adaptation: How minds accommodate experience. **Psychological Bulletin**, v. 143, n. 3, p. 233–262, mar. 2017.

BIALYSTOK, E. Bilingualism as a Slice of Swiss Cheese. **Frontiers in Psychology**, v. 12, p. 769323, 8 nov. 2021.

BIALYSTOK, E.; CRAIK, F. I. M. How does bilingualism modify cognitive function? Attention to the mechanism. **Psychonomic Bulletin & Review**, 28 jan. 2022.

BOLLEN, K. A.; NOBLE, M. D. Structural equation models and the quantification of behavior. **Proceedings of the National Academy of Sciences**, v. 108, n. supplement_3, p. 15639–15646, 13 set. 2011.

BOWMAN, L. L. et al. Can students really multitask? An experimental study of instant messaging while reading. **Computers & Education**, v. 54, n. 4, p. 927–931, maio 2010.

BRÅTEN, I.; BRAASCH, J. L. G.; SALMERÓN, L. Reading Multiple and Non-Traditional Texts. Em: MOJE, E. B. et al. (Eds.). **Handbook of Reading Research, Volume V**. 1. ed. [s.l.] Routledge, 2020. p. 79–98.

BUDD, D.; WHITNEY, P.; TURLEY, K. J. Individual differences in working memory strategies for reading expository text. **Memory & Cognition**, v. 23, n. 6, p. 735–748, nov. 1995.

BURGOYNE, A. P.; ENGLE, R. W. Attention Control: A Cornerstone of Higher-Order Cognition. **Current Directions in Psychological Science**, v. 29, n. 6, p. 624–630, dez. 2020.

CANHOTA, C. Qual a importância do estudo piloto? Em: SILVA, E. E. (Ed.). **Investigação passo a passo: perguntas e respostas para investigação clínica.** 1. ed. Lisboa: Associação Portuguesa de Medicina Familiar, 2008. p. 69–72.

CAO, H. et al. Large Scale Analysis of Multitasking Behavior During Remote Meetings. **Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems**, p. 1–13, 6 maio 2021.

CARLISLE, J. F. Free Recall as a Test of Reading Comprehension for Students with Learning Disabilities. **Learning Disability Quarterly**, v. 22, n. 1, p. 11–22, fev. 1999.

CARRELL, P. L.; DEVINE, J.; ESKEY, D. E. (EDS.). **Interactive Approaches to Second Language Reading**. 1. ed. [s.l.] Cambridge University Press, 1988.

CHABRIS, C. F. Prelude or requiem for the 'Mozart effect'? **Nature**, v. 400, n. 6747, p. 826–827, ago. 1999.

CHANG, Y.-F. On the use of the immediate recall task as a measure of second language reading comprehension. **Language Testing**, v. 23, n. 4, p. 520–543, out. 2006.

CHO, B.-Y.; AFFLERBACH, P. An evolving perspective of constructively responsive reading comprehension strategies in multilayered digital text environments. Em: **Handbook of research on reading comprehension, 2nd ed.** New York, NY, US: The Guilford Press, 2017. p. 109–134.

CHO, K. W.; ALTARRIBA, J.; POPIEL, M. Mental Juggling: When Does Multitasking Impair Reading Comprehension? **The Journal of General Psychology**, v. 142, n. 2, p. 90–105, 3 abr. 2015.

CLINTON-LISELL, V. Stop multitasking and just read: meta-analyses of multitasking's effects on reading performance and reading time. **Journal of Research in Reading**, v. 44, n. 4, p. 787–816, nov. 2021.

**Coh-Metrix**. Disponível em: <http://cohmetrix.com/>. Acesso em: 4 mar. 2021.

CONWAY, A. R. A. Individual Differences in Working Memory Capacity: More Evidence for a General Capacity Theory. **Memory**, v. 4, n. 6, p. 577–590, nov. 1996.

COWAN, N. An Embedded-Processes Model of Working Memory. Em: MIYAKE, A.; SHAH, P. (Eds.). **Models of Working Memory**. 1. ed. [s.l.] Cambridge University Press, 1999. p. 62–101.

COWAN, N. Working Memory Underpins Cognitive Development, Learning, and Education. **Educational Psychology Review**, v. 26, n. 2, p. 197–223, jun. 2014.

COWAN, N. The many faces of working memory and short-term storage. **Psychonomic Bulletin & Review**, v. 24, n. 4, p. 1158–1170, ago. 2017.

COWAN, N.; MOREY, C. C.; NAVEH-BENJAMIN, M. An embedded-processes approach to working memory: How is it distinct from other approaches, and to what ends? Em: **Working memory: State of the science.** New York, NY, US: Oxford University Press, 2021. p. 44–84.

DANEMAN, M.; CARPENTER, P. A. Individual differences in working memory and reading. **Journal of Verbal Learning and Verbal Behavior**, v. 19, n. 4, p. 450–466, ago. 1980.

DANEMAN, M.; MERIKLE, P. M. Working memory and language comprehension: A meta-analysis. **Psychonomic Bulletin & Review**, v. 3, n. 4, p. 422–433, dez. 1996.

DARROCH, I. et al. The Effect of Age and Font Size on Reading Text on Handheld Computers. Em: COSTABILE, M. F.; PATERNÒ, F. (Eds.). **Human-Computer Interaction - INTERACT 2005**. Lecture Notes in Computer Science. Berlin, Heidelberg: Springer Berlin Heidelberg, 2005. v. 3585p. 253–266.

DAVID, P. et al. Mobile phone distraction while studying. **New Media & Society**, v. 17, n. 10, p. 1661–1679, nov. 2015.

DE BRUIN, A. Not All Bilinguals Are the Same: A Call for More Detailed Assessments and Descriptions of Bilingual Experiences. **Behavioral Sciences**, v. 9, n. 3, p. 33, 24 mar. 2019.

DE LA MORA VELASCO, E.; HIRUMI, A. The effects of background music on learning: a systematic review of literature to guide future research and practice. **Educational Technology Research and Development**, v. 68, n. 6, p. 2817–2837, dez. 2020.

DELGADO, P. et al. To click or not to click: investigating conflict detection and sourcing in a multiple document hypertext environment. **Reading and Writing**, v. 33, n. 8, p. 2049–2072, out. 2020.

DELUCA, V. et al. Redefining bilingualism as a spectrum of experiences that differentially affects brain structure and function. **Proceedings of the National Academy of Sciences**, v. 116, n. 15, p. 7565–7574, 9 abr. 2019.

DESTEFANO, D.; LEFEVRE, J.-A. Cognitive load in hypertext reading: A review. **Computers in Human Behavior**, v. 23, n. 3, p. 1616–1641, maio 2007.

DIAMOND, A. Executive Functions. **Annual Review of Psychology**, v. 64, n. 1, p. 135–168, 3 jan. 2013.

DRAHEIM, C. et al. The role of attention control in complex real-world tasks. **Psychonomic bulletin & review**, p. 1–55, 15 fev. 2022.

ENGLE, R. W. Working Memory Capacity as Executive Attention. **Current Directions in Psychological Science**, v. 11, n. 1, p. 19–23, fev. 2002.

ENGLE, R. W. Working Memory and Executive Attention: A Revisit. **Perspectives on Psychological Science**, v. 13, n. 2, p. 190–193, mar. 2018.

ENGLE, R. W.; KANE, M. J.; TUHOLSKI, S. W. Individual Differences in Working Memory Capacity and What They Tell Us About Controlled Attention, General Fluid Intelligence, and Functions of the Prefrontal Cortex. Em: MIYAKE, A.; SHAH, P. (Eds.). **Models of Working Memory**. 1. ed. New York, NY, US: Cambridge University Press, 1999. p. 102–134.

ESKEY, D. E. Holding in the bottom: an interactive approach to the language problems of second language readers. Em: CARRELL, P. L.; DEVINE, J.; ESKEY, D. E. (Eds.). **Interactive Approaches to Second Language Reading**. Cambridge Applied Linguistics. Cambridge: Cambridge University Press, 1988. p. 93–100.

FAN, Y. et al. Applications of structural equation modeling (SEM) in ecological studies: an updated review. **Ecological Processes**, v. 5, n. 1, p. 19, dez. 2016.

FANTE, R.; JACOBI, L. L.; SEXTON, V. D. The effects of instant messaging and task difficulty on reading comprehension. **North American Journal of Psychology**, v. 15, n. 2, p. 287–298, 2013.

FERNÁNDEZ-SOTOS, A.; FERNÁNDEZ-CABALLERO, A.; LATORRE, J. M. Influence of Tempo and Rhythmic Unit in Musical Emotion Regulation. **Frontiers in Computational Neuroscience**, v. 10, 3 ago. 2016.

FINARDI, K. R. (ED.). **English in Brazil: views, policies and programs**. Londrina: Universidade Estadual de Londrina. UEL, 2016.

FLEISS, J. L. Measuring nominal scale agreement among many raters. **Psychological Bulletin**, v. 76, n. 5, p. 378–382, 1971.

FLORES, D. R. A. The Effects of Music Genre on Scores in Different Exam Types: A Pilot Study. **Kwantlen Psychology Student Journal**, n. 3, p. 86–97, 2021.

FONTANINI, I. **An Investigation of L2 Reading Comprehension of Linear Texts and Hypertexts and Working Memory Capacity**. Tese de Doutorado—Florianópolis: Universidade Federal de Santa Catarina, 2007.

FONTANINI, I.; TOMITCH, L. B. Working memory capacity and L2 University Students comprehension of linear texts and hypertexts. **International Journal of English Studies**, v. 9, n. 2, p. 1–18, 1 dez. 2009.

FOX, A. B.; ROSEN, J.; CRAWFORD, M. Distractions, Distractions: Does Instant Messaging Affect College Students' Performance on a Concurrent Reading Comprehension Task? **CyberPsychology & Behavior**, v. 12, n. 1, p. 51–53, fev. 2009.

FRIEDMAN, N. P. et al. Individual differences in executive functions are almost entirely genetic in origin. **Journal of Experimental Psychology: General**, v. 137, n. 2, p. 201–225, maio 2008.

FRIEDMAN, N. P.; MIYAKE, A. Comparison of four scoring methods for the reading span test. **Behavior Research Methods**, v. 37, n. 4, p. 581–590, nov. 2005.

GAGNÉ, E.; YEKOVICH, C. W.; YEKOVICH, F. Reading. Em: **Cognitive Psychology of School Learning**. 2. ed. New York, NY: Allyn & Bacon, 1993. p. 512.

GARCIA, G. D. **Data Visualization and Analysis in Second Language Research**. 1. ed. [s.l.] Routledge, 2021.

GARCIA-ARGIBAY, M.; SANTED, M. A.; REALES, J. M. Efficacy of binaural auditory beats in cognition, anxiety, and pain perception: a meta-analysis. **Psychological Research**, v. 83, n. 2, p. 357–372, mar. 2019.

GERNSBACHER, M. A. Two decades of structure building. **Discourse Processes**, v. 23, n. 3, p. 265–304, jan. 1997.

GOODMAN, K. S. Reading: A psycholinguistic guessing game. **Journal of the Reading Specialist**, v. 6, n. 4, p. 126–135, maio 1967.

GOUGH, P. B. One second of reading. Em: **Language by ear and by eye: The relationship between speech and reading.** Oxford, England: Massachusetts Inst. of Technology P, 1972.

GRABE, W. **Reading in a second language: moving from theory to practive**. New York, NY: Cambridge University Press, 2009.

GRAESSER, A. C. et al. Coh-Metrix: Analysis of text on cohesion and language. **Behavior Research Methods, Instruments, & Computers**, v. 36, n. 2, p. 193–202, maio 2004.

GRAESSER, A. C. et al. Coh-Metrix Measures Text Characteristics at Multiple Levels of Language and Discourse. **The Elementary School Journal**, v. 115, n. 2, p. 210–229, dez. 2014.

GRAESSER, A. C.; MCNAMARA, D. S.; KULIKOWICH, J. M. Coh-Metrix: Providing Multilevel Analyses of Text Characteristics. **Educational Researcher**, v. 40, n. 5, p. 223–234, jun. 2011.

HALLAM, S.; MACDONALD, R. The Effects of Music in Community and Educational Settings. Em: HALLAM, S.; CROSS, I.; THAUT, M. (Eds.). **The Oxford Handbook of Music Psychology**. Second ed. Oxford, UK: Oxford University Press, 2016. p. 775–788.

HALLGREN, K. A. Computing Inter-Rater Reliability for Observational Data: An Overview and Tutorial. **Tutorials in Quantitative Methods for Psychology**, v. 8, n. 1, p. 23–34, 1 fev. 2012.

HAMBRICK, D. Z.; BURGOYNE, A. P.; ARAUJO, D. Working Memory and Expertise: An Ecological Perspective. Em: HAMBRICK, D. Z.; BURGOYNE, A. P.; ARAUJO, D. (Eds.). **Working Memory**. [s.l.] Oxford University Press, 2021. p. 212–234.

HANNON, B. Understanding the Relative Contributions of Lower-Level Word Processes, Higher-Level Processes, and Working Memory to Reading Comprehension Performance in Proficient Adult Readers. **Reading Research Quarterly**, v. 47, n. 2, p. 125–152, abr. 2012.

HAUKE, J.; KOSSOWSKI, T. Comparison of Values of Pearson's and Spearman's Correlation Coefficients on the Same Sets of Data. **QUAGEO**, v. 30, n. 2, p. 87–93, 1 jun. 2011.

HUGHES, R. W. Auditory distraction: A duplex-mechanism account: Duplex-mechanism account of auditory distraction. **PsyCh Journal**, v. 3, n. 1, p. 30–41, mar. 2014.

HUGHES, R. W.; VACHON, F.; JONES, D. M. Disruption of short-term memory by changing and deviant sounds: Support for a duplex-mechanism account of auditory distraction. **Journal of Experimental Psychology: Learning, Memory, and Cognition**, v. 33, n. 6, p. 1050–1061, 2007.

IMMORDINO-YANG, M. H.; DAMASIO, A. We Feel, Therefore We Learn: The Relevance of Affective and Social Neuroscience to Education. **Mind, Brain, and Education**, v. 1, n. 1, p. 3–10, mar. 2007.

IMMORDINO-YANG, M. H.; GOTLIEB, R. J. M. Understanding Emotional Thought Can Transform Educators' Understanding of How Students Learn. Em: THOMAS, M. S. C.; MARESCHAL, D.; DUMONTHEIL, I. (Eds.). **Educational neuroscience: development across the life span**. Frontiers of developmental science. New York London: Routledge, Taylor & Francis Group, 2020. p. 244–269.

IN'NAMI, Y.; HIJIKATA, Y.; KOIZUMI, R. Working Memory Capacity and L2 Reading: a Meta-Analysis. **Studies in Second Language Acquisition**, p. 1–26, 2 ago. 2021.

JÄNCKE, L. Music and Memory. Em: JÄNCKE, L. (Ed.). **The Oxford Handbook of Music and the Brain**. [s.l.] Oxford University Press, 2019. p. 235–262.

JOHANSSON, R. et al. Eye movements and reading comprehension while listening to preferred and non-preferred study music. **Psychology of Music**, v. 40, n. 3, p. 339–356, maio 2012.

JUSLIN, P. N.; SLOBODA, J. A. (EDS.). **Handbook of music and emotion: theory, research, and applications**. Oxford ; New York: Oxford University Press, 2010.

JUST, M. A.; BUCHWEITZ, A. **What Brain Imaging Reveals About the Nature of Multitasking**. [s.l.] Oxford University Press, 2014. v. 1

JUST, M. A.; CARPENTER, P. A. A capacity theory of comprehension: Individual differences in working memory. p. 29, 1992.

KAMIL, M. L.; CHOU, H. K. Comprehension and Computer Technology: Past Results, Current Knowledge, and Future Promises. Em: ISRAEL, S. E.; DUFFY, G. G. (Eds.). **Handbook of research on reading comprehension**. 1. ed. New York: Routledge, 2009. p. 289–304.

KÄMPFE, J.; SEDLMEIER, P.; RENKEWITZ, F. The impact of background music on adult listeners: A meta-analysis. **Psychology of Music**, v. 39, n. 4, p. 424–448, out. 2011.

KINTSCH, W. **Comprehension: a paradigm for cognition**. Cambridge, ; New York, NY, USA: Cambridge University Press, 1998.

KINTSCH, W. Revisiting the Construction–Integration Model of Text Comprehension and Its Implications for Instruction. Em: UNRAU, N. (Ed.). **Theoretical Models and Processes of Reading**. 6. ed. [s.l.] International Reading Association, 2013. p. 807–839.

KINTSCH, W.; RAWSON, K. A. Comprehension. Em: SNOWLING, M. J.; HULME, C. (Eds.). **The Science of Reading: A Handbook**. Oxford, UK: Blackwell Publishing Ltd, 2005. p. 211–226.

KINTSCH, W.; VAN DIJK, T. A. Toward a model of text comprehension and production. **Psychological Review**, v. 85, n. 5, p. 363–394, 1978.

KONONOVA, A. G.; YUAN, S. Take a Break: Examining College Students' Media Multitasking Activities and Motivations During Study- or Work-Related Tasks. **Journalism & Mass Communication Educator**, v. 72, n. 2, p. 183–197, jun. 2017.

KRAUS, N.; CHANDRASEKARAN, B. Music training for the development of auditory skills. **Nature Reviews Neuroscience**, v. 11, n. 8, p. 599–605, ago. 2010.

LANDIS, J. R.; KOCH, G. G. The measurement of observer agreement for categorical data. **Biometrics**, v. 33, n. 1, p. 159–174, mar. 1977.

LARSON-HALL, J. **A Guide to Doing Statistics in Second Language Research Using SPSS**. 0. ed. [s.l.] Routledge, 2010.

LARSON-HALL, J. **A guide to doing statistics in second language research using SPSS and R**. Second Edition ed. London ; New York: Routledge, 2016.

LEIVADA, E. et al. On the phantom-like appearance of bilingualism effects on neurocognition: (How) should we proceed? **Bilingualism: Language and Cognition**, v. 24, n. 1, p. 197–210, jan. 2021.

LIMA JR, R. M.; GARCIA, G. D. Diferentes análises estatísticas podem levar a conclusões categoricamente distintas. **Revista da ABRALIN**, p. 1–19, 5 ago. 2021.

LIN, L.; LEE, J.; ROBERTSON, T. Reading While Watching Video: The Effect of Video Content on Reading Comprehension and Media Multitasking Ability. **Journal of Educational Computing Research**, v. 45, n. 2, p. 183–201, set. 2011.

LINCK, J. A. et al. Working memory and second language comprehension and production: A meta-analysis. **Psychonomic Bulletin & Review**, v. 21, n. 4, p. 861–883, ago. 2014.

LINDERHOLM, T. et al. Fluctuations in the Availability of Information During Reading: Capturing Cognitive Processes Using the Landscape Model. **Discourse Processes**, v. 37, n. 2, p. 165–186, abr. 2004.

LINDERHOLM, T.; VAN DEN BROEK, P. The effects of reading purpose and working memory capacity on the processing of expository text. **Journal of Educational Psychology**, v. 94, n. 4, p. 778–784, 2002.

LIU, Y. et al. Effects of Musical Tempo on Musicians' and Non-musicians' Emotional Experience When Listening to Music. **Frontiers in Psychology**, v. 9, p. 2118, 13 nov. 2018.

LOGIE, R. H.; BELLETIER, C.; DOHERTY, J. M. Integrating Theories of Working Memory. Em: LOGIE, R. H.; BELLETIER, C.; DOHERTY, J. M. (Eds.). **Working Memory**. Oxford, United Kingdom ; New York, NY: Oxford University Press, 2021. p. 389–430.

LOGIE, R. H.; CAMOS, V.; COWAN, N. (EDS.). **Working memory: state of the science**. First edition ed. Oxford, United Kingdom ; New York, NY: Oxford University Press, 2021a.

LOGIE, R. H.; CAMOS, V.; COWAN, N. The State of the Science of Working Memory: An Introduction. Em: LOGIE, R. H.; CAMOS, V.; COWAN, N. (Eds.). **Working Memory**. 1. ed. Oxford, United Kingdom ; New York, NY: Oxford University Press, 2021b. p. 1–9.

LÓPEZ, B. G.; LUQUE, A.; PIÑA-WATSON, B. Context, intersectionality, and resilience: Moving toward a more holistic study of bilingualism in cognitive science. **Cultural Diversity and Ethnic Minority Psychology**, 5 ago. 2021.

LUK, G.; BIALYSTOK, E. Bilingualism is not a categorical variable: Interaction between language proficiency and usage. **Journal of Cognitive Psychology**, v. 25, n. 5, p. 605–621, ago. 2013.

MARIAN, V.; BLUMENFELD, H. K.; KAUSHANSKAYA, M. The Language Experience and Proficiency Questionnaire (LEAP-Q): Assessing Language Profiles in Bilinguals and Multilinguals. **Journal of Speech, Language, and Hearing Research**, v. 50, n. 4, p. 940–967, ago. 2007.

MARSH, J. E.; HUGHES, R. W.; JONES, D. M. Interference by process, not content, determines semantic auditory distraction. **Cognition**, v. 110, n. 1, p. 23–38, jan. 2009.

MASHBURN, C. A.; TSUKAHARA, J. S.; ENGLE, R. W. Individual Differences in Attention Control: Implications for the Relationship Between Working Memory Capacity and Fluid Intelligence. Em: MASHBURN, C. A.; TSUKAHARA, J. S.; ENGLE, R. W. (Eds.). **Working Memory: the state of the science**. 1. ed. United Kingdom: Oxford University Press, 2021. p. 175–211.

MAY, K. E.; ELDER, A. D. Efficient, helpful, or distracting? A literature review of media multitasking in relation to academic performance. **International Journal of Educational Technology in Higher Education**, v. 15, n. 1, p. 13, dez. 2018.

MIYAKE, A. et al. The Unity and Diversity of Executive Functions and Their Contributions to Complex “Frontal Lobe” Tasks: A Latent Variable Analysis. **Cognitive Psychology**, v. 41, n. 1, p. 49–100, ago. 2000.

MIYAKE, A.; FRIEDMAN, N. P. The Nature and Organization of Individual Differences in Executive Functions: Four General Conclusions. **Current Directions in Psychological Science**, v. 21, p. 8–14, 31 jan. 2012.

MIYAKE, A.; SHAH, P. Toward Unified Theories of Working Memory: Emerging General Consensus, Unresolved Theoretical Issues, and Future Research Directions. Em: MIYAKE, A.; SHAH, P. (Eds.). **Models of Working Memory: Mechanisms of Active Maintenance and Executive Control**. 1. ed. New York, NY, US: Cambridge University Press, 1999a. p. 442–482.

MIYAKE, A.; SHAH, P. (EDS.). **Models of Working Memory: Mechanisms of Active Maintenance and Executive Control**. 1. ed. [s.l.] Cambridge University Press, 1999b.

**MODERATOR VARIABLE**. Disponível em: <https://www.statisticssolutions.com/free-resources/directory-of-statistical-analyses/moderator-variable/>. Acesso em: 19 jan. 2022.

MORTON, J. B.; HARPER, S. N. What did Simon say? Revisiting the bilingual advantage. **Developmental Science**, v. 10, n. 6, p. 719–726, nov. 2007.

MOTA, M. B.; BUCHWEITZ, A.; MASCARELLO, L. J. Memória de trabalho e dificuldades de aprendizagem da leitura no 2o. ano do ensino fundamental: os resultados de uma intervenção. Em: MAIA, M. (Ed.). **PsicolinguÍstica e Educação**. Campinas, SP: Mercados das Letras, 2018. p. 173–195.

OLIVEIRA, D. A.; TOMITCH, L. M. B. Correlations between working memory capacity and EFL reading comprehension: an investigation with Brazilian university students. **Ciências & Cognição**, v. 26, n. 1, p. 77–93, 2021.

OLIVEIRA, D. A.; WOELFER, S.; TOMITCH, L. Construindo um Teste de Capacidade de Leitura Autoaplicável com apresentação aleatória de estímulos. **Revista Neuropsicologia Latinoamericana**, v. 13, n. 1, p. 62–76, 9 jun. 2021.

OZURU, Y. et al. Comparing comprehension measured by multiple-choice and open-ended questions. **Canadian Journal of Experimental Psychology/Revue canadienne de psychologie expérimentale**, v. 67, n. 3, p. 215–227, 2013.

PAAP, K. The Bilingual Advantage Debate: Quantity and Quality of the Evidence. Em: SCHWIETER, J. W.; PARADIS, M. (Eds.). **The Handbook of the Neuroscience of Multilingualism**. 1. ed. [s.l.] Wiley, 2019. p. 701–735.

PAAP, K. R.; GREENBERG, Z. I. There is no coherent evidence for a bilingual advantage in executive processing. **Cognitive Psychology**, v. 66, n. 2, p. 232–258, mar. 2013.

PAÑOS, L. P. **Defining and Operationalizing Propositional Complexity into Idea Units: Effects of Mode, Discourse Type, Task Type and Task Complexity**. MA Thesis—Barcelona, Spain: University of Barcelona, 2015.

PASHLER, H.; KANG, S. H. K.; IP, R. Y. Does Multitasking Impair Studying? Depends on Timing: Does multitasking impair studying? **Applied Cognitive Psychology**, v. 27, n. 5, p. 593–599, set. 2013.

PEARSON, P. D.; JOHNSON, D. D. **Teaching Reading Comprehension**. New York: Holt, Rinehart & Winston, 1978.

PEREIRA, C. S. et al. Music and Emotions in the Brain: Familiarity Matters. **PLoS ONE**, v. 6, n. 11, p. e27241, 16 nov. 2011.

PERHAM, N.; CURRIE, H. Does listening to preferred music improve reading comprehension performance?: Preferred music and reading comprehension. **Applied Cognitive Psychology**, v. 28, n. 2, p. 279–284, mar. 2014.

PIETSCHNIG, J.; VORACEK, M.; FORMANN, A. K. Mozart effect–Shmozart effect: A meta-analysis. **Intelligence**, v. 38, n. 3, p. 314–323, maio 2010.

PIROLLI, P. **Information foraging theory: adaptive interaction with information**. Oxford ; New York: Oxford University Press, 2007.

POARCH, G. J.; BIALYSTOK, E. Bilingualism as a model for multitasking. **Developmental Review**, v. 35, p. 113–124, mar. 2015.

POARCH, G. J.; KROTT, A. A Bilingual Advantage? An Appeal for a Change in Perspective and Recommendations for Future Research. **Behavioral Sciences**, v. 9, n. 9, p. 95, 4 set. 2019.

POLLARD, M. A.; COURAGE, M. L. Working memory capacity predicts effective multitasking. **Computers in Human Behavior**, v. 76, p. 450–462, nov. 2017.

PROCAILO, L. **Reading Digital Texts in L2: Working Memory Capacity, Text Mode, and Reading Condition Accounting for Differences in Processes and Products of Reading**. Tese de Doutorado—Florianópolis: Universidade Federal de Santa Catarina, 2017.

PROCAILO, L.; TOMITCH, L. M. B. Investigating Digital Reading in L2 to Criticize and to Summarize: Working Memory Capacity and Reading Purpose Influencing Strategy. **Lingüística y Literatura**, v. 41, n. 78, p. 320–351, 20 set. 2020.

R CORE TEAM. **R: A Language and Environment for Statistical Computing**. Vienna, AustriaR Foundation for Statistical Computing, , 2020. Disponível em: <https://www.R-project.org/>

RAVIV, L.; LUPYAN, G.; GREEN, S. C. How variability shapes learning and generalization. **Trends in Cognitive Sciences**, v. 26, n. 6, p. 462–483, jun. 2022.

RAYNER, K. Eye movements in reading and information processing: 20 years of research. **Psychological Bulletin**, v. 124, n. 3, p. 372–422, 1998.

REDICK, T. S. et al. Cognitive Predictors of a Common Multitasking Ability: Contributions From Working Memory, Attention Control, and Fluid Intelligence. **ournal of Experimental Psychology: General**, v. 145, n. 11, p. 1473–149, 2016.

RODRIGUES, M. Scientists reel as Brazilian government backtracks on research funds. **Nature**, p. d41586- 021- 02886–9, 22 out. 2021.

RONDON, T. K. **Schema activation and working memory: the effect of different prereading activities on pre-intermediate and advanced Brazilian EFL students' reading comprehension**. Florianópolis: Universidade Federal de Santa Catarina, 2019.

RONDON, T. K.; TOMITCH, L. M. B. The effect of different pre-reading activities on pre-intermediate and advanced EFL students' reading comprehension. **Revista (Con)Textos Linguísticos**, v. 14, n. 29, p. 719–378, 2020.

ROSCIOLI, D. C. **The Relationship Between Technical High School Brazilian Students' Working Memory Capacity, Pre-Reading Activities, and Inference Generation in Reading Comprehension in L2**. PhD Dissertation—Florianópolis: Universidade Federal de Santa Catarina, 2017.

ROSCIOLI, D. C.; TOMITCH, L. M. B. A Influência da Capacidade de Memória de Trabalho na Geração de Inferências e na Compreensão Leitora. **Alfa: Revista de Linguística (São José do Rio Preto)**, v. 66, p. e13543, 2022.

RUMELHART, D. Toward an Interactive Model of Reading. Em: UNRAU, N. (Ed.). **Theoretical Models and Processes of Reading**. 6. ed. [s.l.] International Reading Association, 2013. p. 719–747.

RUMELHART, D. E. Toward an Interactive Model of Reading. Em: SINGER, H.; RUDDELL, R. B. (Eds.). **Theoretical Models and Processes of Reading**. 3. ed. Newark, DE: International Reading Association, 1985. p. 722–750.

RUPP, A. A.; FERNE, T.; CHOI, H. How assessing reading comprehension with multiple-choice questions shapes the construct: a cognitive processing perspective. **Language Testing**, v. 23, n. 4, p. 441–474, out. 2006.

SALAMÉ, P.; BADDELEY, A. D. Disruption of short-term memory by unattended speech: Implications for the structure of working memory. **Journal of Verbal Learning and Verbal Behavior**, v. 21, n. 2, p. 150–164, abr. 1982.

SALAMÉ, P.; BADDELEY, A. D. Noise, unattended speech and short-term memory. **Ergonomics**, v. 30, n. 8, p. 1185–1194, ago. 1987.

SALAMÉ, P.; BADDELEY, A. D. Effects of Background Music on Phonological Short-Term Memory. **The Quarterly Journal of Experimental Psychology Section A**, v. 41, n. 1, p. 107–122, fev. 1989.

SALMERÓN, L. et al. Comprehension processes in digital reading. Em: BARZILLAI, M. et al. (Eds.). **Learning to read in a digital world**. Amsterdam ; Philadelphia: John Benjamins Publishing Company, 2018. p. 91–120.

SALVUCCI, D. D.; TAATGEN, N. A. Threaded cognition: An integrated theory of concurrent multitasking. **Psychological Review**, v. 115, n. 1, p. 101–130, 2008.

SALVUCCI, D. D.; TAATGEN, N. A. **The multitasking mind**. New York: Oxford University Press, 2011.

SALVUCCI, D. D.; TAATGEN, N. A.; BORST, J. P. **Toward a unified theory of the multitasking continuum: from concurrent performance to task switching, interruption, and resumption**. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. **Anais**...Boston MA USA: ACM, 4 abr. 2009. Disponível em: <https://dl.acm.org/doi/10.1145/1518701.1518981>. Acesso em: 17 fev. 2022

SCHOLL, A. P.; FINGER, I. Elaboração de um questionário de histórico da linguagem para pesquisas com bilíngues. **Nonada: Letras em revista**, v. 2, n. 21, p. 1–17, 2013.

SCHOLL, A. P.; FINGER, I.; FONTES, A. B. A. DA L. Fatores de experiência linguística associados à proficiência autoavaliada por usuários de inglês como língua adicional. **Letrônica**, v. 10, n. 2, p. 689–699, 2017.

SCHOLL, A. P.; FONTES, A. B. A. DA L.; FINGER, I. Can bilinguals rate their proficiency accurately in a language background questionnaire?: A correlation between self-rated and objective proficiency measures. **Revista da Anpoll**, v. 52, n. 1, p. 142–161, 31 maio 2021.

SHIN, J. A meta-analysis of the relationship between working memory and second language reading comprehension: Does task type matter? **Applied Psycholinguistics**, v. 41, n. 4, p. 873–900, jul. 2020.

SÖRMAN, D. E. et al. Longitudinal effects of bilingualism on dual-tasking. **PLOS ONE**, v. 12, n. 12, p. e0189299, 27 dez. 2017.

SPIRO, R. et al. Cognitive flexibility theory: Hypermedia for complex learning, adaptive knowledge application, and experience acceleration. **Educational Technology**, v. 43, p. 5–10, jan. 2003.

SPIRO, R. J.; JEHNG, J.-C. Cognitive flexibility and hypertext: Theory and technology for the nonlinear and multidimensional traversal of complex subject matter. Em: **Cognition, education, and multimedia: Exploring ideas in high technology.** Hillsdale, NJ, US: Lawrence Erlbaum Associates, Inc, 1990. p. 163–205.

SPIRO, R. J.; KLAUTKE, H.; JOHNSON, A. K. All Bets Are Off: How Certain Kinds of Reading to Learn on the Web Are Totally Different from What We Learned from Research on Traditional Text Comprehension and Learning from Text. Em: SPIRO, R. J. et al. (Eds.). **Reading at a crossroads? Disjunctures and continuities in current conceptions and practices.** New York: Routledge, 2015. p. 45–52.

STADTLER, M.; BROMME, R.; ROUET, J.-F. Learning from multiple documents. Em: MANALO, E.; UESAKA, Y.; CHINN, C. A. (Eds.). **Promoting Spontaneous Use of Learning and Reasoning Strategies**. 1. ed. [s.l.] Routledge, 2017. p. 46–61.

STEELE, K. M.; BASS, K. E.; CROOK, M. D. The Mystery of the Mozart Effect: Failure to Replicate. **Psychological Science**, v. 10, n. 4, p. 366–369, jul. 1999.

SUPPER, A. Listening for the hiss: lo-fi liner notes as curatorial practices. **Popular Music**, v. 37, n. 2, p. 253–270, maio 2018.

SURRAIN, S.; LUK, G. Describing bilinguals: A systematic review of labels and descriptions used in the literature between 2005–2015. **Bilingualism: Language and Cognition**, v. 22, n. 2, p. 401–415, mar. 2019.

TAPIERO, I. **Situation models and levels of coherence: toward a definition of comprehension**. Mahwah, N.J: Lawrence Erlbaum Associates, 2007.

THOMPSON, W. F.; SCHELLENBERG, E. G.; LETNIC, A. K. Fast and loud background music disrupts reading comprehension. **Psychology of Music**, v. 40, n. 6, p. 700–708, nov. 2012.

TOMITCH, L. M. B. **Reading: Text Organization Perception and Working Memory Capacity.** Tese de Doutorado—Florianópolis: Universidade Federal de Santa Catarina, 1995.

TOMITCH, L. M. B. Individual differences in working memory capacity and the recall of predicted elements in the text. **Lenguas Modernas**, n. 26–27, p. 31–51, 1999.

TOMITCH, L. M. B. Teaching main ideas Are we really 'teaching'? **Linguagem & Ensino**, v. 3, n. 1, p. 45–53, 2000.

TOMITCH, L. M. B. **Reading: text organization perception and working memory capacity**. Florianópolis: UFSC-DLLE, 2003.

TOMITCH, L. M. B. Pesquisas sobre os aspectos cognitivos da leitura: 40 anos de PPGI. Em: FUNCK, S. B. (Ed.). **História e memória: 40 anos do programa de pós-graduação em inglês da Universidade Federal de Santa Catarina.** Florianópolis: UFSC-CCE-PPGI, 2011. p. 51–62.

TOMITCH, L. M. B. **Produção textual acadêmica**. Florianópolis: Universidade Federal de Santa Catarina, 2012.

TOMITCH, L. M. B. Aspectos importantes para a construção, aplicação e interpretação dos resultados de um instrumento de medida da capacidade da memória de trabalho - o Teste de Capacidade de Leitura. Em: GUARESI, R.; PEREIRA, V. W. (Eds.). **Leitura e Escrita em Avaliação: a ciência em busca de maior esclarecimento da linguagem verbal**. Vitória da Conquista: Fonema e Grafema, 2020. p. 50–78.

TORRES, A. C. DA G. Diferenças individuais na memória de trabalho e o desempenho na tarefa de construção de idéias principais em língua materna e língua estrangeira. **Revista Fragmentos**, v. 24, p. 131–147, jun. 2003.

TRAN, P.; CARRILLO, R.; SUBRAHMANYAM, K. Effects of online multitasking on reading comprehension of expository text. **Cyberpsychology: Journal of Psychosocial Research on Cyberspace**, v. 7, n. 3, 1 dez. 2013.

TURNER, M. L.; ENGLE, R. W. Is working memory capacity task dependent? **Journal of Memory and Language**, v. 28, n. 2, p. 127–154, abr. 1989.

VALIAN, V. Bilingualism and cognition. **Bilingualism: Language and Cognition**, v. 18, n. 1, p. 3–24, jan. 2015.

VAN DEN BROEK, P. et al. The landscape model of reading: Inferences and the one-line construction of memory representation. Em: VAN OOSTENDORP, H.; GOLDMAN, S. R. (Eds.). **The construction of mental representations during reading**. Mahwah, N.J: Lawrence Erlbaum Associates, Inc, 1999. p. 71–98.

VAN DEN BROEK, P.; KENDEOU, P. Building coherence in web-based and other non-traditional reading environments: Cognitive opportunities and challenges. Em: SPIRO, RAND J., R. et al. (Eds.). **Reading at a Crossroads? Disjunctures and Continuities in Current Conceptions and Practices**. 1. ed. New York: Routledge, 2015. p. 104–114.

VAN DEN BROEK, P.; KENDEOU, P. Reading Comprehension I: Discourse. Em: SNOWLING, M. J.; HULME, C.; NATION, K. (Eds.). **The Science of Reading: A Handbook**. Second Edition ed. Hoboken, NJ, US: John Wiley & Sons Ltd, 2022. p. 239–260.

VAN DEN BROEK, P.; RAPP, D. N.; KENDEOU, P. Integrating Memory-Based and Constructionist Processes in Accounts of Reading Comprehension. **Discourse Processes**, v. 39, n. 2–3, p. 299–316, maio 2005.

VAN DIJK, T. A. Semantic Macro-Structures and Knowledge Frames in Discourse Comprehension. Em: JUST, M. A.; CARPENTER, P. A. (Eds.). **Cognitive Processes in Comprehension**. 1. ed. New York: Lawrence Erlbaum Associates, Inc, 1977. p. 3–32.

VAN DIJK, T. A.; KINTSCH, W. **Strategies of discourse comprehension**. New York: Academic Press, 1983.

VASILEV, M. R. et al. Reading is disrupted by intelligible background speech: Evidence from eye-tracking. **Journal of Experimental Psychology: Human Perception and Performance**, v. 45, n. 11, p. 1484–1512, nov. 2019.

VASILEV, M. R.; KIRKBY, J. A.; ANGELE, B. Auditory Distraction During Reading: A Bayesian Meta-Analysis of a Continuing Controversy. **Perspectives on Psychological Science**, v. 13, n. 5, p. 567–597, set. 2018.

WAX, D. **The Value of Writing Well**. Disponível em: <https://www.lifehack.org/articles/communication/the-value-of-writing-well.html>. Acesso em: 23 fev. 2022.

WEN, Z. Working Memory in Second Language Acquisition and Processing: The Phonological/ Executive Model. Em: WEN, Z.; MOTA, M. B.; MCNEILL, A. (Eds.). **Working Memory in Second Language Acquisition and Processing**. [s.l.] Multilingual Matters, 2015. p. 41–62.

WEN, Z.; LI, S. Working Memory in L2 Learning and Processing. Em: SCHWIETER, J. W.; BENATI, A. (Eds.). **The Cambridge Handbook of Language Learning**. 1. ed. Cambridge, UK: Cambridge University Press, 2019. p. 365–389.

WEN, Z.; SCHWIETER, J. W. Toward an Integrated Account of Working Memory and Language. Em: WEN, Z.; SCHWIETER, J. W. (Eds.). **The Cambridge handbook of working memory and language**. 1. ed. Cambridge, UK: Cambridge University Press, 2022.

WIGDOROWITZ, M.; PÉREZ, A. I.; TSIMPLI, I. M. A holistic measure of contextual and individual linguistic diversity. **International Journal of Multilingualism**, p. 1–19, 29 out. 2020.

WIGDOROWITZ, M.; PÉREZ, A. I.; TSIMPLI, I. M. Sociolinguistic context matters: Exploring differences in contextual linguistic diversity in South Africa and England. **International Multilingual Research Journal**, p. 1–20, 4 maio 2022.

WINSTON, E.; SAYWOOD, L. Beats to Relax/Study To: Contradiction and Paradox in Lo-Fi Hip Hop. **IASPM Journal**, v. 9, n. 2, p. 40–54, dez. 2019.

WOELFER, S. W. **Constructing Meaning from Cartoons: The Effects of EFL Reading Proficiency and Working Memory Capacity on the Processing of Verbal and Pictorial Information**. Dissertação de Mestrado—Florianópolis: Universidade Federal de Santa Catarina, 2016.

WOELFER, S. W.; TOMITCH, L. M. B. Working Memory Capacity, Reading Proficiency, and the Processing of Verbal and Pictorial Information in English as a Foreign Language Reading. v. 63, n. 3, p. 633–660, nov. 2019.

WORRINGER, B. et al. Common and distinct neural correlates of dual-tasking and task-switching: a meta-analytic review and a neuro-cognitive processing model of human multitasking. **Brain Structure and Function**, v. 224, n. 5, p. 1845–1869, jun. 2019.

YEARI, M. The role of working memory in inference generation during reading comprehension: Retention, (re)activation, or suppression of verbal information? **Learning and Individual Differences**, v. 56, p. 1–12, maio 2017.

YEARI, M.; VAN DEN BROEK, P. A cognitive account of discourse understanding and discourse interpretation: The Landscape Model of reading. **Discourse Studies**, v. 13, n. 5, p. 635–643, out. 2011.

YEARI, M.; VAN DEN BROEK, P. The role of textual semantic constraints in knowledge-based inference generation during reading comprehension: A computational approach. **Memory**, v. 23, n. 8, p. 1193–1214, 17 nov. 2015.

ZHANG, H. et al. How listening to music affects reading: Evidence from eye tracking. **Journal of Experimental Psychology: Learning, Memory, and Cognition**, v. 44, n. 11, p. 1778–1791, nov. 2018.

# APPENDICES

## APPENDIX A – Termo de Consentimento Livre e Esclarecido

Prezada (o) Sra./Sr.

Convido você para ser participante na pesquisa: “A capacidade da memória de trabalho é preditora da performance em multitarefas? Uma investigação da compreensão leitora de bilíngues na leitura de hipertexto ao escutar música”, do Programa de Pós-Graduação em Inglês da UFSC.

**Por que esta pesquisa está sendo realizada?**
É comum as pessoas lerem enquanto ouvem música, e tal fato tem chamado a atenção de pesquisadores em relação tanto da porcentagem de pessoas que realizam essas duas tarefas ao mesmo tempo, quanto dos efeitos (benéficos ou não) que a música pode ter na compreensão leitora, principalmente quando realizada em ambiente virtual. No entanto, os resultados de estudos anteriores, até onde sabemos, não tem sido conclusivos. Portanto, este estudo pretende investigar se a capacidade de memória de trabalho das pessoas pode influenciar no seu desempenho em multitarefas.

**O que vai acontecer?**
Este estudo vai acontecer de forma não presencial, por meio de uma plataforma online elaborada para estudos na área de linguística. Todas as etapas da pesquisa serão realizadas no endereço fornecido no e-mail de convite. Este estudo é composto de cinco etapas, conforme descritas a seguir:
Na primeira etapa, você vai responder a um questionário com informações sobre sua experiência com a língua inglesa e vai autoavaliar sua proficiência. Na segunda etapa, você realizará um teste de memória, envolvendo a leitura de frases em língua portuguesa seguidas da recordação das palavras contidas nessas frases. Na terceira etapa, você escolherá uma música para escutar durante a leitura de um texto. Em seguida, você vai ler um texto em ambiente virtual enquanto escuta a música selecionada, e vai tentar compreender o texto. Na quarta etapa, você vai escrever o que você lembra do texto. Na quinta etapa, você vai responder a perguntas sobre o texto. Na última etapa, você responder a um breve questionário sobre suas percepções no experimento, sobre seus hábitos em multitarefas e sobre sua experiência musical.

**Haverá algum risco ao participar dessa pesquisa?**
Os riscos são mínimos. O que pode acontecer é você ficar um pouco desconfortável (ansioso(a) e/ou constrangido(a)), pois essa geralmente é a reação que as pessoas têm quando pensam que podem ter suas limitações expostas. Com relação ao teste de memória, para evitar que você se sinta ansioso(a) e/ou constrangido(a), você receberá instruções bem detalhadas e realizará sessões de treino antes do teste propriamente dito. Sobre o teste de multitarefas, você pode sentir um desconforto pelo fato de ter que ler ao mesmo tempo que ouve uma música. Além disso, em função das limitações das tecnologias utilizadas, há o risco de vazamento de dados e de perda de dados, que sempre existe, muito embora estejamos utilizando os servidores do Google durante a coleta, que são conhecidos pela sua segurança. Após a coleta de dados, estes

serão baixados em dispositivo eletrônico local e serão apagados da plataforma do experimento. Os dados ficarão armazenados pelo pesquisador por cinco anos, e após esse período serão excluídos.

**O que fazer em caso de dúvidas?**
Caso tenha alguma dúvida durante os procedimentos de coleta de dados, o pesquisador estará disponível via WhatsApp, telefone ou e-mail para prestar toda a assistência necessária, através do telefone **(48) 99***-****** ou WhatsApp **(link do WhatsApp)** ou e-mail: **bruno_de_azevedo@hotmail.com** e responderei prontamente no telefone e e-mail citados. O e-mail da minha orientadora é: **leda@cce.ufsc.br** ou **ledatomitch@gmail.com**

Caso você queira entrar em contato com o Comitê de Ética em Pesquisas com Seres Humanos da UFSC, que é o órgão que oferece apoio e proteção aos participantes de pesquisas no Brasil, use uma dessas formas de contato: Prédio Reitoria II, 4ºandar, sala 401, localizado na Rua Desembargador Vitor Lima, nº 222, Trindade, Florianópolis - Telefone (48) 3721-6094 - E-mail: cep.propesq@contato.ufsc.br

**Haverá algum benefício?**
Os benefícios são indiretos. Primeiro, você estará colaborando com a construção do conhecimento científico. Segundo, ao realizar o teste de proficiência, você estará refletindo sobre sua experiência com a língua inglesa. Quanto ao teste de memória, este pode levá-lo a refletir sobre suas possíveis dificuldades e a utilizar estratégias para compensá-las. Por fim, com relação à leitura ao ouvir música, essa experiência possibilitará você refletir sobre seu comportamento em um ambiente multitarefas.

**A identidade dos/as participantes será revelada?**
Não. Os dados da participação serão confidenciais, ou seja, os nomes dos/as participantes não serão divulgados. No entanto, há a possibilidade remota da quebra do sigilo, mesmo que involuntário e não intencional, conforme apontado anteriormente.

**A participação nessa pesquisa é obrigatória?**
Não. A participação é totalmente voluntária. Esse documento é um convite. Caso haja a recusa na participação, você não será afetada (o) no curso de modo algum. Além disso, o direito de não responder qualquer questão, sem necessidade de explicação ou justificativa para tal, podendo também se retirar da pesquisa a qualquer momento.

**Haverá alguma despesa?**
Não. A pesquisa vai acontecer online. Poderá haver ressarcimento no caso de eventuais despesas não previstas pelos pesquisadores e devidamente comprovadas pelo participante.

**Haverá benefício financeiro?**

Não. A participação na pesquisa é voluntária e não envolve dinheiro, mas me comprometo a garantir indenização diante de eventuais danos devidamente comprovados.

**É possível desistir de participar ou cancelar essa autorização?**
Sim. É possível cancelar a participação da pesquisa **a qualquer momento** sem qualquer prejuízo ou necessidade de justificativa. Para a retirada do consentimento, basta entrar em contato através do telefone, WhatsApp ou e-mail descritos acima. Caso isso acontecer, o pesquisador responderá dando ciência do interesse do participante de pesquisa retirar seu consentimento.

**Essa pesquisa cumpre os termos das resoluções CNS 466/12 e 510/16 e também suas complementares, que são as os documentos que normatizam pesquisas como essa no Brasil.**

**Abaixo, você dará o aceite ou a recusa de participação neste estudo. Em caso de aceite, você receberá em seu e-mail uma via deste documento assinada digitalmente pelos pesquisadores. Guarde cuidadosamente a sua via, pois é um documento que traz importantes informações de contato e garante os seus direitos como participante da pesquisa. Recomendamos que realize um *printscreen* da tela deste documento e guarde. Caso concorde em participar, além do consentimento inicial, será considerado anuência quando você realizar as tarefas previstas neste experimento.**

**Por favor escolha uma das opções:**
( ) Declaro que sou maior de 18 anos e que li e compreendi as informações do Termo de Consentimento Livre e Esclarecido. Compreendo o objetivo do estudo bem como os procedimentos que serão realizados. Eu compreendo meu direito como voluntário(a) da pesquisa, concordo em participar deste estudo e em ceder meus dados para a pesquisa.

( ) Não aceito participar desta pesquisa.

## APPENDIX B – QuExPli

### PARTE I - Informações pessoais

Nome completo:
Data de Nascimento:
Local de Nascimento (Cidade, Estado, País):

### PARTE II - Questionário acerca da aquisição de inglês

Indique onde você aprendeu inglês (marque tantas opções quanto forem necessárias):
( ) Casa
( ) Escola
( ) Curso de Línguas
( ) Ouvindo música
( ) Jogando jogos (online e/ou videogame)
( ) Usando a internet em geral
( ) Lendo leituras gerais
( ) Assistindo TV, séries, e/ou filmes
( ) Interagindo com alguém que falava inglês
( ) Outro (especifique abaixo)

Informe a idade em que você começou a aprender inglês:

( ) 0-3 anos
( ) 4-7 anos
( ) 8-11 anos
( ) 12-15 anos
( ) 16-19 anos
( ) 20-23 anos
( ) 24-27 anos
( ) 28-31 anos

Informe a idade em que você tornou-se fluente em inglês:

( ) 0-3 anos
( ) 4-7 anos
( ) 8-11 anos
( ) 12-15 anos
( ) 16-19 anos
( ) 20-23 anos
( ) 24-27 anos
( ) 28-31 anos

**PARTE III - Fatores de contribuição para a aprendizagem de inglês**

Em uma escala de 0 a 6 (0 = nada; 3 = razoavelmente; 6 = muito), indique o quanto cada um destes fatores contribuiu para a aprendizagem de inglês:

Interagir com a família
( ) 0 - nada ( ) 3 - razoavelmente ( ) 6 - muito

Interagir com as/os amigas/os
( ) 0 - nada ( ) 3 - razoavelmente ( ) 6 - muito

Ler por prazer
( ) 0 - nada ( ) 3 - razoavelmente ( ) 6 - muito

Ler textos acadêmicos
( ) 0 - nada ( ) 3 - razoavelmente ( ) 6 - muito

Assistir TV, séries e/ou filmes e vídeos no Youtube ou serviço de streaming
( ) 0 - nada ( ) 3 - razoavelmente ( ) 6 - muito

Ouvir rádio e/ou música
( ) 0 - nada ( ) 3 - razoavelmente ( ) 6 - muito

Usar internet
( ) 0 - nada ( ) 3 - razoavelmente ( ) 6 - muito

Jogar jogos online e/ou videogame
( ) 0 - nada ( ) 3 - razoavelmente ( ) 6 - muito

Fazer curso de línguas
( ) 0 - nada ( ) 3 - razoavelmente ( ) 6 – muito

Selecione a frequência em que você realiza as seguintes atividades em inglês:

**Fala com sua família**
( ) 1 - Algumas vezes por ano
( ) 2 - Uma vez por mês
( ) 3 - Uma vez a cada duas semanas
( ) 4 - Uma vez por semana
( ) 5 - Mais de uma vez por semana
( ) 6 - Todos os dias

**Fala com amigos(as)**
( ) 1 - Algumas vezes por ano
( ) 2 - Uma vez por mês
( ) 3 - Uma vez a cada duas semanas

( ) 4 - Uma vez por semana
( ) 5 - Mais de uma vez por semana
( ) 6 - Todos os dias

**Fala no trabalho/universidade**
( ) 1 - Algumas vezes por ano
( ) 2 - Uma vez por mês
( ) 3 - Uma vez a cada duas semanas
( ) 4 - Uma vez por semana
( ) 5 - Mais de uma vez por semana
( ) 6 - Todos os dias

**Lê/escreve no trabalho/universidade**
( ) 1 - Algumas vezes por ano
( ) 2 - Uma vez por mês
( ) 3 - Uma vez a cada duas semanas
( ) 4 - Uma vez por semana
( ) 5 - Mais de uma vez por semana
( ) 6 - Todos os dias

**Lê livros/revistas/jornais impressos**
( ) 1 - Algumas vezes por ano
( ) 2 - Uma vez por mês
( ) 3 - Uma vez a cada duas semanas
( ) 4 - Uma vez por semana
( ) 5 - Mais de uma vez por semana
( ) 6 - Todos os dias

**Lê livros/revistas/notícias online**
( ) 1 - Algumas vezes por ano
( ) 2 - Uma vez por mês
( ) 3 - Uma vez a cada duas semanas
( ) 4 - Uma vez por semana
( ) 5 - Mais de uma vez por semana
( ) 6 - Todos os dias

**Lê redes sociais**
( ) 1 - Algumas vezes por ano
( ) 2 - Uma vez por mês
( ) 3 - Uma vez a cada duas semanas
( ) 4 - Uma vez por semana
( ) 5 - Mais de uma vez por semana
( ) 6 - Todos os dias
**Escrever em geral (e-mails, mensagens, chats, redes sociais...)**
( ) 1 - Algumas vezes por ano

( ) 2 - Uma vez por mês
( ) 3 - Uma vez a cada duas semanas
( ) 4 - Uma vez por semana
( ) 5 - Mais de uma vez por semana
( ) 6 - Todos os dias

**Assistir TV, filmes, séries, Youtube e outros vídeos**
( ) 1 - Algumas vezes por ano
( ) 2 - Uma vez por mês
( ) 3 - Uma vez a cada duas semanas
( ) 4 - Uma vez por semana
( ) 5 - Mais de uma vez por semana
( ) 6 - Todos os dias

**Ouvir música, podcasts e outros áudios**
( ) 1 - Algumas vezes por ano
( ) 2 - Uma vez por mês
( ) 3 - Uma vez a cada duas semanas
( ) 4 - Uma vez por semana
( ) 5 - Mais de uma vez por semana
( ) 6 - Todos os dias

**Jogar videogame e/ou jogos online**
( ) 1 - Algumas vezes por ano
( ) 2 - Uma vez por mês
( ) 3 - Uma vez a cada duas semanas
( ) 4 - Uma vez por semana
( ) 5 - Mais de uma vez por semana
( ) 6 - Todos os dias

PARTE IV - Proficiência autoavaliada

Em uma escala de 1 a 6, indique sua proficiência em inglês:

**Leitura**
( ) 1 - muito baixo ( ) 2 - baixo ( ) 3 - razoável ( ) 4 - bom
( ) 5 - muito bom ( ) 6 - proficiente

**Escrita**
( ) 1 - muito baixo ( ) 2 - baixo ( ) 3 - razoável ( ) 4 - bom
( ) 5 - muito bom ( ) 6 - proficiente

**Compreensão Auditiva**
( ) 1 - muito baixo ( ) 2 - baixo ( ) 3 - razoável ( ) 4 - bom
( ) 5 - muito bom ( ) 6 - proficiente

**Fala**
( ) 1 - muito baixo ( ) 2 - baixo ( ) 3 - razoável ( ) 4 - bom
( ) 5 - muito bom ( ) 6 - proficiente

Há alguma informação que você considere importante mencionar sobre sua experiência com o inglês?
_____
_____

## APPENDIX C – Sentences of Self-Applicable Reading Span Test

1) O comando do exército do país confirmou o lançamento
2) A avenida tem apenas trechos pequenos de pista central
3) O advogado do vereador negou que tenha ocorrido qualquer irregularidade
4) O homem não discutiu publicamente nenhuma conversa que teve com o presidente
5) Neste ano, participantes de vários países tiveram a oportunidade de se apresentar
6) Até o momento o suspeito não foi identificado ou preso
7) Alguns lotes chegaram a alcançar entre mil a dois mil euros
8) Ainda de acordo com o médico, a criança não teve nenhuma sequela
9) A juíza ainda ressaltou os riscos da prática da irregularidade no setor
10) Os presos serão indiciados por associação criminosa, estelionato e lavagem de dinheiro
11) As mulheres já sabem o que querem fazer no futuro
12) Todas as decisões atenderam a pedidos do procurador-geral da república
13) Segundo o policial, entre os mortos estão três meninos e uma menina
14) No decorrer da manhã, parentes e vizinhos devem ser chamados para prestar depoimento
15) Houve ainda um salto nos casos de doenças como malária
16) A população vive constantes racionamentos - entre eles, o de vacinas
17) A antropóloga foi a única eleita na área de humanas
18) O parque disse ter fechado a atração após o acidente
19) Esses dois primeiros pedidos adiariam o depoimento marcado para esta quarta
20) Especula-se na mídia americana que o satélite será usado para missões de inteligência
21) Não há previsão de quando ele vai decidir sobre os pedidos
22) Em razão da marcha, trinta estações de metrô permaneceram fechadas
23) O presidente buscou o sucessor alguns minutos antes na tribuna oficial
24) Eles comunicaram que desejavam fazer uma gravação própria, com som e imagem
25) O último concurso dos Correios foi realizado para nove mil vagas
26) Ele teria recebido ofertas de seis países para abrigar a instituição de ensino
27) Como no resto do país, os ambientalistas têm perdido força
28) O presidente tanzaniano, após o atentado, apresentou suas condolências às famílias
29) A comissão abrirá uma investigação interna para apurar o caso
30) Segundo os policiais, a seita religiosa começou há anos no estado
31) A equipe do jornal não conseguiu localizar as pessoas citadas na reportagem
32) Essa explosão matou duas pessoas e feriu outras quatro, acrescentou
33) O entorno do edifício também terá bloqueios num raio de cem metros
34) A adolescente acabou sendo incluída no programa de proteção do governo
35) O homem caiu no chão e um segundo carro freou próximo ao pedestre
36) O homem morreu devido a um ferimento a bala na cabeça
37) No sábado, eles tiveram o pedido de liberdade negado pela justiça
38) Para o professor, a aproximação americana também poderia ser motivada por interesses econômicos
39) O ministro informou que só vai se manifestar nos autos

40)De acordo com a empresa, o problema já foi corrigido
41)A medida ocorreu às duas, conforme post na internet do centro de operações
42)Já o prefeito pediu desculpas pela ação dos guardas e desejou melhoras
43)A primeira-ministra expressou a mais profunda gratidão ao príncipe
44)O aprendiz também foi morto no acidente, junto a outros três soldados afegãos
45)O último passo é fazer sexo com pessoas do sexo oposto
46)Sua hipnoterapia busca ensinar ao paciente formas adequadas de se comportar e reagir
47)Os confrontos deixaram quase trezentos feridos, incluindo dirigentes da oposição
48)Desde o afastamento dos conselheiros, eles vinham sendo substituídos por auditores
49)Até a publicação da reportagem, nenhum dos acusados tinha advogado constituído no processo
50)Alguns bens podem ser utilizados durante longos períodos, como automóveis e geladeira
51)Houve confronto, mas não há registros de feridos, prisões ou apreensões
52)Foi divulgado nesta manhã os dados da produção industrial em março
53)A moeda norte-americana caiu, negociada a três reais na venda
54)A nota também informa que o empresário não responde a qualquer acusação
55)Só foi possível saber que a carga é um satélite, sem mais detalhes
56)Os autores devem responder por homicídio qualificado e associação criminosa
57)As ações da empresa exibiam queda de dois por cento após o fechamento dos mercados
58)Os cinco feridos foram levados para hospitais próximos, onde estão sendo atendidos
59)A autoria do ataque ainda não foi reivindicada por nenhum grupo
60)As causas e eventuais responsabilidades pelo acidente deverão ser apuradas pela polícia
61)Três pessoas foram encaminhadas para atendimento médico no hospital universitário
62)Todas as aulas e atividades no campus nesta segunda-feira foram canceladas
63)Atualmente, centenas de policiais trabalham para garantir a segurança dentro da comunidade
64)O filme lançou o ator como um dos mais honrados de sua geração
65)O hospital informou que o estado de saúde do rapaz é estável
66)A equipe conversou com o entrevistado sobre os protestos e as possíveis soluções
67)Conforme a prefeitura, duas unidades municipais de ensino funcionaram normalmente
68)As duas maiores empresas de ônibus não operaram na cidade
69)A delegacia de homicídios da capital foi acionada e foi para o local
70)Representantes da empresa não puderam ser contatados para comentar o assunto
71)As centrais sindicais entendem que a mudança fragiliza direitos dos trabalhadores
72)Os juízes estipulam o valor em ações envolvendo danos morais
73)A homologação da rescisão contratual deve ser feita em sindicatos
74)Pesquisas de opinião sugerem que as eleições podem resolver esse problema
75)A economia havia crescido a ritmo de lento no quarto trimestre
76)O homem disse que sente falta de estar atrás do volante
77)Para o pesquisador, do instituto de câncer, a descoberta é significativa
78)São necessários mais testes para confirmar a eficácia do método

79) A mulher, já idosa, é uma dos pacientes participando dos testes
80) O homem foi encaminhado para o hospital e está em observação
81) Cidades de dois estados do sul também amanheceram geladas nesta quinta
82) Eles deixaram as florestas onde vivem em direção às praias
83) O destino é a praia, onde depositam os ovos, sob as ondas
84) Os bebês nascem no mar e depois retornam ao convívio dos pais
85) O entrevistado ainda reforçou que apresentará o recurso assim que houver a publicação
86) Uma aluna diz que, sem o álcool, fica um pouco tímida
87) A sambista passou mal e teve que deixar o cortejo carregada
88) A filha do presidente promoveu isenções fiscais para o cuidado dos filhos
89) Apesar da dificuldade, especialistas acreditam em quatro possíveis desdobramentos
90) A grande pergunta é se o enfrentamento será generalizado ou localizado
91) Há duas possibilidades mais extremas, porém consideradas menos prováveis por analistas
92) Ainda segundo a equipe médica, o senador será reavaliado ao longo da semana
93) O exército ainda não sabe se eles sabiam mesmo nadar
94) Um policial paraguaio que estava em um carro foi morto pelos bandidos
95) Também existe a possibilidade de completar todos os participantes com seleções asiáticas
96) O indicado pelo presidente prometeu exercer o posto com imparcialidade e independência
97) Outros sete adolescentes ficaram feridos no incidente, disseram as autoridades
98) As perguntas que eles fazem podem ser produtos de seus preconceitos sociais
99) O político facilitaria a aprovação de legislação favorável aos interesses da empresa
100) Quase cinquenta milhões de eleitores franceses devem comparecer às urnas
101) O pleito é considerado crucial para definir o futuro da união europeia
102) Por enquanto, nenhuma das duas partes iniciou o processo formal de impugnação
103) O prazo de entrega do imposto de renda vai até final de abril
104) A investigação prossegue na polícia federal em relação a outros fatos
105) Raramente, as expulsões de universidades em Cuba por motivos políticos são tornadas públicas
106) Segundo o comunicado, a jovem não apoia o projeto social cubano
107) Ela acrescenta que não quer permanecer apenas com seu diploma do ensino médio
108) Um outro homem possivelmente ligado ao ataque se entregou à polícia belga
109) Economistas disseram que cerca de metade da proposta original foi diluída
110) Segundo a mulher, proprietária do animal, tudo foi muito rápido
111) O fenômeno foi descrito em uma publicação científica de grande prestígio
112) A técnica poderia ser usada para entender melhor o fenômeno, dizem os pesquisadores
113) Você provavelmente nunca viu a Antártida desta forma: pelos olhos de uma baleia
114) Se for sancionada, a lei terá um prazo de noventa dias de regulamentação
115) Mas agora as imagens finalmente foram liberadas pelo governo americano
116) As explosões ocorreram no deserto e no mar, em plena guerra

117) Ainda não há informações sobre qual dos dois investigados está sendo interrogado primeiro
118) Campanhas eleitorais feitas no Brasil também estão relacionadas nas delações ainda sob sigilo
119) Para não cair neste tipo de golpe, vale lembrar aquelas recomendações de segurança
120) A diferença diminuiu nos últimos dias entre os quatro principais candidatos
121) A contraindicação é para quem tem alergia severa ao alimento
122) O crescimento da economia chinesa pode não ser confirmado nos próximos meses
123) Hoje, adulto, o aluno estuda bioquímica em uma universidade estrangeira
124) O cenário econômico ajuda a entender essa tendência de rebaixamento voluntário do currículo
125) No mês passado, a ONU descreveu a situação dos povos sitiados como catastrófica
126) Na delegacia foi registrado o ato infracional praticado pela mãe da criança
127) Foram vários executivos delatores, que geraram vários pedidos de inquérito
128) Essa fábrica, quando inaugurada, também será o maior edifício do mundo
129) Esse medidor era usado também como referência para calcular o valor dos impostos
130) Numa reunião, as partes selaram a união acertando a taxa de câmbio
131) O registro de candidaturas começou na terça-feira e prosseguirá até sábado
132) Enfrentar a barreira da língua em um país estrangeiro se provou difícil
133) Ao longo da carreira, o atleta recebeu diversos prêmios por seu trabalho
134) Os repasses, disse o delator, eram sempre feitos aos partidos políticos
135) Sua ideia inicial foi ir à farmácia e comprar um colírio simples
136) O IBGE revisou ainda a taxa de janeiro em relação a dezembro
137) A assessoria de imprensa informa que ele não vai se pronunciar
138) Nesta quinta-feira, mais de cinquenta colégios permaneceram fechados, informou o ministério
139) No pedido de prisão, o promotor considerou a soltura um equívoco
140) Os deputados federais citados disseram que não estão envolvidos em esquemas ilegais
141) As drogas são formuladas e licenciadas separadamente para humanos e bichos
142) Gatos também podem sofrer da mesma condição, ainda que isso seja menos comum
143) A assessoria informa que desconhece que o nome dele esteja na lista
144) A compensação, contudo, ainda não foi totalmente paga via tarifa de energia
145) Por segurança, o shopping foi esvaziado e o setor dos cinemas isolado
146) A empresa já começou como fabricante de carros totalmente elétricos
147) O caso é investigado como feminicídio e tentativa de homicídio
148) A maior parte optou que ele ocorresse em dois domingos seguidos
149) O incêndio ocorreu na avenida principal durante um protesto
150) É possível ver pessoas entrando correndo na loja, fugindo para não serem atropeladas
151) Anteriormente, a imprensa havia divulgado que a colisão havia deixado vinte mortos
152) Dos quinze feridos, dois continuavam internados neste domingo, em estado crítico
153) Isto arrastou as potências regionais e internacionais para o conflito, conferindo-lhe outra dimensão

154) A rebelião armada da oposição evoluiu significativamente desde suas origens
155) Um fator chave é a intervenção de potências regionais e internacionais
156) Segundo o secretário, nesses estados haverá ainda rodízio dos fiscais agropecuários
157) Não houve transtorno no trânsito na região por causa do incidente
158) Segundo o secretário, esses produtos foram retirados do mercado e descartados
159) Ele não informou o motivo da abertura do processo contra esses frigoríficos
160) No local, era esperado por uma guarda militar de honra
161) Na avaliação do ministro caracterizaria um privilégio em relação às concorrentes
162) Um porta-voz das forças de segurança disse que o ferido é um gari
163) Os dois policiais foram presos em flagrante por outro crime
164) Nos padrões brasileiros, no entanto, o atleta vestiria tamanhos pequenos durante sua carreira
165) O centro espacial é a principal fonte econômica da região
166) De acordo com o jornal local, sete policiais também ficaram feridos
167) Nenhum corpo foi encontrado nesta quarta-feira, relatou a guarda costeira
168) É neste momento que os pilotos do helicóptero percebem que não podem atacar
169) Atualmente, usinas de dessalinização ao redor do mundo usam membranas feitas com polímeros
170) As oportunidades estão distribuídas em todos os estados e no distrito federal
171) Nos registros do observatório estão duzentos mil homicídios por encomenda
172) As medidas motivaram protestos da oposição e críticas da comunidade internacional
173) Um voo internacional foi adiado em consequência do fechamento temporário das instalações
174) Contado à parte, o segmento de motos recuou muito no mês passado
175) Na quinta-feira, um motociclista morreu após um acidente na marginal
176) Fortalecida pela pressão internacional sobre o governo, a oposição reativou suas manifestações
177) Além da qualidade das frutas, a embalagem também faz diferença
178) Já à noite, o presidente depositou flores na estação em tributo às vítimas
179) O homem lamentou o fato e destacou a atuação da embaixatriz
180) Ao todo, seis sistemas fornecem água para as cidades paulistas

## APPENDIX D – Text used in the Reading Task

### English as a *Lingua Franca*: implications for language policies and pedagogical practices

There are many terms for the use of English worldwide. Here, we use the notion of English as a Lingua Franca (ELF) since it appears to be a broader term that covers translingual situations where people use English to negotiate meanings in one's country and outside of it.

ELF discussions are important for pedagogical practices because they present the constitution of a different view on additional language education. First, an ELF perspective deconstructs the idea of 'proper' or 'legitimate' uses of language, since this idea derives from specific and privileged normative groups. Then, ELF shows that lingua-cultural norms should be understood as always negotiated, and therefore legitimized in specific contexts.

The perspective of ELF also challenges the idea of language ownership. This perspective deconstructs the ideology of native speakers and the naturality of it being considered a linguistic model to be followed. These ideas are the basis for the reorganization of English language teaching.

The native speaker as a goal in the English language use normally represents a western culture and its ideals of English language and methodologies for teaching it. Although ELF is set in a post-modern world, it co-exists, in constant tension, with modernist fictions that commonly shape contemporary pedagogical practices.

An ELF perspective leads us to a view of language as languaging. It is a post-structuralist concept that focuses on the social diversity of speech types, and deconstructs the notion of distinct national languages, bilingualism and multilingualism. The languaging view emphasizes an understanding of different languages based on the way that individuals become social actors and distinguish among themselves through their particular languaging.

Considering the interpretations of some ELF authors, the main objective in learning English is not to achieve a native-speaker proficiency, but to become translingual subjects. This does not mean, however, having the same level of proficiency in the languages they speak. On the contrary, it means being aware of the social, cultural and emotional contexts in which one's various languages have grown, and of the life experiences they evoke.

Here, the notion of translingualism does not refer to a collection of different national languages only, but rather to various socioideological languages, codes and voices in the different contexts where social actors participate. That said, considering the reality of our classrooms, we should recognize our students as subjects whose linguistic repertoires are composed by various (national and socioideological) languages. Our students might use their languages for different purposes, not only for accomplishing

practical communicative goals. In the end, people also use language as a source of pleasure, a puzzle, or a way of understanding oneself and others.

Adapted from: http://www.ufrgs.br/revistabemlegal/vol-7-2017-2/let2019s-talk-about-english-as-a-lingua-franca-elf-a-cycle-of-project-based-task Acess in 31/03/21.

***OS CONCEITOS SUBLINHADOS NO TEXTO FORAM ADICIONADOS COMO JANELAS POP-UP. A definição de cada contexto se encontra abaixo.***

Post-modern: Related to postmodernism. Postmodernism is a philosophical questioning of many of the foundational concepts of received canons of knowledge. In other words, it is the constant problematization of what is usually accepted as true.

Post-structuralism: this perspective views language as an opportunity to negotiate meanings where the context of practice is set as the norm, as opposed to a more static view of language.

Socioideological: it refers to the inseparability of language, happening in society, which carries ideology in it.

Lingua-cultural: related to the inseparability of language and culture of a given language.

Translingual situations: it refers to situations where languages are used in a fluid manner – without named language categories – to make meaning and to communicate.

Bilingualism: the ability to use two languages.

Multilingualism: the ability to use two or more languages.

## APPENDIX E – Comprehension Measures

### TAREFA DE RECORDAÇÃO LIVRE – *WRITEEN FREE RECALL*

Em português, tente escrever tudo o que você lembra do texto lido. Procure utilizar frases completas.

*(caixa de texto para participante escrever)*

### PERGUNTAS DE COMPREENSÃO

Responda às perguntas abaixo de acordo com o texto.

1. De acordo com o texto, como a perspectiva de ILF – Inglês como Língua Franca – aborda os falantes nativos de inglês?

2. Qual é a visão de língua adotada por ILF?

3. Qual é o principal objetivo em aprender inglês, de acordo com a perspectiva abordada no texto?

4. De acordo com o texto, o que significa ser um sujeito translíngue?

5. A perspectiva de ILF desafia o status quo. Como isso se dá, de acordo com o texto?

## APPENDIX F – Retrospective Questionnaire

### PARTE I - SOBRE O EXPERIMENTO ATUAL

As seguintes perguntas se relacionam ao experimento que você acabou de realizar.[57]

Em uma escala de 1 a 6 (1 sendo muito fácil e 6 sendo muito difícil), julgue as tarefas que você acabou de realizar:

Dificuldade do teste de memória

Dificuldade do texto lido

Dificuldade de ler e ouvir música ao mesmo tempo

Dificuldade de lembrar as informações do texto

Dificuldade das perguntas de compreensão

### PARTE II - SOBRE O PERFIL MULTITAREFAS

Quando você lê em inglês, qual é a finalidade da leitura? (Mais de uma resposta pode ser marcada)

a. Prazer
b. Trabalho
c. Estudos
d. Outros
Especifique:

Você ouve música enquanto lê em inglês?
a. Sim. Por quê? _____
b. Não. Por quê? _____
c. Somente em ocasiões específicas.
Cite quais: _____

Em caso afirmativo na pergunta anterior, responda as perguntas a seguir. Em caso negativo, deixe-as em branco.

[57] Este questionário foi montado na plataforma do experimento com 1) botões clicáveis para as perguntas de múltipla escolha; 2) campos de digitação para que participantes adicionem informações adicionais; e 3) botões de escala para as questões que contém escala.

Marque as alternativas que se aplicam a você (mais de uma pode ser marcada).
a. Escuto música enquanto leio por prazer
b. Escuto música enquanto leio para trabalho
c. Escuto música enquanto leio para estudar
d. Outro. Escuto música enquanto leio para _____

Com que frequência você ouve música quando lê por prazer?
*Nunca Raramente Às vezes Frequentemente Sempre*

Com que frequência você ouve música quando lê para o trabalho?
*Nunca Raramente Às vezes Frequentemente Sempre*

Com que frequência você ouve música ao estudar?
*Nunca Raramente Às vezes Frequentemente Sempre*

Outro: Com que frequência você ouve música para _____ (completar com a atividade)
*Nunca Raramente Às vezes Frequentemente Sempre*

Qual seu gênero musical favorito para as seguintes tarefas?

Leitura por prazer
Rock - Pop - Jazz - Clássica - Eletrônica - Samba - Pagode - Sertanejo - Funk - Hip Hop - Gospel - MPB - Indie - K-pop
Outro: _____

Leitura para trabalho
Rock - Pop - Jazz - Clássica - Eletrônica - Samba - Pagode - Sertanejo - Funk - Hip Hop - Gospel - MPB - Indie - K-pop
Outro: _____

Leitura para estudos
Rock - Pop - Jazz - Clássica - Eletrônica - Samba - Pagode - Sertanejo - Funk - Hip Hop - Gospel - MPB - Indie - K-pop
Outro: _____

Que tipo de música você prefere para:
Leitura por prazer
Com letras - Instrumental

Leitura para trabalho
Com letras - Instrumental

Leitura para estudos
Com letras - Instrumental

Você acredita que estuda melhor quando ouve música?
Sim
Não

Você acredita que trabalha melhor quando ouve música?
Sim
Não

**PARTE III - SOBRE A EXPERIÊNCIA MUSICAL**

Você já estudou música formalmente?
Sim
Não

Você toca algum instrumento musical?
Sim
Não

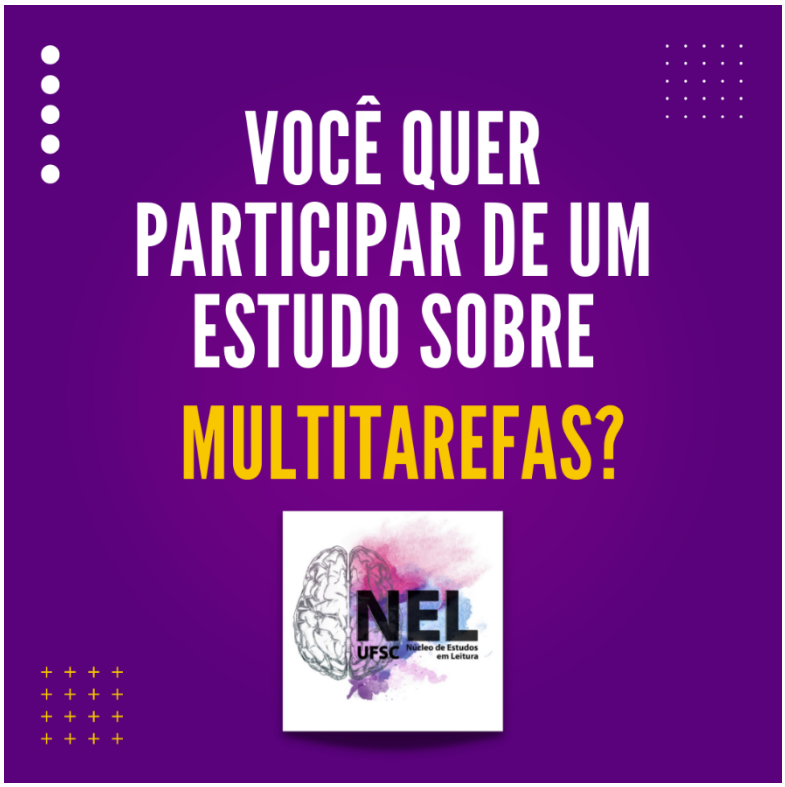
Você canta?
Sim
Não

Existe algum aspecto que você considera importante mencionar sobre sua experiência musical?

Existe algum aspecto que você considera importante mencionar sobre sua escolha musical para leitura?

**APPENDIX G – Invitation via social media**

**Image used on *Instagram* feed**



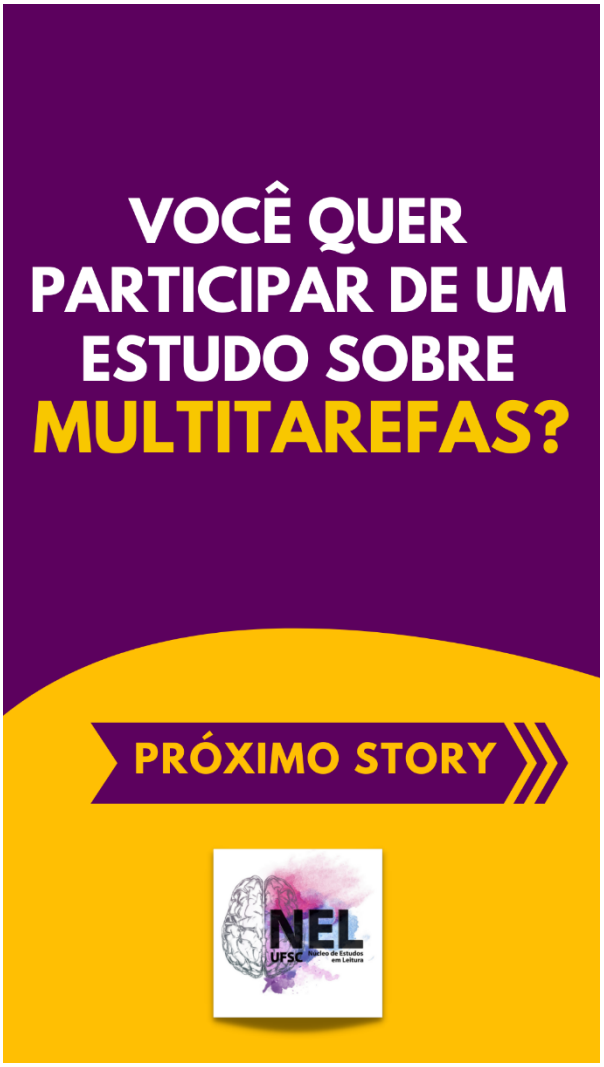

**Text used below the image**

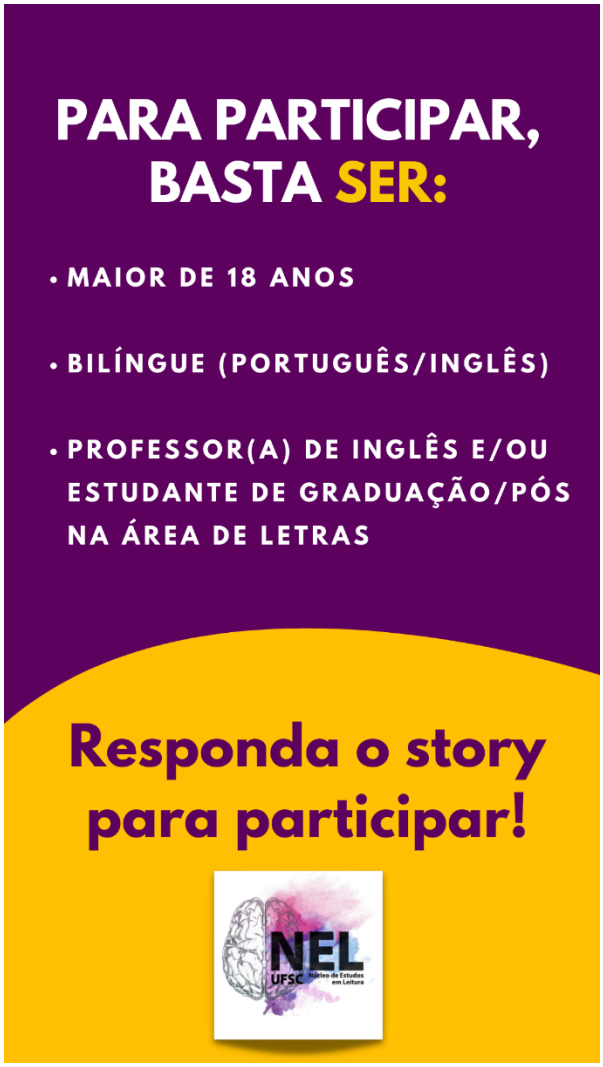
Você quer participar de um experimento sobre multitarefas?
O pesquisador Bruno de Azevedo do Núcleo de Estudos em Leitura da UFSC gostaria de convidar você para participar de uma pesquisa on-line sobre leitura em inglês enquanto você ouve músicas – multitarefas.
Perfil desejado:
- Ser maior de 18 anos;
- Ser proficiente em inglês (falante nativo de português brasileiro);
- Ser professor(a) de inglês e/ou estudante de Letras/Inglês e/ou pós-graduando na área de Letras.

O experimento dura em torno de 50 minutos e você precisará de um computador e fones de ouvido.

Para participar, envie e-mail para bruno_de_azevedo@hotmail.com
Ajude a ciência brasileira e ganhe declaração de participação!

**Image used on *Instagram* stories**



## APPENDIX H – Invitation via e-mail

Olá, (nome do participante)!
Meu nome é Bruno de Azevedo, doutorando do Programa de Pós-Graduação em Inglês da Universidade Federal de Santa Catarina. Faço pesquisa na área de Processamento da Leitura em ambiente Multitarefas sob a orientação da professora Lêda Maria Braga Tomitch (UFSC) e coorientação da professora Ingrid Finger (UFRGS).

**Este e-mail é um convite para sua participação na minha pesquisa** sob o título "A capacidade da memória de trabalho é preditora da performance em multitarefas? Uma investigação da compreensão leitora de bilíngues na leitura de hipertexto ao escutar música", aprovada pelo Comitê de Ética em Pesquisas com Seres Humanos da Universidade Federal de Santa Catarina.

Para entender as tarefas deste estudo você poderá: 1) assistir ao tutorial no Youtube no link https://youtu.be/aT44CHlS958 **ou** 2) ler o tutorial no link http://bit.ly/Tutorial-Experimento-Bruno

**Caso aceite participar, peço que realize o experimento no link abaixo** e faça o download e leitura do Termo de Consentimento Livre e Esclarecido (TCLE) disponível em https://bit.ly/TCLE-NEL. Guarde seu TCLE pois este assegura seus direitos enquanto participante desta pesquisa, aprovada pelo Comitê de Ética em Pesquisas com Seres Humanos da Universidade Federal de Santa Catarina.

**Link do Experimento: (link do experimento)**

Se tiver alguma dúvida, entre em contato comigo através deste e-mail, ou WhatsApp **(link do WhatsApp)**

Agradeço desde já sua disponibilidade para contribuir com a ciência brasileira!

Atenciosamente,

## APPENDIX I – E-mail after acceptance (via social media)

Olá, (nome do participante)!
Agradeço seu interesse em participar do meu estudo de doutorado cujo objetivo é investigar se a capacidade de memória de trabalho de bilíngues proficientes é preditora da performance em multitarefas. Abaixo seguem algumas informações importantes.

Para entender as tarefas deste estudo você poderá: 1) assistir ao tutorial no Youtube no link https://youtu.be/aT44CHlS958 **ou** 2) ler o tutorial no link http://bit.ly/Tutorial-Experimento-Bruno

**Caso aceite participar, peço que realize o experimento no link abaixo** e faça o download e leitura do Termo de Consentimento Livre e Esclarecido (TCLE) disponível em https://bit.ly/TCLE-NEL. Guarde seu TCLE pois este assegura seus direitos enquanto participante desta pesquisa, aprovada pelo Comitê de Ética em Pesquisas com Seres Humanos da Universidade Federal de Santa Catarina.

**Link do Experimento:**

Se tiver alguma dúvida, entre em contato comigo através deste e-mail ou por WhatsApp **(link do WhatsApp)**

Agradeço desde já sua disponibilidade para contribuir com a ciência brasileira!

Atenciosamente,

## APPENDIX J – Idea Units

( ) English as a *Lingua Franca*:
( ) implications for language policies
( ) and pedagogical practices

( ) **There are** many terms for the use of English worldwide.
( ) Here, we **use** the notion of English as a Lingua Franca (ELF)
( ) since it **appears to be** a broader term
( ) that **covers** translingual situations
( ) where people **use** English
( ) to **negotiate** meanings in one's country and outside of it.

( ) ELF discussions **are** important for pedagogical practices
( ) because they **present** the constitution of a different view on additional language education.
( ) First, an ELF perspective **deconstructs** the idea of 'proper' or 'legitimate' uses of language,
( ) since this idea **derives** from specific and privileged normative groups.
( ) Then, ELF **shows** that lingua-cultural norms **should** be understood as always negotiated,
( ) and therefore **legitimized** in specific contexts.

( ) The perspective of ELF also **challenges** the idea of language ownership.
( ) This perspective deconstructs the ideology of native speakers
( ) and the naturality of it being considered a linguistic model to be followed.
( ) These ideas are the basis for the reorganization of English language teaching.

( ) The native speaker as a goal in the English language use normally **represents** a western culture
( ) and its ideals of English language
( ) and methodologies for teaching it.

( ) Although ELF **is set** in a post-modern world,
( ) it **co-exists**, in constant tension, with modernist fictions
( ) that commonly **shape** contemporary pedagogical practices.

( ) An ELF perspective **leads** us to a view of language as languaging.
( ) It **is** a post-structuralist concept
( ) that **focuses** on the social diversity of speech types,
( ) and **deconstructs** the notion of distinct national languages,
( ) bilingualism
( ) and multilingualism.
( ) The languaging view **emphasizes** an understanding of different languages

(  ) based on the way that individuals become social actors
(  ) and distinguish among themselves through their particular languaging.

(  ) Considering the interpretations of some ELF authors,
(  ) the main objective in learning English **is** not to achieve a native-speaker proficiency,
(  ) but to become translingual subjects.
(  ) This does not mean, however,
(  ) **having** the same level of proficiency in the languages they speak.
(  ) On the contrary, it **means** being aware of the social,
(  ) cultural
(  ) and emotional contexts
(  ) in which one's various languages have grown,
(  ) and of the life experiences they evoke.

(  ) Here, the notion of translingualism **does not refer** to a collection of different national languages only,
(  ) but rather to various socioideological languages,
(  ) codes
(  ) and voices
(  ) in the different contexts where social actors participate.
(  ) That said, considering the reality of our classrooms,
(  ) we should **recognize** our students as subjects
(  ) whose linguistic repertoires are composed by various (national and socioideological) languages.
(  ) Our students **might use** their languages for different purposes,
(  ) not only for accomplishing practical communicative goals.
(  ) In the end, people also use language as a source of pleasure,
(  ) a puzzle,
(  ) or a way of understanding oneself and others.

Adapted from: http://www.ufrgs.br/revistabemlegal/vol-7-2017-2/let2019s-talk-about-english-as-a-lingua-franca-elf-a-cycle-of-project-based-task Acess in 31/03/21.

## APPENDIX L – Rated idea units

| RATER #1 | RATER #2 | RATER #3 | RATER #4 | RATER #5 | OUTCOME | AGREEMENT |
|---|---|---|---|---|---|---|
| MI | MI | MI | MI | MI | **MI** | |
| S | MI | MI | MI | S | **MI** | |
| S | MI | MI | MI | S | **MI** | |
| S | D | D | S | D | **D** | |
| MI | S | MI | MI | MI | **MI** | |
| D | D | D | D | S | **D** | |
| MI | S | S | D | MI | **error** | **S** |
| MI | S | S | D | MI | **error** | **S** |
| MI | S | D | D | MI | **error** | **MI** |
| S | S | MI | MI | D | **error** | **MI** |
| S | S | S | S | MI | **S** | |
| S | S | MI | MI | S | **S** | |
| S | D | S | S | D | **S** | |
| S | S | S | S | S | **S** | |
| S | D | D | D | S | **D** | |
| S | D | MI | MI | MI | **MI** | |
| D | S | S | S | S | **S** | |
| D | S | S | S | S | **S** | |
| S | S | S | S | D | **S** | |
| S | S | S | MI | S | **S** | |
| D | D | D | S | D | **D** | |
| D | D | S | S | D | **D** | |
| S | S | D | D | S | **S** | |
| S | S | D | MI | S | **S** | |
| S | S | S | D | S | **S** | |
| S | S | MI | MI | MI | **MI** | |
| S | S | D | S | S | **S** | |
| S | S | S | S | S | **S** | |
| D | S | S | S | D | **S** | |
| D | S | D | S | D | **D** | |
| D | S | D | S | D | **D** | |
| S | S | D | S | S | **S** | |
| S | S | D | D | S | **S** | |

| | | | | | | |
|---|---|---|---|---|---|---|
| S | S | D | D | S | **S** | |
| D | S | D | D | D | **D** | |
| S | S | MI | MI | S | **S** | |
| S | S | S | MI | MI | **S** | |
| S | D | D | D | S | **D** | |
| S | D | S | D | S | **S** | |
| S | S | S | S | MI | **S** | |
| D | S | D | S | D | **D** | |
| D | S | D | S | D | **D** | |
| D | S | D | S | MI | **error** | **D** |
| S | S | D | S | MI | **S** | |
| S | S | S | MI | S | **S** | |
| S | S | MI | MI | MI | **MI** | |
| D | S | D | MI | D | **D** | |
| D | S | D | MI | D | **D** | |
| D | D | S | MI | MI | **error** | **D** |
| S | S | MI | D | S | **S** | |
| S | S | S | S | MI | **S** | |
| S | S | S | S | MI | **S** | |
| MI | S | MI | MI | MI | **MI** | |
| MI | S | S | D | S | **S** | |
| S | D | S | S | S | **S** | |
| D | D | D | S | D | **D** | |
| S | D | D | S | D | **D** | |

## APPENDIX M – Descriptive Statistics

| Condition | Variable | Mean | SE |
|---|---|---|---|
| Control | 1 Working Memory Capacity (Lenient) | 44.9000 | 1.6872 |
| Experimental | 1 Working Memory Capacity (Lenient) | 42.5294 | 1.6073 |
| Control | 2 Working Memory Capacity (Strict) | 3.6500 | 0.2423 |
| Experimental | 2 Working Memory Capacity (Strict) | 3.2353 | 0.2428 |
| Control | 3 Literal Comprehension | 0.6509 | 0.0382 |
| Experimental | 3 Literal Comprehension | 0.6601 | 0.0379 |
| Control | 4 Inferential Comprehension | 0.5903 | 0.0453 |
| Experimental | 4 Inferential Comprehension | 0.6140 | 0.0351 |
| Control | 5 Recall (Main Ideas) | 4.0667 | 0.3743 |
| Experimental | 5 Recall (Main Ideas) | 3.5000 | 0.3250 |
| Control | 6 Recall (Secondary Ideas) | 9.2667 | 1.0547 |
| Experimental | 6 Recall (Secondary Ideas) | 6.2059 | 0.7087 |
| Control | 7 Recall (Details) | 3.8333 | 0.5893 |
| Experimental | 7 Recall (Details) | 1.7353 | 0.2810 |

Source: the author.

## APPENDIX N – Correlations between self-reported proficiency and linguistic experience (contributing factors)

**Table N1 - Correlations between self-reported proficiency and linguistic experience (contributing factors - Pearson's Coefficient)**

Source: the author.

**Table N2 - Correlations between self-reported proficiency and linguistic experience (contributing factors - Spearman's Coefficient)**

Source: the author.

## APPENDIX O – Correlations between self-reported proficiency and linguistic experience (frequency of activities)

### Table O1 - Correlations between self-reported proficiency and linguistic experience (frequency of activities - Pearson's Coefficient)

| Activity | Reading | Writing | Listening | Speaking |
|---|---|---|---|---|
| Speak with family | -0.08 | 0.15 | 0.20 | 0.25 |
| Speak with friends | -0.01 | 0.18 | 0.07 | 0.01 |
| Speak at work/university | **0.32*** | **0.55*** | 0.24 | **0.39*** |
| Read/Write at work/university | **0.34*** | **0.39*** | 0.24 | 0.20 |
| Read printed material | 0.18 | **0.36*** | 0.14 | **0.28*** |
| Read onscreen | **0.38*** | **0.31*** | **0.28*** | 0.22 |
| Read social media | 0.12 | 0.13 | 0.10 | 0.04 |
| Write in general | **0.31*** | **0.44*** | 0.20 | **0.40*** |
| Watching TV/Streaming | **0.38*** | **0.30*** | 0.18 | 0.09 |
| Listening to music/podcasts | 0.00 | 0.00 | 0.04 | 0.02 |
| Playing games | 0.13 | 0.18 | 0.13 | 0.07 |

Source: the author.

**Table O2 - Correlations between self-reported proficiency and linguistic experience (frequency of activities - Spearman's Coefficient)**

| Activity | Reading | Writing | Listening | Speaking |
|---|---|---|---|---|
| Speak with family | -0.19 | 0.05 | 0.11 | 0.16 |
| Speak with friends | 0.05 | 0.14 | 0.09 | -0.06 |
| Speak at work/university | **0.36*** | **0.52*** | **0.37*** | **0.39*** |
| Read/Write at work/university | **0.41*** | **0.48*** | **0.31*** | **0.29*** |
| Read printed material | 0.15 | **0.34*** | 0.13 | 0.21 |
| Read onscreen | **0.26*** | 0.24 | 0.12 | 0.12 |
| Read social media | 0.16 | 0.19 | 0.06 | 0.11 |
| Write in general | **0.34*** | **0.41*** | **0.30*** | **0.39*** |
| Watching TV/Streaming | **0.36*** | **0.26*** | **0.33*** | 0.20 |
| Listening to music/podcasts | 0.02 | 0.00 | 0.05 | 0.02 |
| Playing games | 0.17 | 0.21 | 0.20 | 0.06 |

Source: the author.

## APPENDIX P – Factors of Self-Reported Proficiency and Linguistic Experience that predict Comprehension

**Table P1 – Predictions of Literal Comprehension (Lenient)**

| Names | β | p | 95% CI |
|---|---|---|---|
| Intercept | 0.8600 | 0.0384 | [0.066, 1.7] |
| WMC (Lenient) | 0.0032 | 0.4950 | [-0.0059, 0.012] |
| Condition | 0.1700 | 0.5520 | [-0.39, 0.73] |
| Contributing factors | -0.0330 | 0.4050 | [-0.11, 0.045] |

| | | | |
|---|---|---|---|
| Frequency of activities | 0.0140 | 0.7640 | [-0.078, 0.11] |
| Self-rate proficiency | -0.0380 | 0.4090 | [-0.13, 0.052] |
| Age of onset | -0.0046 | 0.5840 | [-0.021, 0.012] |
| Age of fluency | -0.0028 | 0.7030 | [-0.017, 0.012] |
| Interaction WMC and Condition | -0.0032 | 0.6190 | [-0.016, 0.0093] |

Source: the author.

**Table P2 – Predictions of Literal Comprehension (Strict)**

| Names | β | p | 95% CI |
|---|---|---|---|
| Intercept | 1.0000 | 0.00383 | [0.36, 1.7] |
| WMC (Strict) | 0.0110 | 0.74100 | [-0.052, 0.073] |
| Condition | 0.1500 | 0.36000 | [-0.17, 0.47] |
| Contributing factors | -0.0380 | 0.34500 | [-0.12, 0.04] |
| Frequency of activities | 0.0057 | 0.90200 | [-0.085, 0.096] |
| Self-rated proficiency | -0.0350 | 0.44100 | [-0.12, 0.054] |
| Age of onset | -0.0060 | 0.46900 | [-0.022, 0.01] |
| Age of fluency | -0.0032 | 0.66000 | [-0.018, 0.011] |
| Interaction WMC and Condition | -0.0350 | 0.42000 | [-0.12, 0.049] |

Source: the author.

**Table P3 – Predictions of Inferential Comprehension (Lenient)**

| Names | β | p | 95% CI |
|---|---|---|---|
| Intercept | -0.42000 | 0.29900 | [-1.2, 0.36] |
| WMC (Lenient) | 0.01200 | 0.00991 | [0.0032, 0.021] |
| Condition | 0.34000 | 0.23300 | [-0.21, 0.89] |
| Contributing factors | 0.04500 | 0.25300 | [-0.032, 0.12] |
| Frequency of activities | 0.01800 | 0.70600 | [-0.073, 0.11] |
| Self-rated proficiency | 0.02900 | 0.52200 | [-0.059, 0.12] |
| Age of onset | -0.00089 | 0.91300 | [-0.017, 0.015] |
| Age of fluency | 0.00520 | 0.47900 | [-0.0091, 0.02] |
| Interaction WMC and Condition | -0.00750 | 0.23700 | [-0.02, 0.0048] |

Source: the author.

**Table P4 – Predictions of Inferential Comprehension (Strict)**

| Names | β | p | 95% CI |
|---|---|---|---|
| Intercept | 0.0200 | 0.9530 | [-0.65, 0.69] |
| WMC (Strict) | 0.0790 | 0.0163 | [0.017, 0.14] |
| Condition | 0.3400 | 0.0422 | [0.019, 0.66] |
| Contributing factors | 0.0390 | 0.3320 | [-0.039, 0.12] |
| Frequency of activities | -0.0094 | 0.8400 | [-0.1, 0.081] |
| Self-rated proficiency | 0.0290 | 0.5270 | [-0.06, 0.12] |
| Age of onset | -0.0030 | 0.7220 | [-0.019, 0.013] |
| Age of fluency | 0.0033 | 0.6540 | [-0.011, 0.018] |
| Interaction WMC and Condition | -0.0920 | 0.0363 | [-0.18, -0.008] |

Source: the author.

**Table P5 – Predictions of Main Ideas Recall (Lenient)**

| Names | β | p | 95% CI |
|---|---|---|---|
| Intercept | -4.40000 | 0.1980 | [-11, 2.2] |
| WMC (Lenient) | 0.05900 | 0.1320 | [-0.017, 0.13] |
| Condition | -0.75000 | 0.7550 | [-5.4, 3.9] |
| Contributing factors | 0.60000 | 0.0768 | [-0.052, 1.2] |
| Frequency of activities | 0.55000 | 0.1680 | [-0.22, 1.3] |
| Self-rated proficiency | 0.27000 | 0.4720 | [-0.47, 1] |
| Age of onset | 0.00130 | 0.9850 | [-0.13, 0.14] |
| Age of fluency | 0.00740 | 0.9060 | [-0.11, 0.13] |
| Interaction WMC and Condition | 0.00043 | 0.9930 | [-0.1, 0.1] |

Source: the author.

**Table P6 – Predictions of Main Ideas Recall (Strict)**

| Names | β | p | 95% CI |
|---|---|---|---|
| Intercept | -1.6000 | 0.578 | [-7.3, 4.1] |
| WMC (Strict) | 0.3800 | 0.170 | [-0.16, 0.91] |
| Condition | 0.7000 | 0.615 | [-2, 3.4] |
| Contributing factors | 0.5300 | 0.127 | [-0.14, 1.2] |
| Frequency of activities | 0.3200 | 0.413 | [-0.45, 1.1] |
| Self-rated proficiency | 0.2800 | 0.471 | [-0.48, 1] |
| Age of onset | -0.0130 | 0.856 | [-0.15, 0.13] |
| Age of fluency | -0.0098 | 0.876 | [-0.13, 0.11] |
| Interaction WMC and Condition | -0.4100 | 0.275 | [-1.1, 0.32] |

Source: the author.

**Table P7 – Predictions of Secondary Ideas Recall (Lenient)**

| Names | β | p | 95% CI |
|---|---|---|---|
| Intercept | -8.800 | 0.3100 | [-26, 8] |
| **WMC (Lenient)** | **0.200** | **0.0427** | **[0.011, 0.39]** |
| Condition | -2.000 | 0.7400 | [-14, 9.8] |
| **Contributing factors** | **1.700** | **0.0440** | **[0.086, 3.4]** |
| Frequency of activities | 1.100 | 0.2750 | [-0.85, 3] |
| Self-rated proficiency | -0.360 | 0.7110 | [-2.2, 1.5] |
| Age of onset | -0.130 | 0.4490 | [-0.47, 0.21] |
| Age of fluency | 0.090 | 0.5680 | [-0.22, 0.4] |
| Interaction WMC and Condition | -0.027 | 0.8380 | [-0.29, 0.23] |

Source: the author.

**Table P8 – Predictions of Secondary Ideas Recall (Strict)**

| Names | β | p | 95% CI |
|---|---|---|---|
| Intercept | -0.810 | 0.9130 | [-15, 14] |
| WMC (Strict) | 1.400 | 0.0480 | [0.043, 2.8] |
| Condition | 0.620 | 0.8620 | [-6.3, 7.5] |

| | | | |
|---|---|---|---|
| Contributing factors | 1.600 | 0.0652 | [-0.068, 3.3] |
| Frequency of activities | 0.530 | 0.6000 | [-1.4, 2.5] |
| Self-rated proficiency | -0.410 | 0.6810 | [-2.4, 1.5] |
| Age of onset | -0.160 | 0.3820 | [-0.51, 0.19] |
| Age of fluency | 0.039 | 0.8050 | [-0.27, 0.35] |
| Interaction WMC and Condition | -1.100 | 0.2620 | [-2.9, 0.77] |

Source: the author.

**Table P9 – Predictions of Details Recall (Lenient)**

| Names | β | p | 95% CI |
|---|---|---|---|
| Intercept | -3.000 | 0.4810 | [-11, 5.3] |
| **WMC (Lenient)** | **0.120** | **0.0197** | **[0.021, 0.21]** |
| Condition | 1.800 | 0.5420 | [-4, 7.7] |
| **Contributing factors** | **0.960** | **0.0243** | **[0.15, 1.8]** |
| Frequency of activities | 0.410 | 0.4030 | [-0.55, 1.4] |
| Self-rated proficiency | -0.530 | 0.2700 | [-1.5, 0.4] |
| Age of onset | -0.130 | 0.1430 | [-0.3, 0.041] |
| Age of fluency | 0.030 | 0.7020 | [-0.12, 0.18] |
| Interaction WMC and Condition | -0.089 | 0.1820 | [-0.22, 0.04] |

Source: the author.

**Table P10 – Predictions of Details Recall (Strict)**

| **Names** | **β** | **p** | **95% CI** |
|---|---|---|---|
| Intercept | 0.590 | 0.8680 | [-6.4, 7.6] |
| **WMC (Lenient)** | **0.790** | **0.0213** | **[0.14, 1.5]** |
| Condition | 0.960 | 0.5730 | [-2.4, 4.3] |
| **Contributing factors** | **0.940** | **0.0288** | **[0.12, 1.8]** |
| Frequency of activities | 0.220 | 0.6510 | [-0.73, 1.2] |
| Self-rated proficiency | -0.540 | 0.2620 | [-1.5, 0.4] |
| Age of onset | -0.140 | 0.1070 | [-0.31, 0.028] |
| Age of fluency | 0.016 | 0.8330 | [-0.13, 0.17] |
| Interaction WMC and Condition | -0.870 | 0.0603 | [-1.8, 0.019] |

Source: the author.