UNIVERSIDADE FEDERAL DE SANTA CATARINA
CENTRO DE COMUNICAÇÃO E EXPRESSÃO - CCE
PROGRAMA DE PÓS-GRADUAÇÃO EM INGLÊS – ESTUDOS LINGUÍSTICOS E LITERÁRIOS

Juliana do Amaral

Look how I navigate:

Video models as a potential tool to foster processing, learning, and misconception change when reading multiple documents in English (L2)

Florianópolis
2023

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Tese submetida ao Programa de Pós-Graduação em Inglês – Estudos Linguisticos e Literários da Universidade Federal de Santa Catarina como requisito parcial para a obtenção do título de Doutora em Letras.

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Florianópolis
2023

do Amaral, Juliana
Look how I navigate : Video models as a potential tool to foster processing, learning, and misconception change when reading multiple documents in English (L2) / Juliana do Amaral ; orientadora, Lêda Maria Braga Tomitch, coorientadora, Ladislao Salmerón, 2023.
180 p.

Tese (doutorado) - Universidade Federal de Santa Catarina, Centro de Comunicação e Expressão, Programa de Pós-Graduação em Inglês: Estudos Linguísticos e Literários, Florianópolis, 2023.

Inclui referências.

1. Inglês. 2. competências digitais. 3. vídeos modelo. 4. leitura em L2. 5. compreensão de textos múltiplos. I. Tomitch, Lêda Maria Braga. II. Salmerón, Ladislao . III. Universidade Federal de Santa Catarina. Programa de Pós-Graduação em Inglês: Estudos Linguísticos e Literários. IV. Título.

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O presente trabalho em nível de Doutorado foi avaliado e aprovado, em 27 de outubro de 2023, pela banca examinadora composta pelos seguintes membros:

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Certificamos que esta é a versão original e final do trabalho de conclusão que foi julgado adequado para obtenção do título de Doutora em Letras.

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Profa. Lêda Maria Braga Tomitch, Dra. – Orientadora

Florianópolis, 2023.

To my dear Felipe M. M.

ACKNOWLEDGMENTS

This study would not have been possible without the collaboration of the many people involved with its development. First, I owe a lot to my advisor professor Lêda Tomitch for having accepted me as her advisee since the masters without knowing me (how risky!) and for guiding me throughout this long journey of my doctoral studies. Lêda is the one who has introduced me to the world of research in reading and its possibilities; her attentive, critical feedback helped me develop my academic writing and analytic skills. She is also a very sensitive person who will understand your problems and be supportive at hard times.

I am also in debt to my coadvisor, professor Ladislao Salmerón, who kindly welcomed me in Valencia and supported my research endeavors throughout my stay, discussing the study design in meetings, helping with the conception of the instruments, and making available the eye tracking laboratory. I have learned a lot from his commitment to excellence in research, his criticism and his sharp and insightful comments on my work. I also thank Laura Royo for her technical support with SMI software, Pablo Delgado for his help with the edition of the EMMEs, Nadia Gomez-Merino for teaching me how to use the eye-tracker, and Anastasia for her kind assistance with data collection. Having the support of this highly qualified Spanish team made all the difference to this study; I learned a lot from each one of you guys. Last, my deepest gratitude to all the Spanish undergraduate and graduate students who dedicated almost two hours of their time to participate in the study, and to Adriana, Anastasia, Claudia, Diana, Giacomo and Mario for their help with the pilot study.

I am deeply grateful for the technical assistance provided by Davi Alves de Oliveira, who generously and patiently spent countless hours in online meetings with me running statistical models, constructing diagrams, and much more. Your help with the analysis was nothing but crucial, Davi! In sum, thank you to all the colleagues of my study group Núcleo de Estudos em Leitura (NEL) for sharing thoughts and concerns even through the hard times of the pandemic: Bruno (who is also a publishing partner), Claudia (for the help with rating), Sidnei, and Tatiana.

I would also like to express my gratitude to the highly qualified professors who kindly accepted the invitation to compose the reviewer committee of this doctoral dissertation: Mônica Macedo-Rouet (Cergy Paris Université), Marcus Maia (UFRJ), Donesca Xhafaj, and Leonilda Procailo (UNICENTRO). I have had the chance to meet professor Mônica at EARLI 2023 in Thessaloniki; I strongly admire her work and her efforts in building connections between theory and classroom interventions aimed at developing students' web evaluation skills.

I had first had contact with the use of eye movement data to diagnose and inform interventions in the basic education context through the work of professor Marcus Maia; his book *Psicolinguística e metacognição na escola* (2019) gave me many insights into how research in psycholinguistics can serve educational needs. Professor Donesca Xhafaj was one of the first professors of the department I have had the chance to meet when I was starting in the program as a special student. She had always been very easy to reach and very sensitive.

To all the friends who encouraged me to persevere, who listened to my concerns and gave me wise advice, Mariana, Liliane, Marília, Andrea, thank you for every moment shared. Also to my family for believing in me and understanding my short weekend visits, thank you for the unconditional support. Special thanks to my dear Felipe for the emotional support; sharing the path of our doctoral studies has made it lighter. You were a patient listener, a careful reviewer, a partner of so many hours of writing.

Last but not least important, I would like to thank CAPES (Coordenação de Aperfeiçoamento do Ensino Superior) for granting me not just one but two scholarships which covered my basic living expenses during the last four years, including a crucial six-month predoctoral period at University of Valencia (Spain). May many more researchers after me have the necessary financial support to fully dedicate to their studies; may research thrive again in Brazil after the dark times of misinformation, scientific negationism, and attacks to public universities.

RESUMO

Com o aumento do uso da internet para consultas informais e aprendizado, a questão de como os leitores navegam por hiperlinks em busca de informações, como avaliam a confiabilidade das fontes e como integram informações de múltiplos documentos - que podem apresentar alegações repetidas, contraditórias ou até mesmo falsas - tornou-se de suma importância. Nesse cenário, modelos de vídeo surgem como uma ferramenta para promover processos de autorregulação na leitura online. Exemplos de modelagem de movimentos oculares (EMMEs) são as gravações dos movimentos oculares de um especialista capturados por um rastreador ocular durante a execução de uma tarefa de aprendizado. Eles são usados para modelar a atenção e os procedimentos da tarefa. Os EMMEs usados neste estudo modelaram a competência de navegação (fixação nas características da SERP - página de resultados do mecanismo de busca - e inspeção de todos os resultados da SERP); a competência de avaliação foi abordada modelando a fixação nas características da fonte (banner do site, logotipo, nome do autor e posição) e a alocação estratégica de tempo (por exemplo, abandonar rapidamente uma fonte não confiável). Embora estudos tenham investigado o desenvolvimento dessas competências digitais em L1, as investigações no contexto de leitura em L2 são escassas. Este estudo buscou investigar a eficácia dos EMMEs como uma ferramenta para promover os processos de navegação e avaliação. A hipótese era de que esse efeito seria mediado pelo nível de L2 e pelo comportamento estratégico autorreportado. Também hipotetizamos um efeito estendido dos EMMEs nos resultados de aprendizado (medidos pelas pontuações de argumentação em uma tarefa de escrita), memória das fontes (medida em uma tarefa de memória da fonte) e mudança de concepção (medida pela diferença entre as pontuações no pré e pós-teste). Presumiu-se que o efeito dos EMMEs na aprendizagem seria mediado pelas medidas de processamento (navegação e avaliação) e por L2. Os participantes (N=57) eram estudantes de graduação e pós-graduação de uma universidade espanhola. Eles fizeram um teste de nível de L2 e tiveram suas crenças prévias em estilos de aprendizagem avaliadas. Em seguida, foram designados para as condições experimental (EMME) ou controle (vídeo instrucional sem EMME). Depois, os participantes leram textos sobre estilos de aprendizagem (LS) enquanto seus movimentos oculares eram registrados. As páginas da web que corroboravam os LS foram manipuladas para serem percebidas como não confiáveis (por exemplo, página comercial, blog pessoal), enquanto as páginas confiáveis (por exemplo, revista científica) refutavam a concepção errônea. Por fim, os participantes escreveram um ensaio, responderam uma tarefa de memória da fonte e um pós-teste para verificar a persistência (ou atualização) das crenças prévias. Resultados das análises de regressão linear indicaram que os EMMEs tiveram um efeito positivo na navegação (aumento da fixação na SERP) e na avaliação (menos fixações totais em páginas não confiáveis), embora nenhum efeito na fixação nas características da fonte tenha sido observado. Não foram encontrados efeitos diretos ou indiretos dos EMMEs nas pontuações da redação e da memória da fonte; no entanto, a navegação mediou o efeito dos EMMEs na mudança de concepção. Nível de L2 foi um preditor significativo das fixações nas páginas da web, pontuações da redação, memória da fonte, e da mudança de concepção. Em geral, os resultados apoiam efeitos mais robustos dos EMMEs no processamento do que na aprendizagem no contexto de L2; mais estudos são necessários para explorar a eficácia dessa ferramenta na mudança de concepção.

Palavras-chave: competências digitais; vídeos modelo; leitura em L2; compreensão de textos múltiplos.

ABSTRACT

With the increasing use of the internet for informal inquiry and learning, the issue of how readers navigate through hypermedia when seeking for information, how they evaluate the trustworthiness of sources, and how they integrate information from multiple documents – which might present overlapping, contradictory or even untrue claims – has become of paramount importance. In this scenario, video models arise as a tool to foster self-regulation processes in online reading. Eye-movement modeling examples (EMMEs) are the recordings of an expert's eye movements captured by an eye tracker during performance on a learning task. They are used to model attention and task procedures. The EMMEs used in this study modeled the navigation competence (fixation on the features of the SERP – search engine results page – and inspection of all SERP results); the evaluation competence was approached by modeling fixation on source features (website banner, logo, author's name and position) and strategic allocation of time (e.g., quickly abandoning an unreliable source). Although studies have investigated the development of these digital competences in L1, investigations in the L2 reading context are scarce. This study sought to investigate the effectiveness of EMMEs as a tool to foster navigation and evaluation processes. This effect was hypothesized to be mediated by L2 level and self-reported strategic behavior. We also hypothesized an extended effect of EMMEs on learning outcomes (measured by argumentation scores on an essay task), memory for the sources (measured in a source memory task), and misconception change (measured by the difference between scores on pre and posttest). The effect of EMMEs on learning was assumed to be mediated by the processing measures (navigation and evaluation) and by L2. Participants (N=57) were undergraduate and graduate students from a Spanish university. They answered an L2 level test had prior beliefs in Learning styles assessed. Next, they were assigned to the experimental (EMME) or control (instructional video without EMME) conditions. Afterwards, participants read texts about Learning styles (LS) while their eye movements were recorded. The web pages that corroborated LS were manipulated to be perceived as unreliable (e.g., commercial page, personal blog), whereas the reliable pages (e.g., scientific journal) refuted the misconception. Last, participants wrote an essay, answered a source memory task and a posttest to check for persistence (or update) of prior beliefs. Results from linear regression analyses indicated that EMMEs had a positive effect on navigation (increased fixation on the SERP), and evaluation (less total fixations on non-reliable pages), although no effects on fixation on source features were observed. Neither direct nor indirect effects of EMMEs were found on essay and source memory scores; nonetheless, navigation mediated the effect of EMMEs on misconception change. L2 level was a significant predictor of fixations on the webpages, essay and source memory scores, and misconception change. Overall, findings support more robust effects of EMMEs on processing than learning in the L2 context; more studies are needed to explore the effectiveness of this tool on misconception change.

Keywords: digital competencies; video models; L2 reading; multiple document comprehension.

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LIST OF ABBREVIATIONS AND ACRONYMS

AOIs – Areas of Interest

C-I – Construction-Integration model

COVID-19 – Corona virus disease

CSI – Content-source integration model

D-ISC – Discrepancy-induced source comprehension model

DMF – Documents model framework

EEG – electroencephalogram

EMMEs – Eye-movement modeling examples

ERI – Estructura de Recerca Interdisciplinar en Lectura (UV)

IBGE – Instituto Brasileiro de Geografia e Estatística

IQ – Intelligence quotient

LER – Laboratório de Eletrofisiologia e Rastreamento Ocular (UFRJ)

L2 – Second or additional language

MARSI – Metacognitive Awareness of Reading Strategies Inventory

OSORS – Online Survey of Reading Strategies

PISA – Program for International Students Assessment

SERP – Search engine results page

SLORSI – Second Language Online Reading Strategies Inventory

SRL – Self-regulated learning

STEM – Science, technology, Engineering and Math

VARK – visual, auditory, reading/writing, kinesthetic

WM – Working memory

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1 INTRODUCTION

Just as printing made everyone a potential reader,
today digitalisation is making everyone into a potential author.
But how long did it take until everyone was able to read?"

Habermas, *Reflections and Hypotheses on a Further*
Structural Transformation of the Political Public Sphere

The rise of new technologies and in particular the fast-paced growth and wide spreading of the internet have definitely changed the way we deal with information, facilitating inquiry and access to several sources of knowledge (Leu; Mcverry; O'byrne; Zawilinski; Everett-Cacopardo; Kennedy; Forzani, 2011). Because the technological landscape changes very quickly, with the emergence of new tools such as applications, browsers, websites, search engines, cloud platforms, etc., users are challenged to be continuously acquiring new skills and strategies to cope with the flow of innovations. Notwithstanding, these changes do not happen at the same pace worldwide. In broad economic terms, developed countries and emergent economies experience the technological advancements first; socioeconomic status defines, for instance, who uses 5G (the fastest type of mobile data network). In Brazil, 90% of the houses has access to the internet; the percentage has risen 6 points since the last measure, in 2019. Smartphones and smart TVs are the two most used devices (IBGE, 2021).

In the societies with access to technology, adolescents and young adults born after 1984 (the release year of the 8-bit videogame) have been labeled *digital natives* (Prensky, 2001). Because this generation is surrounded by digital technologies since they were born, it is assumed that they can easily handle the technological tools at their disposal. Such belief has its repercussions in education, supporting claims that these new learners from the 21st century have different needs and learning styles that the current school system is allegedly unprepared for. Nonetheless, despite this massive contact with iCTs (Information and Communication Technologies), learners do not seem to make efficient use of these tools for educational purposes. The notions of *digital native* and *multitasker* have already been discredited by many studies in several countries and cultures (for a more detailed account, see Kirschner; De Bruyckere, 2017).

A study with Chinese undergraduate students, for instance, showed that they do not seem to hold deep knowledge in technology, using online resources mainly for "personal empowerment and entertainment, but not always digitally literate in using technology to support their learning" (Kennedy; Fox, 2013, p.76). A more drastic example comes from the COVID-

19 pandemic and the closing of schools in Brazil. Even though many students were connected through their smartphones, the majority did not have a device suitable for study purposes (e.g., laptop or tablet). That is, availability of internet access and smartphones has fallen short to ensure a rich educational experience. Up to that moment, students had used their smartphone mostly for communication and social media; their application as an educational tool was less explored and found to be more limited.

That said, handling iCTs for education purposes has become a crucial skill given its potential to assist learning in the digital era and increase learners' motivation. One example of a digital source of information are the web pages. The hypertext has unique features related to its electronic support that are said to impose new demands on the reader. Its nonlinear, multimedia structure requires the capacity to navigate through the results of a SERP (search engine results page), integrate knowledge across varied (and perhaps contradictory) web pages, and evaluate the quality of these sources (Salmerón; Stromso; Kammerer; Stadtler; Van Den Broek, 2018c). Internet hypertext differs from other digital formats (such as pdf files, for instance) since the latter does not offer as many possibilities of interaction; navigation is restricted to the graphic overview or within the titles and subtitles of a document, for instance.

As a result of these transformations, not only the text but also the reading behavior has changed. In the Pulitzer prize winner *The Shallows – what the internet is doing to our brains,* Nicholas Carr defines the internet as "the single most powerful mind-altering technology that has ever come into general use (…) since the book." (Carr, 2010, p.116). In his view, internet users dedicate little time to individual concentration; as a consequence, they are losing the ability to focus on a task for longer periods and to engage in deep reflection. We read more quickly and superficially, experience difficulty persevering in longform readings, and often abandon them with no much commitment. Carr advocates that link selection and evaluation processes overload our cognitive resources, "distracting the brain from the work of interpreting text or other information." (p.122). He also defends that reading on the internet is associated with increased use of skimming strategies, resulting in shallow processing.

Yet, the issue of cognitive overload associated with navigation (e.g., link selection) and evaluation processes might be subject to disagreement since task difficulty might trigger deep processing, resulting in enhanced learning (Zaromb; Karpicke; Roediger, 2010). Zaromb and colleagues found an effect of "effort after meaning" on retention, measured by a delayed-clue condition in a sentence recall task. Thus, the cognitive overload experienced by internet users should be interpreted as a warning, indicating directions for research that will help us trace the strategies that need to be developed to cope with the online text.

In this context, the present study investigates the effect of video models, described in the literature as "eye movement modeling examples" (EMMEs) on the readers' self-regulatory behavior (navigation, attention to sources, and integration) in the task of reading web pages in English as L2[1]. In addition, these web pages brought perspectives that were either favorable or contrary to the theory of Learning styles – which is currently considered a neuromyth. Thus, we also examined a possible indirect effect of EMMEs on misconception change mediated by skilled navigation and source evaluation.

1.1 WHY DIGITAL READING? ARE PRINT AND ONSCREEN TEXTS READ DIFFERENTLY?

Print and digital forms of reading bear a number of similarities: both modalities are usually presented in the canonic linear form, including a title and the authorship. If we consider the nonlinearity – a strong characteristic of digital texts –, it can also be found in print footnotes and bibliography or index lists (Elias, 2005, my translation)[2]. Another example of peripherical nonlinearity in print is the presence of boxes or diagrams near the main text; they are related to the topic but make sense on their own. Even though one can decide whether or not to read this content, the order proposed by the writer is usually followed. Although both forms may be nonlinear, the fact that the printed text is enclosed within its physicality restrains its possibilities of ramification. Differently, the borders of digital texts are less strict, allowing more possibilities for intertextual associations through hyperlinks (Fachinetto, 2005; Lévy, [1993] 2010).

Baron emphasizes the role of longform reading (i.e., reading of long works such as novels) and the emotional engagement with literary works in reading education. According to the empirical evidence reviewed by the researcher in her book *How We Read Now* (2021), comprehension in print predicts performance in digital reading, being related to the development of complex reading skills such as inference generation and vocabulary. Researchers agree that screen reading did not come to replace paper – on the contrary, they argue that the reading of physical books should be fostered at schools. Screens should be

[1] The terms ESL, L2 and additional language will be hereby used interchangeably to refer to the same phenomena: learning a language in addition to your mother tongue.

[2] Originally "O texto impresso, 'enclausurado' entre capa, contracapa, margens e linhas, tem a sua ramificação contida, exceto pelas notas de rodapé que, pelo espaço ocupado e modo de constituição, são periféricas em relação ao texto central."

introduced only at later stages of literacy development and never as the only modality to be used (Salmerón *et al*, 2022; Salmerón, García and Vidal-Abarca, 2018).

Evidence for similarity in processing between paper and screen reading comes from Fontanini and Tomitch (2009), in a study that investigated the role of working memory capacity in digital reading. The results evidenced that, regardless of medium, both high- and low-spans were able to process and retain specific information necessary for answering the comprehension questions. Similarly, participants in the study of Singer and Alexander (2017) read expository texts and narratives in both print and digital forms and answered comprehension questions. The researchers found no difference between paper and digital forms of reading in terms of main idea identification, although in previous studies readers recalled better some main ideas when reading print text (Mangen; Walgemro; Bronnick, 2013; Kerr; Symons, 2006; Rideout, Foehr; Roberts, 2010). In addition, participants judged their performance to be better in the digital medium, but comprehension scores were higher in print, revealing poor calibration[3].

To clarify the print versus screen issue, Delgado, Vargas, Ackerman, and Salmerón (2018) carried out a meta-analysis on the effects of the medium on reading comprehension. Albeit mixed, their findings corroborate the understanding that reading comprehension is better on paper than in digital devices, with studies (2000-2017) indicating a growing tendency to favor paper. In other words, the issue of screen inferiority persists over the years, regardless of the increasing degree of exposure we all are subject to. Reading in print has resulted in better comprehension under time-constrained conditions and also across expository texts and narratives. A possible explanation for the lower performance on screen is the instructional design of online learning environments, which may not yet be adequately suited for educational purposes. This *paper advantage* is, in the authors' words, "a call for researchers, policy-makers, and education professionals to join forces to develop methods to support effective digital-based reading and learning" (Delgado *et al*, 2018, p.26).

From the above stated we can assert that, despite the similarities, medium affects processing. A distinguishing feature of hypertexts is the presence of hyperlinks, words in typographical emphasis (usually underlined, in blue) that, when clicked, redirect the reader to another page for further information. Thus, hyperlinks provide the reader with complementary resources to build comprehension (Koch, 2007; Elias, 2005). If any curiosity about the meaning of a word arouses while reading paper, the reader will unlikely look up at a dictionary; thus, the ease and speed of access provided by the hyperlink tool implies a significant change in the

[3] Calibration is the learner's self-perceived comprehension abilities as compared to their actual performance (SINGER; ALEXANDER, 2017). It is also said to affect strategy selection (SALMERÓN *et al*, 2010).

reader's behavior. At the same time, accessing these links disrupts the regular flow of reading; for this reason, hypertext reading is referred to as non-linear.

Another metaphor that illustrates the concept of hypertext is the idea of "a group of nodes linked by connections. The nodes might be words, pages, images, graphs (…) [that] are not linearly connected like the knots of a rope, but each (or most) of them extends their connections in star shape, in a reticular manner" (Lévy, [1993] 2010, p.33, my translation). These connections are made by buttons that make the transition from one node to the other, such as hyperlinks, references and bookmarks (Fachinetto, 2005). Indeed, the multiple connections established with other texts through hyperlinks results in a complex network of meanings. In this sense, an association can be drawn between the nonlinear nature of hypertext reading and human cognitive architecture, since both operate in an associative manner. Just like the human mind, hypertexts can comprise an infinite number of possible connections, given the apparently boundless nature of cyberspace (Lévy, [1993] 2010).

Hypertexts also enable interactivity with the online pages, which allows the user to engage in forums and edit collaborative pages in an unprecedented manner. Readers can leave comments, engage in forums, and edit collaborative pages (Coiro, 2003). This feature changes the relationship between reader and content as it requires planning possible interactions, considering the more active role of the reader in this context. Finally, and under a discourse perspective, the hyperlinks within a hypertext can be seen as mechanisms of intertextuality: when clicked, the texts might be integrated and/or overlap in multiple ways (Koch, 2007). Intertextuality is constrained to hypertext connectivity: closed hypertexts are more static systems such as a pdf file, while internet texts are situated in an open networked system (Coiro; Dobler, 2007). As a consequence, while closed hypertexts provide connections that are restricted to that document or system, internet hypertexts benefit from the multiple possibilities to link textual nodes with information available in other pages (Fachinetto, 2005).

The blurred boundaries of the hypertext compared to the constrained physicality of paper opens possibilities of choosing a reading path among the hyperlinks made available by the writer. For this reason, hypertexts are also said to be partly written by the reader as processing unfolds (Lévy, [1996] 2011). Put differently, the network of complementary data provided by hyperlinks calls for careful navigation decisions such as the selection of goal-appropriate links in order to construct a coherent mental representation of the content (Sullivan; Putambekar, 2015). This coherent representation is derived from the writer's organization added to the reader's ability to make inferences, activate prior knowledge, and weight the context (Van Dijk, 1994). Koch (2007) goes further pointing out that, given the multiplicity of

paths that hyperlinked texts offer, the construction of coherence is heavily dependent upon the reader's link selection as guided by her/his objectives. In this scenario, the reader has an increasingly active role and can thus be regarded as a sort of "co-author". This quest leads us to the crucial role of competencies in online reading.

1.2 WHY DIGITAL READING COMPETENCIES?

Strategic behavior has been compared to print and digital reading, with studies showing that skilled linear reading and evaluation skills predict good performance in hypertext. (Hahnel; Goldhammer; Naumann; Kröhne, 2016). In addition, many of the strategies used in linear texts are transferred to nonlinear reading; transfer also happens from L1 to L2 contexts (see Do Amaral; Torres; Tomitch, 2018 for a review). Yet, a new set of strategies is used in digital environments, involving computer skills (e.g.: use of computer applications) and navigation strategies (accessing webpages, navigating through hypermedia). Afflerbach and Cho (2010) also point to the similarity in behavior across mediums in actions such as overviewing texts to determine the quality and relevance of the material to one's goal, evaluating the content, and constructing meaning by integrating information from multiple documents. Yet, these authors identify strategies that are exclusive to internet texts, which they label *realizing and constructing potential texts to read.* This category involves analyzing sources in an apparently boundless cyberspace, selecting links, and deciding on reading order.

Online reading[4] refers to the characteristics of digital texts as well as the new competencies and strategies that need to be developed in order to cope with these characteristics. With the ubiquity of smartphones with access to the internet, *Googling* has become an ordinary activity, being used to check trivial information (e.g., the casting and director of a movie you are talking about), to look up for the meaning of a word in English you do not know or related synonyms, or to search for relevant information (e.g., the side effects of some medicine or an unknown concept). Regardless of the purpose, it is crucial to understand how a search engine works and how it can be used to find reliable information.

This procedural knowledge can be taught and fostered through metacognitive instruction (a section is fully dedicated to the topic in chapter 2). The navigation competence comprises strategies such as choosing keywords to carry out an effective search, and inspecting its results considering the nature of the website and information on the snippets. Yet, readers

[4] The term "online reading" is going to be used throughout this dissertation to refer to texts that are available on the internet.

more often than not click on the first link they are shown to on the results page, demonstrating overreliance on the search engine algorithms and uncritically ignoring its underlying mechanisms (e.g., the presence of paid advertisements in the first results).

Once these navigation decisions are made, the resulting selected webpages must go through careful inspection – which requires the reader's capacity to evaluate the both the credibility of the source (author, his/her credentials, if he/she represents an institution) and the truthfulness of the information (Stadler; Bromme, 2014). The evaluation competence is especially important when reading on the internet because there are no gatekeepers to weight the quality and trustworthiness of what is published online. For some intellectuals that is the main novelty of the digital public sphere (Habermas, 2022). As a result, it is left to the reader the work of analyzing source features and content according to his/her parameters.

Another important competence concerns the ability to integrate meaning across the multiple texts read in order to construct a coherent mental representation. Given the multitude of sources available, integrating may also involve analyzing controversial perspectives before taking a stance on a controversial topic (Salmerón *et al*, 2018c). These three competencies (navigation, evaluation, and integration) will be retaken in chapter 2, where we review the literature.

1.3 WHY LEARNING STYLES?

In the context of investigating online reading comprehension, many studies have been particularly interested in how readers construct meaning from online sources that present opposing perspectives on the same issue (Anmarkrud; Braten; Stromso, 2014; Braasch; Braten, 2017). This topic emerges when reading texts which approach psychological misconceptions in education. Misconceptions are a type of prior belief and, as such, lack scientific basis. They are usually difficult to be updated because, when the reader is confronted with information that contradicts his/her belief, she/he tends to ignore or refute it to reduce cognitive dissonance, even though (or precisely because) the material presents valid arguments that put his/her beliefs at stake (Karimi; Richter, 2021). Prior beliefs and misconceptions are further discussed in chapter 2.

The Learning styles (LS) theory are the educational misconception chosen to be analyzed in this study; albeit much investigated, it is the most pervasive myth among preservice teachers (Dekker; Lee; Howard-Jones; Jolles, 2012) and students of psychology (Menz;

Spinath; Seifried, 2020). That is to say, having a teaching license or a bachelor's degree in psychology does not prevent these professionals from endorsing educational misconceptions.

The LS myth advocates that instruction should be tailored to individuals' most suitable channel (visual, auditory, kinesthetic etc). But the student's preferred style does not necessarily lead to actual learning outcomes; the theory lacks a consistent explanatory framework and empirical evidence and is thus regarded as a misconception (Kirschner, 2017). A quick Google search (carried out in Brazil on February 25th, 2023) using the terms "Learning styles" yielded all the first nine results favoring the misconception. The webpages described the VARK (visual, auditory, reading, kinesthetic) model or other frameworks that explained each style, and also offered tips to teachers. Other pages provided tests to find your individual learning style. That said, Learning styles can be included in the realm of controversial topics – a controversy between commonsense and scientific knowledge. Even though there is solid evidence against their effectiveness, the topic is still much debated in the educational context, with educational psychologists still including the identification of learning styles in pre-service teaching programs in schools – as this author has experienced in as recent as February 2023.

1.4 WHY VIDEO MODELS (EMMES)?

As previously discussed, reading comprehension is better in print compared to digital – which indicates the need to develop the reader's metacognitive strategies in the online environment. Eye-movement modeling examples (EMMEs) are videos that show the recorded eye movements of competent readers as they perform a learning task onscreen; they aim at modeling strategic behavior. Data from less successful readers may also be used in a compare-contrast paradigm (Salmerón; Llorens, 2019). Recordings of eye movements arise as a potential material to foster metacognitive behavior among students. In addition, they promote the connection between research in psycholinguistic and classroom practices (Maia, 2018). In Brazil, out of the laboratory and into school, researchers from the Laboratory of electrophysiology and eye tracking (LER group[5]) investigated sentence processing among 8th and 9th-grade students using eye tracking (Maia, 2018; 2019). The results of the participants with poor performance were used to identify their needs and plan an intervention, which was applied to the same group in the format of workshops that used eye tracking gaze plots to foster students' metalinguistic awareness.

[5] Laboratório de Eletrofisiologia e Rastreamento Ocular

In Spain, researchers from the Interdisciplinary Research Structure in reading (ERI-lectura[6]) have been investigating the effectiveness of eye movement modeling examples (EMMEs) as a tool to foster the processing of online texts (Salmerón; Llorens, 2019; Salmerón; Delgado; Mason, 2020). This dissertation extends research on the effects of EMMEs in (L1) to reading in English as a second language (L2). It also investigates the possible effects of EMMEs on misconception change in the context of reading multiple documents that either corroborated or refuted the Learning styles theory.

1.5 SIGNIFICANCE OF THE STUDY

Research on hypertext reading has compared print versus digital reading strategies (Singer; Alexander, 2017; Gruspe *et al*, 2015; Zaki; Hassan; Razali, 2008; Tien; Talley, 2014; Usó-Juan; Ruiz-Madrid, 2009; Gilbert, 2017); link selection strategies (Salmerón; Kintsch; Kintsch, 2010); cognitive processes involved in navigation (Kornmann *et al*, 2016; Li; Tseng; Chen, 2016); selection and evaluation of sources, (Hahnel *et al*, 2016). Narrowing to L2, studies have often approached issues of strategy use and comprehension (Anderson, 2003; Zaki; Hassan; Razali, 2008; Usó-Juan; Ruiz-Madrid, 2009; Park; Kim, 2011; 2017; Gilbert, 2017).

Under an L1/L2 comparative paradigm, Gruspe and colleagues (2015) conducted a qualitative study comparing hypertext reading among adults who spoke Filipino as their L1 and English as an L2. The researchers departed from the assumption that nonlinear hypertext reading might lead to confusion and hinder comprehension. The analyses of interviews and group discussions showed that readers' motivation was related to interest on the topic and rather for texts in English than in Filipino. In addition, participants reported feeling that materials in the L2 were more reliable and pointed to the lack of online material in their L1, which partially explained their overreliance in the L2. Regarding the strategies used, readers adapted their behavior from traditional forms of reading to hypertext reading, in consonance with previous research.

The role of metacognitive instruction is indicated as essential in developing strategies for digital reading in the reader's L1 (Leu *et al*, 2004; 2015; Klois; Segers; Verhoeven, 2013; Sullivan; Puntambekar, 2015; Hahnel *et al*, 2016; Li Tseng; Chen, 2016; Salmerón *et al*, 2018c), as well as in the hypertext reading strategies used by L2 readers (Chen, 2015; Gilbert, 2017, Huang; Chern; Lin, 2009; Mokhtari; Sheorey, 2002; Park; Kim, 2017; Park; Yang; Hsieh,

[6] Estructura de Recerca Interdisciplinar en Lectura

2014; Taki, 2015; Tien; Talley, 2014). Nonetheless, the aforementioned studies were either exploratory or focused on the analysis of reading behavior using surveys to trace self-reported strategy use in L2. None of them approached the effects of metacognitive instruction through the use of eye movement modeling examples (EMMEs) on the development of digital reading competencies and misconception update – and this is precisely the main goal of the present study.

Eye movement modeling examples (EMMEs) have been explored in their potential to develop learners' metacognitive strategies and text-picture integration (Mason; Pluchino; Tornatora, 2016; Scheiter; Schubert; Schüler, 2017). In the digital reading context, it has been used to enhance attention to navigation and source features (Salmerón; Delgado; Mason, 2020; Salmerón; Llorens, 2019). The present study adds to the field by investigating the effect of EMMEs on the processing of multiple documents in English as an L2 – which is believed to impose greater cognitive demand on the reader. The underlying assumption is that performance while navigating and reading the webpages might increase as an effect of the intervention – which in turn might help learners identify – and ultimately, change – misconceptions about learning styles.

Research on multiple document reading has investigated the processing of texts that present opposing perspectives on an unsettled scientific issue such as climate change (Salmerón; Gil; Braten, 2018), sun exposure (Andresen; Anmarkrud; Braten, 2019), use of cell phones (Anmarkrud; Braten; Stromso, 2014), and genetically modified food (Salmerón; Delgado, Mason, 2020). Differently, the present study sought to investigate the processing of texts about the Learning styles theory. As previously said, LS is a widespread myth in educational psychology: students will label themselves as visual or auditory learners and teachers also reproduce it as a truth without much criticism. In this context, prior beliefs play a strong role in the construction of a mental representation from the topic – and changing this representation is a rather complex matter. Yet, to the best of our knowledge, no prior study has used EMMEs as an indirect tool to mitigate misconceptions in education.

In the Brazilian context, research in digital reading has been mostly situated within the realm of discourse and literacy studies (Almeida, 2020; Coscarelli, 2017; Xavier, 2003, to mention a few examples). In the field of metacognition, Maia and colleagues have already employed eye movements to inform instruction of subordinate clauses. Yet, no study insofar has used eye movement modeling examples (EMMEs) to enhance undergraduate students' navigation and evaluation strategies when reading multiple online documents in English (L2).

1.6 ORGANIZATION OF THIS DISSERTATION

This dissertation is divided into five parts: the present Introduction; chapter 2 - Review of the Literature; chapter 3 – Method; chapter 4 – Results and discussion; and chapter 5 – Final remarks. The main theoretical constructs that underlie this dissertation are brought and reviewed in chapter 2. Informed by these discussions, chapter 3 presents the research questions proposed and its underlying hypotheses, followed by the description of the participants, instruments and materials used as well as a report of the pilot study. In chapter 4, the results of the statistical and qualitative analyses are presented and the hypotheses are discussed under the light of the relevant literature. Last, chapter 5 provides a summary of the results on the effects of EMMEs on both processing and learning outcomes, highlighting the pedagogical implications of the findings and making necessary caveats in relation the limitations of the study and pointing to future directions for research in the field.

2 REVIEW OF THE LITERATURE

Read more. Focus when you do. Medium matters.

Baron, *How we read now*

The present chapter begins by reviewing models of the comprehension process in both single and multiple documents, situating this dissertation within the second realm. Next, we elaborate on the role of prior beliefs in meaning construction and narrow down to the case of Learning styles. Afterwards, digital reading is contextualized in relation to its specific competencies of navigation, integration and evaluation as proposed by Salmerón and colleagues (2018c). We then move to the use of metacognitive instruction in developing these competencies, also drawing the line between the strategies used to read in print versus onscreen. Last, we review eye tracking studies in digital reading in L1 and L2, gathering evidence from previous studies on the use of eye movement modeling examples to foster self-regulated learning when learning from texts.

2.1 COMPREHENSION MODELS IN SINGLE AND MULTIPLE DOCUMENT READING

What does it mean to comprehend a text? This is the fundamental question that has instigated research in reading over its course. Psychologist Walter Kintsch (1998) situates comprehension as another *paradigm for cognition.* This means, the key to understand higher-order cognitive processes of the human brain lies in its ability to understand language, adding to the well-established problem-solving paradigm. Comprehension is thus understood as a process of constraint-satisfaction that takes place "when and if the elements [perceptions, concepts, ideas, images] that enter into the process achieve a stable state in which the majority of elements are meaningfully related to one another and other elements that do not fit the pattern of the majority are suppressed" (Kintsch, 1998, p.4). The fuzzy puzzle metaphor might illustrate this process: to build an image, we put together the pieces that match and leave out the ones that do not seem to belong. Importantly, this process does not look into the text itself, but rather at the reader's online processing in the task of constructing a mental representation of the text.

2.1.1 Single documents: the construction-integration (C-I) model

The processing levels involved in the construction of mental representations during reading are described by the construction-integration (henceforth C-I) model (Kintsch, 1998).

The *surface level* refers to the processing of the words and phrases in text itself and involves word recognition and lexical, syntactic, and semantic parsing. The level of meaning construction is divided into the *textbase*, comprising the representation of the ideas from the text in hierarchical order, and the *situation model*, which integrates text information to the reader's prior knowledge.

As we read a text, we combine the meaning of words in our mind to form *propositions* or idea units. Together, the *propositions* as well as the syntactic relations between them form the *microstructure* of the text. These syntactic relations may be signaled in the text by cohesion markers or triggered by inference processes such as anaphora or bridging inferences, through which the reader fills the gaps of less explicit relations between sentences. To depict the text structure at a global level, we form the *macrostructure* of a text by identifying a set of higher-level propositions that are more hierarchically salient. Underlying the identification of these relevant propositions are deletion and generalization processes (Kintsch; Van Dijk, 1978). Thus, the process of constructing the *textbase* begins from the representation of smaller units of meaning and develops until the whole text is read. If successful, the resulting mental representation is a hierarchically organized summary of the main ideas of the text..

Nonetheless, understanding textual information explicitly is a rather shallow way to process texts (Kintsch; Rawson, 2005). To achieve a deeper understanding, the reader needs to integrate text information with what is already known. In other words, the *textbase* propositions must be integrated with the reader's prior knowledge, previous experiences, emotions, and/or memory of previously read information from the text. This integration occurs by means of generating inferences at a global level (i.e., identifying the relations between paragraphs) or elaborative inferences that can be either *text-based* or *knowledge-based*. This integration process enables the construction of a *situation model*.

The possible interactions between the *textbase* and *situation model* levels are diverse. As stressed by Kintsch (1998), the textbase could also be stated as *text-derived* since it is hardly ever a pure result of text processing: even at this early stage, prior knowledge enters into play, in inference generation processes, for instance. It might also be the case that the reader fails to construct a coherent textbase, but is able to derive a situation model from the topic (Bransford; Barclay; Franks, 1972). On the other hand, a well-written text might help the reader build a coherent textbase, but if s/he lacks prior knowledge on the topic, a poor situation model will emerge. Furthermore, prior knowledge and beliefs are added to text information in situation model construction. Kintsch (1998) highlights that knowledgeable readers are in advantage since they reorganize text information and create richer, more complex situation models.

How do these levels of representation are integrated to construct a mental structure of the text? According to the C-I theory, integration is a bottom-up flexible process that involves both suppressing weak connections among propositions and strengthening what is salient, in a process named spreading activation. This process goes on until it reaches certain stability or constraint satisfaction. It might be slowed down by ambiguity or comprehension problems, although readers tend to rely on upcoming information to solve these difficulties (Kintsch, 1998).

Integration is highly dependent on working memory (WM)[7] resources: as each sentence is read, its representation is integrated with the previously processed text parts held in WM. Because WM storage capacity is limited, when we finish processing a sentence, the resulting representation is either transferred to long-term memory or deleted, depending on the strength of its relations with previous propositions. The retrieval cues in the text make it easier for the reader to bring whatever previous information is needed back to the focus of attention; as highlighted by Kintsch (1998), this retrieving process is important because "only those relations that hold between propositions that were together in working memory at some time during the sentence-by-sentence process of comprehension play a role in the text representation" (p.102).

The C-I model accounts for both print and onscreen reading (Destefano; Lafevre, 2007). When reading onscreen – and on the internet in particular – the construction of a coherent mental representation may be affected by aspects such as hyperlinks, which might result in nonlinear processing depending on the reader's choices. Although textbase formation seems to be less affected by nonlinearity, the hyperlinks provided by the author might either aid or hinder situation model construction depending on the coherence of the reader's navigation path (Salmerón *et al*, 2005). Indeed, situation model construction is believed to be affected by non-linear hypertext since "readers will encounter propositions that are unrelated to those held in working memory more frequently than in linear text." (Destefano; Lafevre, 2007, p.1627). In an attempt to explain the comprehension process of digital texts, Hahnel and colleagues (2016) associate the navigation skill with the C-I model proposed by Kintsch (1998):

> The navigation metaphor reflects how readers access digital text parts and arrange their order to gain information, that is, how readers create their own text base by their selection and sequencing of pages. If readers fail to appropriately navigate through hypertext for a particular reading purpose, they will not locate relevant information. As a result, readers' textbase will be less complete and coherent requiring an increased elaboration of knowledge-derived information (HAHNEL, 2016, p.487).

[7] "Working memory (WM) refers to our ability to keep a small amount of information readily available for our current activities, and to support decisions, guide actions, make statements, and keep track of conversations, to navigate and support creative thinking and problem- solving, to remember to do things, and to update what is going on around us throughout the day" (LOGIE; CAMOS; COWAN, 2021).

That is, constructing integrated meaning becomes more challenging when readers need to navigate through a number of results on a search engine results page (SERP) to locate content, evaluate this content, and integrate information into a coherent representation (Salmerón *et al*, 2018c) – or, in the words of Naomi Baron, to "search, scrutinize and synthesize" (Baron, 2021, p.99). An upcoming section will be devoted to describe these three competencies in depth. Beforehand, other models are needed to account for the processing of multiple documents; they are approached in the next lines.

2.1.2 Multiple document integration: the documents model framework (DMF)

Multiple document processing refers to the situations in which the reader resorts to two or more textual sources to learn about a topic, to understand the sides of an unsettled issue, or to take a stance on a controversial matter – either for learning purposes or personal inquiry. Depending on the task at hand, it may call for the capacity of selecting content that is task-relevant, evaluating reliable sources, and integrating information into a coherent mental representation (see Mccruden; Braten; Salmerón, 2022 for a more extensive account of models of learning from multiple texts). In terms of processing, the integration of multiple texts in memory is affected by factors such as conceptual consistency between the texts, the distance in reading context, similarities in the structure of these texts, and the causal relations between them (Britt *et al, 1999;* Beker; Jolles; Lorch Jr; Van Den Broek, 2016). Beker and colleagues found that the information read in a previous text is activated during the subsequent processing; if the text being read presents inconsistent information that had been explained in a previous text, reading speed is optimized (Beker *et al*, 2016).

The issue of how readers integrate information from multiple texts presenting different perspectives has been investigated for over 30 years since the Documents Model Framework (DMF) proposed by Perfetti and colleagues (1999). This model builds upon the forestated construction-integration model (Kintsch, 1998) by adding the *Intertext Model* level which comprises text information such as source features (author, setting and form), content (main ideas), and rhetorical goals, as well as the relations among texts and from the texts to their content. These relationships are evidenced by predicates such as "support" vs. "oppose", "agrees with" vs. "disagrees with" (Perfetti *et al*, 1999 p.107), and are especially salient when the documents approach a controversial topic such as different views on the same historical fact. The construction of a rich Documents Model is influenced by the learner's goals, the task,

and prior knowledge: expert readers build “a more interconnected Documents Model”, while non-experts focus on the situation described and tend to simplify the issue (Perfetti *et al*, 1999 p.118).

The DMF explains how readers integrate different situations in relation to their source into an intertext model. Nonetheless, it fails to account for perspectives that are impossible to reconcile. In such conflicting situations, the reader faces a coherence break and thus must check the validity of the arguments presented in order to take a stance. In addition, while the DMF describes reading of multiple texts in print, recent research has been increasingly interested in the digital context. Although the internet has facilitated access to information, the massive number of sources available has brought the need to develop strategies to cope with this flow of information and to assess its quality (Britt *et al*, 2014). Specifically, readers must evaluate the reliability of sources (which may display opposing perspectives on the topic being searched), identify information that is relevant to the task/goal, and integrate this information with their prior knowledge to form a coherent mental representation (Andresen; Anmarkrud; Braten, 2019, p.1150).

2.1.3 The content-source integration model (CSI)

Is global warming real? Are cell phones harmful to people’s health? Which is better: bottled or tap water? Searching on the internet has become a common activity when trying to answer these science-related queries. The resulting webpages often bring complementary, overlapping, or even inconsistent information, but – and most problematic – when they are conflicting, it becomes difficult for the reader to construct meaning from the opposing perspectives. What is true? Which side – if only one is correct – to trust? Does it remain an open question? The issue of how readers construct meaning from texts that provide competing views on the same topic has been approached by the Content-source integration model (CSI) (Stadler; Bromme, 2014).

The CSI model expands on the DMF by explaining the processing of conflicting information and how the conflict is solved to restore coherence. This framework is divided into three stages: 1) conflict detection, 2) conflict regulation, and 3) conflict resolution. In the first stage, readers need to coactivate the conceptually related propositions in working memory in order to detect a coherence breakdown. Conflict detection is facilitated when the text triggers inference generation, when different terms are used with the same meaning, and when conflicting information is distant. The reader’s strategy use, goals, and the resulting standards

for coherence that are set also enhance conflict detection. For instance, readers who strategically check information and read with a global standard for coherence in mind tend to detect contradictions more easily. Yet, readers might fail to detect conflict – and this has implications for the construction of a coherent mental representation from the topic.

The second stage may take place in three ways: 2a) restoring coherence by ignoring a conflict; 2b) restoring coherence by reconciling conflicting propositions, and 2c) restoring coherence by accepting a conflict as due to different sources. Ignoring a conflict (a) is an ineffective strategy, usually used for goal-irrelevant material. In reconciling conflicting propositions (b), readers usually generate explanations which will be more or less assertive depending on how clearly the conflict is stated in the text. Finally, coherence can also be restored by interpreting the nature of the conflict as resulting from different perspectives (c). Indeed, conflict detection increases attention to source features, as we shall see next in the Discrepancy-induced source comprehension model (Braasch; Braten, 2017).

Nonetheless, attributing a conflict to different sources does not ensure the construction of a coherent situation model. To achieve stage 3 and solve the conflict, the reader has to take a stance by judging the validity of the arguments presented. This evaluation is done based on the reader's knowledge about the subject matter (what is true?) as well as on the quality of the sources (whom to believe?). Judging the validity of a claim by using prior knowledge has evident limitations regarding the readers' own epistemic capabilities (which may not suffice) and beliefs (belief-consistent information tends to be judged as more accurate). If prior knowledge does not suffice, readers may resort to basic coherence standards such as the explanations given in the texts to appropriately evaluate the concurrent claims.

Solving the conflict by asking "whom to believe?" entails evaluating source quality, which takes into account the presumed good intention of the author, his/her expertise as well as source features such as website type. To make things more difficult, source information is not always available and clear in the texts; training in source evaluation is indicated as a prominent tool to develop the readers' sourcing skills (Stadler; Bromme, 2014).

2.1.4 The Discrepancy-induced source comprehension model (D-ISC)

Although previous models have depicted the integration of information from multiple sources after reading, fewer described the means by which readers scrutinize this material as they read – a process named *sourcing* (Wineburg, 1991). Braasch and Braten (2017) proposed

the Discrepancy-induced source comprehension model (D-ISC) arguing that detecting contradictions during reading can be a catalyst for sourcing.

According to the D-ISC model, documents presenting either internal or between-text contradictions induce the reader to analyze more carefully the source features (author, expertise etc) in order to investigate the nature of the conflicting information. The resulting mental representation will produce source-content links that indicate where the texts agree and where the discrepancies are (Braasch; Braten, 2017).

Following this rationale, Delgado and colleagues (2020) tested D-ISC in a hypertext environment hypothesizing that hyperlinked sources could foster conflict detection and aid comprehension. As expected, attention to source-content links increased when participants read information that was conflicting across documents. These findings were explained in terms of working memory load, which led to a strategic shifting of attention to the sources.

2.2 PERSONAL EPISTEMOLOGIES AND PRIOR BELIEFS IN THE CONSTRUCTION OF MEANING FROM MULTIPLE DOCUMENTS

When reading multiple texts that convey conflicting information, the degree of strength of the reader's prior beliefs on the topic affects the processing and memory of the texts. Topic (or prior) beliefs "reflect what individuals accept as or want to be true about a particular topic" (Braasch; Braten; Britt; Steffens; Stromso, 2014, p.120). For instance, believing that cell phone radiation causes brain tumors will influence comprehension and memory for texts read in this topic – and information that is in accordance with one's prior beliefs will be considered more reliable. Readers will often search for arguments that support her/his view – even when confronted with accurate evidence that contradicts their preexisting beliefs.

In addition to prior beliefs, the reader's personal epistemologies (beliefs about how knowledge is constructed) also interfere with processing. For instance, believing that knowledge is built in a complex, dynamic process was linked with increased performance in multiple-source integration and comprehension (Jacobson; Spiro, 1995; Rukavina; Daneman, 1996; Stromso *et al*, 2008). Departing from this observation, Braten and colleagues (2011) proposed a model integrating epistemic beliefs and multiple-text comprehension, into four Epistemic Belief Dimensions: Simplicity, Certainty, Source, and Justification (table 1).

Table 1 - Summary of Empirical Links Between Belief Dimensions and Multiple-text comprehension

Simplicity Dimension	*Certainty Dimension*	*Source Dimension*	*Justification Dimension*
Knowledge is theoretical and complex: Better cross-text comprehension and integration; more cross-text elaboration and overview generation; less trust in newspaper.	*Knowledge is tentative and evolving*: Better cross-text comprehension and integration; benefit of argument task; better coverage of complex and uncertain information.	*Knowledge is transmitted from experts*: Better cross-text comprehension and integration; higher trust in textual information; less use of own opinion as basis for trust judgments.	*Justification through reason, rules of inquiry, and cross-checking of knowledge sources*: Better cross-text comprehension and integration; more use of metacognitive strategies; higher trust in scientific text; use of more criteria to justify trust judgments.

Source: Braten; Britt; Stromso; Rouet (2011, p.58).

The belief in knowledge as a complex network of concepts rather than isolated items (Simplicity dimension) enhances multiple-text integration when reading about competing scientific theories (Rukavina; Daneman, 1996), comprehension (Stromso *et al*, 2008), within- and cross-text elaboration (Hagen; Stromso; Braten, 2009), and the application of self-regulated learning strategies (Piesch; Stahl; Bromme, 2008). The Certainty dimension is strongly linked to the construction of an argument schema from reading: the view of knowledge as "tentative and evolving" is associated with an attitude of inquiry towards the multiple perspectives presented and identification of strengths and inconsistencies in each one. On the other hand, if readers believe knowledge is immutable, they might seek for a simple "right" answer, not engaging in more complex strategies such as acknowledging authority or drawing relations among the sources. The Source dimension ranges from belief in knowledge as constructed actively and in cooperation to the view of knowledge as passively acquired and transmitted by experts. The Justification dimension concerns claims of validity and is divided into three categories: justification by opinion, justification by authority, and justification by multiple sources. Beliefs in justification by authority and by multiple sources positively predict inference generation within and across documents as well as memory for the arguments presented (Braash *et al*, 2014). When the text provides accurate conclusions based on empirical evidence, the reader's beliefs do not affect their memory for either the text sources or the arguments.

As a consequence, multiple-source reading calls for the development of "epistemic strategies such as evaluating source reliability and quality, corroborating claims, and integrating information from multiple texts" which might comprise divergent views on the same topic (Barzilai; Kaadan, 2017, p.194). Barzilai and Zohar (2014; 2016) divide epistemic thinking into epistemic cognition and epistemic metacognition. Epistemic cognition refers to the analysis of the epistemic characteristics of information and the strategies used in this reasoning process

(e.g., Is this claim valid? Is this source reliable?). Epistemic metacognition concerns the nature of knowledge and how it is constructed (e.g., What is a valid claim? What is a reliable source?).

Regarding the role of L2, the reader's prior beliefs on the topic as well as the language in which documents are read might affect perception of credibility when reading multiple documents presenting conflicting perspectives on the same issue. Information that is consistent with one's prior beliefs is usually perceived as more reliable compared to belief-inconsistent information – regardless of whether the claim is plausible or not. In the study by Karimi and Richter (2021), participants read two texts approaching a controversial issue in science; when both texts were presented in English (L2), the effect of text-belief consistency was smaller compared to when they were in Persian (L2). They found that when a source was consistent with the reader's prior beliefs, situation model is strengthened compared to belief-inconsistent information regardless of the language – a phenomena explained in terms of a "defensive mechanism (…) to enhance cognitive consistency and reduce cognitive dissonance" (Karimi; Richter, 2021, p.3). Comprehension at the textbase level was not affected by belief consistency nor by language. When information consistent with one's belief was presented in English, participants constructed stronger situation models for the belief-consistent text compared to the belief-inconsistent text presented in Persian. Strikingly, when the text matching the participant's stance was presented in Persian and the belief-inconsistent text was in English, the difference between the situation models constructed from these texts was smaller, showing an increase in strength of the situation model when the belief-inconsistent text was in English. That is, English was perceived as an indicator of source quality when evaluating the trustworthiness of a claim, indicating that readers attach greater or lesser reliability to the text depending on the epistemic value associated with the language in which it is written. This perception will affect how information will be integrated into the mental representation.

2.2.1 Misconceptions – the case of Learning styles

Misconceptions are unwarranted prior beliefs about a topic. They are not grounded on up-to-date scientific knowledge in the field and are very difficult to change (Vosniadou, 1994). Examples of common misconceptions in educational psychology are the argument that handwriting can reveal our personality traits; that people only use 10% of their brain (Hughes; Liddy; Lambe, 2013), and that some of us are "left-brained" while others are "right-brained" (Macdonald *et al*, 2017), or defend the validity of the digital natives myth, multitasking, and the learning pyramid (Kirschner, 2017).

As with prior beliefs, the position stated by the author of the text in relation to the reader's beliefs interferes with the construction of a mental representation during reading. That is, belief in the misconception will strengthen situation model of texts corroborating the misconception and hinder situation model of texts that oppose the misconception. On the other hand, if the reader does not believe the misconception, the situation model of texts that debunk the misconception will be strengthened, whereas the texts that support it will be weakened (Karimi; Richter, 2021).

The Learning styles theories are a widespread misconception in educational psychology. Learning styles questionnaires aim at distinguishing learners between verbalizers and visualizers. Similarly, the VARK model proposes a more modality-driven categorization: visual, auditory, reading/writing, and kinesthetic (Pashler *et al,* 2008). This myth that a student will learn better if the material to be learned matches his/her preferred mode of information presentation (also known as the meshing hypothesis) has been discredited by a number of scientific studies and educational psychologists. Criticism of the theory points to several limitations. First, the absence of an explanation of its cognitive underpinnings, since it fails to explain why individuals fall into one profile or another (Ann; Carr, 2017). Second, experts point to problems with measurement and validity of the learning styles tests used e.g., narrowly tracing "types" instead of accounting for dimensions, low test-retest reliability (Kirschner, 2017). Another problem concerns a mismatch between self-reported preference and actual performance; in the words of Paul Kirschner, "what students prefer is not, per definition, what is best for them" (2017, p.167).

In relation to instruction, the belief that matching students to their supposedly most effective style lacks empirical evidence (Eitel *et al*, 2021). Well-designed studies on the interaction between style and teaching method are scarce; on the other hand, there is mounting evidence indicating no relation between learning style and learning (Rohrer; Pashler, 2012; Kirschner, 2017). Orienting teaching practices towards learning styles also disregards well-established theories that explain how information is processed through sensory channels such as the multi-component model of working memory (Baddeley, 1974), and the theory of multimedia learning (Mayer, 2009).

Macdonald and colleagues (2017) surveyed belief in neuromyths in a large sample size (N = 3,877) comprising educators, general population, and individuals with neuroscience background. They found that the learning styles misconception was the most endorsed item, being the first and second items most rated as true in a list of 32 items. Educators showed the lowest endorsement to neuromyths. Having a graduate degree, completing neuroscience

courses, and reading peer-reviewed journals were the strongest predictors of good performance in the survey, which points to the importance of access to up-to-date knowledge in neuroscience in debunking (albeit not eliminating) neuromyths. In addition, the results of the exploratory factor analysis indicate that participants who believe one misconception related to education will believe others within the same cluster. That is, researchers found a tendency to oversimplify the learning process by relying on "a single explanatory factor, such as the single teaching approach that will be effective for all children (learning styles) or the single sign of dyslexia (reversing letters), or the single explanation for why a child is acting out (sugar)" (Macdonald; Germine; Anderson; Christidoulou; Mcgrath, 2017, p.10). Another explanation regarded the explicit teaching of these neuromyths in training/educational contexts, which gives them more validity and hinders misconception update.

Menz and colleagues (2020) investigated the effect of refutation-style texts on misconception change among preservice teachers in four topics from educational psychology: learning styles, class sizes, multiple intelligences, and the testing effect. The three first topics have been disclaimed by current research while the latter has gained robust evidence. Results have shown that refutation texts affected misconception change for all the four topics, although the shift in position was not extreme (as measured in a Likert scale). This finding indicates the effectiveness of this type of text and the importance of presenting and discussing scientific evidence from studies in educational psychology among preservice teachers (Menz; Spinath; Seifried, 2020).

Despite the lack of evidence, LS is one of the most pervasive myths in education and neuroscience across countries. In light of the above, Kirshner and van Merriënboer (2013) recommend measuring cognitive abilities rather than using learning styles questionnaires. Ann and Carr (2017) suggest that teachers ground their practice on research in cognitive and developmental psychology, diversifying the presentation mode of learning objects and also attending to individual differences in the level of expertise, self-regulation, and personality traits.

When reading about learning styles and other similar educational misconceptions, teachers and psychologists often resort to online sources which, as forestated, might provide them with overlapping, contradicting and/or unreliable information. The next section describes the characteristics of digital reading and the unique competencies that are required from readers in this scenario.

2.3 NEW COMPETENCIES IN DIGITAL READING

The terms “new literacies” and “new competencies” refer to the knowledge and strategies required when reading online material. While “literacies” is more closely related to studies oriented towards a sociocultural perspective, “competencies” is situated in the realm of educational psychology. The term “competencies” was chosen to be employed throughout this dissertation, although studies in new literacies will be reviewed in the next paragraphs given their relevance.

As hypermedia expands the types of possible interactions with a text, the demands on literacy change. This change requires updates on the concept of literacy by including features that are unique to reading in an online environment (Leu; Kinzer; Coiro; Cammack, 2004). The term “new literacies” is believed to represent the strategies required in online reading (Leu; Forzani; Rhoads; Maykel; Kennedy; Timbrell, 2015), including knowledge of technological tools as well as the social practices that are exclusive to this context. New literacies are conceptualized as the “skills, strategies, and dispositions necessary to successfully use and adapt to the rapidly changing information and communication technologies and contexts that continuously emerge” (Leu *et al*, 2004, p.157).

Leu and colleagues (2004) argue that the features of this media require the development of an optimal behavior in aspects such as attending to “the strategic use of color; (...) hyperlinked texts and graphics; meaning-bearing icons and animations; pictures, maps, charts, and graphs” (Leu *et al*, 2004, p.1587). Another distinctive feature of online reading is its use for learning purposes, in a process of “inquiry and problem solving as we seek answers to questions large and small” (Leu *et al*, 2015, p.38). This context also calls for the development of critical literacies which enable the reader to evaluate the credibility of the sources of information available online. Taking into account these new demands, Leu and colleagues list four actions that take place in online reading: locating, critically evaluating, synthesizing and communicating online information (Leu et al, 2011). They were later expanded to include an earlier step: defining important questions (Leu *et al*, 2015). Because these new skills and strategies directly affect the way learners interact with information, they require awareness and practice.

Park and Kim (2017) categorize online literacies into four realms: computer literacy, computer-mediated communication (CMC) literacy, multimedia literacy, and information literacy. Computer literacy consists of knowledge on the use of software and hardware tools, while CMC literacy refers to the use of these tools for communication (message apps, emails

and blogs); multimedia literacy is a person's ability to write and comprehend documents comprising diverse modalities. Last, information literacy comprises the information location and evaluation strategies used when reading online.

Even after two decades of research on the new competencies required when reading online, a number of issues remain unanswered. As stated in the introduction, we comprehend less when reading onscreen (screen inferiority effect) and the problem has not decreased over the years despite the increase in time of screen use (Delgado *et al*, 2018; Salmerón; Vargas; Delgado; Baron, 2022). We process information in a shallower way when scrolling down compared when we read page-by-page; our attention is jeopardized by multimodality and competes with multitasking behavior (Baron, 2021).

Searching on the internet is part of our routine, and knowing how to navigate efficiently, evaluate content and integrate information are essential skills. In describing the comprehension processes readers undergo when dealing with online content, Salmerón and collagues (2018c) categorize the strategies required in this context into three competencies: a) search and navigation skills; b) integration of information from multiple sources and presentation formats, and c) critical evaluation of information. The first comprises choosing keywords that will lead to goal-related results and the scanning of SERP features. The second, integrating and synthesizing the content by selecting what is relevant among sources that may overlap or be contradictory – readers with prior knowledge on the topic have an easier task here. Third, evaluating the numerous results given, which often includes information that is unreliable, conflicting or irrelevant to the task. Each of these three competencies are going to be described next.

2.3.1 Navigation

Navigation refers to the reader's path when inspecting the results of a search engine results page (SERP) as well as selecting relevant hyperlinks as s/he reads a webpage in the task of browsing for goal-relevant information on the internet (Cho, 2014; Lawless; Schrader, 2008; Hahnel *et al*, 2016). Nonetheless, when confronted with the numerous results of a Google-like search engine, readers often access only the first entries, ignoring the subsequent SERP titles and information such as the type of website (.com / .br / .org / .edu), snippets[8], and date of last update. When reading a hyperlinked webpage, optimal navigation comprises examining and

[8] A summary of the website content presented below its title and address.

strategically deciding whether links are relevant to the goal and thus worth the click; failure in hyperlink selection hinders the construction of a mental representation. Navigation choices are usually made based on the ranking position of the result in the SERP, the keywords that were used to search, and source cues (Salmerón *et al*, 2018c). This section reviews studies that define the scope of navigation skills and attempt to define what optimal strategic link selection looks like, as well as the individual differences involved with the development of this competence (i.e., linear reading, basic computer skills, evaluation of online information, working memory, age etc).

One navigation-related skill concerns choosing appropriate keywords to make an efficient search. Guinee, Eagleton and Hall (2003) explored the internet searching strategies used by adolescents. The tools used for data collection were search engines such as *Google, Yahoo, AskJeeves* and a web-based software called *eTrekker*, used to design internet scavenger hunts. Prior to instruction, a smaller sample of participants performed search simulations and performance assessments. In the search simulations, they verbally described the procedures they would follow in an internet search; in the authentic performance assessments, students verbalized their process while conducting an actual internet search. According to the researchers, in general, "students start with what they know, maintain paradigms from the physical world, and adhere to time-tested practices" (p.372). These results point to a need to develop awareness on the reliability of the sources used, familiarity with reputable sites, and planning of online research – which involves metacognitive awareness on what makes a successful or unsuccessful search.

Salmerón, Cañas, Kintsch e Fajardo (2005) argued for an indirect effect of strategy use on hypertext comprehension affecting reading order and amount of information accessed. In experiment 1, participants read an expository text in hypertext format and were instructed to use the overview to choose the reading order. Comprehension tests checked both the textbase and situation model levels. Results showed that the number of hyperlinks visited significantly predicted the scores on text-based questions for low-knowledge readers. Importantly, reading order affected the construction of the situation model, as shown by the sequence of access to nodes and answer to inference questions. In sum, the reading order did not affect comprehension at the text base level, but it did have an impact on situation model construction.

In order to control for node coherence, a second experiment was conducted with two different overviews – one being low-coherence and the other, high-coherence. Following previous research, results showed that participants with low prior knowledge benefit from using a strategy that results in reading in a high coherence order. Low knowledge readers also

performed better on the cued association task and achieved higher comprehension scores when reading in a highly coherent order; the opposite was found for participants with high knowledge. Two navigation styles were identified: coherence and interest. Readers navigating in a coherence-driven manner would select information sources that are semantically or conceptually related to each other, while learners employing interest selection read texts based on more personal criteria. As a result, employing a coherence-driven navigation can lead to a more conceptually coherent representation of the text and greater learning outcomes. (Salmerón; Cañas; Kintsch; Fajardo, 2005).

To investigate the self-regulation processes underlying strategic link selection, Salmerón, Kintsch and Kintsch (2010) carried out two experiments. In experiment 1, participants read a text and selected between two nodes to continue reading, one node denoting high coherence and the other, low coherence with the previous section. The groups were assigned either a high- or a low-learning goal in order to test the assumption that high learning goals – and consequently better learning strategies – foster efficient hyperlink selection. Comprehension was assessed with text-base and inference questions, and criteria for link selection was unveiled in a retrospective methodology; a learning strategies questionnaire was also applied. Results showed a positive correlation between high learning goal and use of the coherence strategy. Learning goal and strategy use were related to both link selection strategies and comprehension scores. Experiment 2 investigated the effect of prior knowledge on calibration of comprehension and link selection. All participants received high learning goals, but were divided into high and low prior knowledge groups. They read the text and performed judgments of learning, a comprehension test and a task of rating the degree of relatedness among the concepts of the text to assess situation model comprehension. Results revealed that calibration of comprehension had a positive effect on the use of the coherence strategy for participants with low prior knowledge. To conclude, the researchers highlight the importance of self-regulation processes for a coherent hyperlink selection, which results on situation model comprehension and learning.

Because accurate calibration and the use of a coherence strategy correlated in the study just described, it is important to define calibration and how it differs from the concept of standards of coherence. The former, as briefly mentioned on a footnote in the introduction, concerns the difference between how one perceives his/her own behavior and actual performance in a cognitive task. Good calibration happens when a priori judgment corresponds with performance, whereas poor calibration reveals a mismatch between them; this datum informs how accurate the reader's comprehension judgments are and if s/he underrates or

overrates his/her own capability (Alexander, 2013). In digital reading, calibration was investigated by first having readers perform the tasks (in print and onscreen) and then asking them about their predictions for each medium – which are then compared to actual task performance. This method allows participants to "gauge their comprehension under both medium conditions with comparable reading content before rendering judgments" (Singer; Alexander, 2017, p.158).

The concept of "standards of coherence" describes "the level of understanding (e.g., deep or shallow) that a reader attempts to attain when reading", which affects his comprehension outcomes (Linderholm; Van Den Broek, 2002, p.783). When the reader notices a coherence break during processing (e.g. a new paragraph that does not seem to integrate to the previous one) – that is, if the reader's desired standards of coherence are not being achieved, then strategic processes will come into play (e.g. backtracking to the beginning of the paragraph to see if something was missed, rereading the previous paragraph) (Van Den Broek; Bohn-Gettler; Kendeou; Carlson, 2011). In this line, standards of coherence are part of the self-regulation processes that play a role in link selection, since they modulate strategy use.

Hahnel and colleagues (2016) analyzed reading skills and navigation behavior to explain individual differences in digital reading. German adolescents evaluated in the 2009 PISA (Program for International Students Assessment) had their digital reading skills assessed and contrasted with linear reading scores. The results demonstrated that skilled linear reading, basic computer skills and evaluation of online information predicted efficient performance in digital reading. The mediation analyses have shown that navigation (measured by visits to task-relevant websites) is predicted by linear reading and computer skills; evaluation had no predictive effect. The researchers concluded that competent readers use optimal navigation strategies, visiting more webpages with task-relevant information, while poor readers might fail to connect the main ideas across multiple webpages or simply cannot access task-relevant content, resulting in the construction of a poor mental representation from the texts read.

In the Latin American context, Burin, Barreyro, Saux and Irrazábal (2015) investigated the effect of hypertext structure, previous domain knowledge and working memory capacity on navigation and comprehension of digital texts. As expected, comprehension was affected by previous knowledge and working memory, although reading times increased among readers with prior knowledge – which might be interpreted as evidence of metacognitive behavior. Burin and colleagues explain the finding in these terms: "previous knowledge served as a source of coherence and organization, providing relief for mental load, when the interface was not structured" (Burin *et al*, 2015, p.544). Navigation was affected by hypertext structure, with

hierarchical hypertext leading to more efficient navigation paths (fewer pages visited). High previous knowledge readers opened more pages than the ones with low knowledge. The nonlinear structure of hypertext had greater impact among readers with low domain knowledge. Working memory affected performance in comprehension questions but did not interact with navigation – which was explained in terms of possible task ease.

According to studies reviewed by Salmerón (2018c), individual differences such as age, working memory, prior knowledge and epistemic beliefs affect navigation. Young readers select content by relying more on superficial cues (e.g. highlighted keywords) than on information in the search results. Reading skills (e.g., main idea identification and inference generation) are linked with optimal selection of search results and less distraction. Visuospatial working memory is related to efficient navigation (Juvina; Van Oostendorp, 2008; Kornmann *et al*, 2016). High prior knowledge enhances goal-relevant navigation (White; Dumais; Teevan, 2009), although lack of domain expertise may be compensated with search skills (Vilbert *et al*, 2009) – but studies are not conclusive: overconfidence interferes negatively with the navigation behavior of experts (Lawless; Mills; Brown, 2002; Sullivan; Puntambekar, 2015). Finally, epistemic beliefs in the reliability of online content enhance the likelihood of choosing goal-related sources and the time spent on them (Kammerer; Gerjets, 2012), although these results could not be replicated (Kammerer; Braten; Gerjets; Stromso, 2013).

For the purposes of the present study, the Navigation competence was approached in the strict sense of SERP (search engine results page) inspection for the following reasons: first, the texts created for the experiment did not comprise embedded hyperlinks; second, separating the fixations on the SERP from the fixations on the reliable and non-reliable pages enabled a finer-grained analysis of the evaluation processes and the identification of discrete traits of each of the two competences (i.e., navigation and evaluation).

2.3.2 Integration

The issue if how readers integrate meaning from two or more texts – especially when they bring different perspectives on the same topic – has already been approached, when comprehension models in multiple document reading were described (see 2.1). Nonetheless, since integration has been regarded as a key competence in digital reading, we here retake some of its main characteristics and the specificities of integrating texts when reading onscreen.

Integration is the reading comprehension process of constructing a situation model from what is read, combining the reader's mental representation of the textbase and his/her prior

knowledge and inferences (Kintsch, 1998). In digital reading, the term refers to a complex task and situates the reader in a more active role: to construct a textbase, one has to draw from a number of document sources and select what should comprise an integrated representation of that content. Integrating information among multiple online texts was identified as a weakness of both good and poor readers (Goldman; Braasch; Wiley; Graesser; Brodowinska, 2012). In addition, this competence is said to be impaired by multitasking behavior, affecting learning outcomes (Kirschner; Van Merriënboer, 2013).

Digital documents might require the integration of diverse media channels (verbal, visual, pictorial). Mayer's (2009) theory of multimedia learning posits some principles to facilitate the integration of words and pictures into a meaningful representation; they are divided into principles for instructional design and principles for learning. The premise is that extraneous processing (i.e., irrelevant material that leads to cognitive overload) is reduced when learning materials are best designed. According to the author, optimal design is achieved when 1) only essential items are kept and relevant items are given prominence; 2) pictures are near the corresponding text; and 3) text-picture redundance is avoided. Regarding instruction, segmenting of material into subsections, providing pre-training on key terms, and resorting to speech when presenting pictures in a lesson are proposed as guidelines to manage essential processing.

Beker and colleagues (2016) investigated the integration processes underlying learning from multiple sources in order to check whether readers made spontaneous connections between the texts read. Indeed, experiment 1 showed that if a text containing inconsistent data was preceded by a text that explained such inconsistency, reading times would decrease compared to reading without this prior exposition. Thus, the results provided evidence for intertextual integration of previously read information, especially if information is contrasting – a quite common situation when navigating among the sources of a search tool, for instance.

Integration is influenced mainly by individual differences in basic reading and computer skills such as "accessing, saving, and communicating information using an interface" (Salmerón *et al*, 2018c, p.100), although the interaction between these individual differences and integration is still unclear. Prior knowledge may also play a positive role: relevant information read in previous texts appears to be activated when readers encountered inconsistencies in a subsequent reading (Beker; Jolles; Lorch; Van Den Broek, 2016). On the other hand, readers with low prior knowledge and low working memory tend to be more negatively influenced by hypertext features (Destefano; Lefevre, 2007).

As aforementioned, the reader's personal epistemologies and prior beliefs on the topic affect the construction of a coherent representation from multiple texts. For example, believing that knowledge is constructed by means of a simple acquisition of unrelated items negatively affects between-text integration and comprehension (Rukavina; Daneman, 1996; Braten *et al,* 2011).

2.3.3 Evaluation

Evaluating the accuracy and trustworthiness of textual sources is a competence required in both paper and onscreen reading. While traditional print sources provide the reader with more reliable gatekeepers such as editors and reviewers, the internet cyberspace allows anyone to publish anything – which often leads to the propagation of inaccurate, misleading content from unknown authors or non-experts.

In the study by Salmerón, Gil and Braten (2018), participants read four texts about climate change that were either presented in their real format (a text except from a print textbook, an editorial from a printed newspaper, a blog entry on a tablet, and a popular science article in a printed popular science magazine), or their print-out versions. Results showed better memory for the sources and more specific references in the essay writing task among participants who read in the real documents in comparison with the print-out condition. Researchers concluded that the size, weight, and texture of these materials act as multisensory cues which in turn enhance memory for the sources.

Given its complexity, source evaluation is a particularly relevant competence when the task involves learning from online sources: it requires from the reader the development of a strong critical stance by carefully analyzing source features such as the author (is authorship even mentioned?), her/his credentials (is the author an authority in the area?), and the presence of any information about the nature of the source (a personal blog? a company? an educational institution?). Among undergraduate students, the ability of judging the reliability of documents is linked with accurate comprehension of these documents (Braten; Stromso; Britt, 2009).

Sourcing is the term coined by Wineburg (1991) to describe the process of evaluating author, genre and date of publication during reading to enhance comprehension. Source features have informative value to evaluate the quality and credibility of a text, since they "may reveal the author's intention, the intended audience, the author's knowledge of the phenomena described, the setting, the nature of the publication, and other information that may be helpful in understanding the role and context of a document" (Brante; Stromso, 2018, p.777).

Nonetheless, sourcing relies to a great extent on the reader's memory: if little attention was paid to the source features, evaluation will be problematic. In a review about sourcing in text comprehension, Brante and Stromso (2018) reviewed 18 intervention studies in diverse educational settings. They found that multiple documents with opposing perspectives have led to improved outcomes in instructional interventions since they trigger the need for source verification to solve the intertextual contradictions. When the documents present converging or simply non-conflicting perspectives, sourcing is triggered to a lesser extent. The researchers also pointed to the need for explicit instruction that includes the different sourcing strategies used depending on the type of text and the reading situation.

Readers usually evaluate the truth of an argument based on the credibility of the source and the conclusions drawn by the author. Credibility comprises analyzing authorship, where the text was published and issues of power in distributing that argument (Braash; Braten; Britt; Steffens; Stromso, 2014). In a think-aloud experiment, Anmarkrud, Braten and Stromso (2014) sought to identify the strategies readers used to evaluate the trustworthiness of a source when reading multiple conflicting documents on a scientific issue. They hypothesized a relationship between strategic processing and increased source citation in essays. The researchers identified three categories of behavior: evaluating, monitoring, and cross-document linking strategies. Confirming their hypothesis, the more students employed evaluation strategies, the less they relied on biased sources and the more they referred to unbiased sources to ground their arguments in the essays.

When reading on the internet, competent evaluators should take into account structural and message features. Structural features are elements such as the layout of a webpage, the presence of advertisement, and suffixes indicating a specific top-level domain (.org, .edu, .com); message features are of a textual nature, including aspects such as authority, currency and scope (Hahnel *et al*, 2016). The trustworthiness of information can also be verified by: reading the "about us" section on a webpage so as to check the authors' expertise in the subject; comparing what is read to previous knowledge; and analyzing the sources (Salmerón *et al*, 2018c). Regarding individual differences, age seems to be a key factor in the development of evaluation strategies (Eastin *et al*, 2006). Readers with low topic knowledge tend to believe false information in professional-looking layout (Fogg *et al*, 2003). Overconfidence in one's own evaluation skills has also been reported – which often does not match actual performance (Kuiper *et al*, 2008). Finally, the belief that the content available online requires critical evaluation correlated with more time spent reading reliable webpages (Kammerer *et al*, 2015).

Considering the complexity of developing the evaluation competence, studies have investigated the effectiveness of different types of instruction aimed at developing student's critical evaluation skills when reading online. The intervention proposed Pérez and colleagues approached three source dimensions: author position, author motivation, and media quality in the context of discussing contradictory views on a same topic and then applying the source dimensions in activities such as rating document descriptions, evaluating documents, and answering questions or writing a short conclusion considering text reliability (transfer task). They achieved positive results in terms of less visits to unreliable sources, increased citations to reliable sources and decreased citations to the non-reliable ones (Pérez; Potocki; Stadler; Macedo-Rouet; Paul; Salmerón; Rouet, 2018). Underlying the studies as the one mentioned above is the idea that if students are taught to evaluate sources, such awareness will help them in similar tasks to come. Thus, metacognitive training has the potential to foster the development of these new digital reading competencies.

2.4 DEVELOPING THE NEW COMPETENCIES OF DIGITAL READING

The human brain has the amazing capacity to adapt to its environment by learning new things**.** In spite of this biological predisposition to acquire knowledge, richness of stimuli is crucial for cognitive development. Our cognitive potential is fostered by the schooling years: we know, for instance, that literacy improves memory and IQ (intelligence quotient) scores (Dehaene, 2020). Yet, as a result of environmental differences, what is seen at schools is a discrepancy among students' performance, which leads educators to wonder how learning can be enhanced. In answering this query Dehaene (2020) defends that educators need to understand the neural bases of learning that are shared by all humans: that means teacher training should account for learning how the human brain works. In his view, teachers who know how the brain learns are better prepared to teach their students how to learn.

The term metacognition is often employed to refer to one's thinking about thinking. Veenman (2015) defines metacognition as explicit knowledge and control of cognition. This awareness of cognitive processes stimulates learner autonomy and influences several aspects of academic performance. The importance of metacognition to learning has become even more important in times of global pandemic and distance education. Between the years 2020 and 2021, the peaks of the COVID-19 pandemic led schools to close; as a result, many students were deprived of their usual learning context in which the interaction with peers, teachers and school staff took place. At home, even though these students had help of family in their school

tasks, most of the time they were by themselves, being required to take a higher degree of responsibility for their learning outcomes – something most young learners were unprepared for. In addition to being on their own, they had to quickly adapt to the change in education modality – from board and print books to Powerpoint slides and Word or pdf documents. This sudden change in study routine has placed the discussion about how we learn on the spotlight, with focus on self-regulated learning and study strategies. Of course, this debate is not restricted to the pandemic scenario: a similarity can be drawn between distance education and learning on the internet, since both are often carried out individually, requiring one's capacity to self-regulate their learning.

Self-regulated learning (henceforth SRL) has been regarded as the metacognitive actions employed by the learner in study situations, such as: setting goals, being aware of what is already known and what is yet unknown, and planning the strategies to achieve these goals. In being conscious, they involve a great deal of motivation and effort (Winne, 1995). Students who regulate their learning control for the time they spend retrieving information, monitoring performance in relation to the goals, reconsidering the strategies to be used to optimize performance, assessing beliefs about their prior knowledge and strategies. When a problem arises, they revise their goals and motivation to learn: difficulty triggers the use of effortful self-regulation processes especially among experienced learners. If the difficulties persist, they might go back, select new strategies, or (ultimately) give up the task (Winne, 1995).

Self-regulated behavior is described by Winne (1995) as comprising three *stages of skill development*. In the first stage, declarative representations are created: the conditions for applying a study tactic (conditional knowledge) are matched with operations to be performed in these conditions (action knowledge). At a second – associative – stage, the parts of a procedure are linked, creating an executable skill. Last, at the third stage, the repeated use of study tactics leads to automatization. These stages illustrate the inherent complexity involved in modifying one's behavior in learning. Winne also points to task difficulty, epistemological beliefs and learning goals as central aspects of self-regulation. The first, task difficulty, situates self-regulation as a task-dependent process: when the effort employed on a task leads to success there is a tendency to transfer the strategies to new tasks, especially if they are considered difficult. Yet, novice and low-ability learners who have not automatized newly acquired study strategies will avoid using them because regulating these processes would demand time and effort (Winne, 1995). The second, epistemological beliefs, influences the strategies students choose, which in turn affect performance in subsequent learning tasks. For instance, beliefs in the simplicity of knowledge correlate with the use of shallow cognitive strategies and low

posttest achievement (Schommer; Crouse; Rhodes, 1992). Thus, the transfer of cognitive strategies to new tasks will be successful if learners acknowledge the value of spending effort on strategy use to reach the desired learning outcomes. A third aspect of self-regulation is goal setting: learners who set more goals and higher standards for their learning are more successful in monitoring their progress. All they need are basic study strategies to start with.

In a more recent study, Winne (2018) draws parallels between SRL and the perspective of levels of processing. To him, in each of the four phases of self-regulated learning (surveying task conditions, setting goals and planning, execution and monitoring, and reviewing), different levels of processing can be identified as a function of the learner's standards, the nature and number of goals and plans set, and the quality of metacognitive monitoring. Winne also describes the multiple uses of the software *nStudy* to investigate levels of processing in SRL. This software collects data about navigation behavior and provides tools to enhance self-regulation such as notes, bookmarks, highlighting, and location marks. In sum, SRL does not inherently lead to greater processing depth, but happens in a complex interplay between the complexity of the material to be learned, the reader's standards for coherence, and the task at hand.

Providing training in self-regulated learning decreases cognitive load, promotes deep processing and facilitates learning from hypertext (Niederhauser, 2000; Azevedo; Cromley, 2004). Evidence for the effectiveness of metacognitive instruction on hypermedia learning is provided by Azevedo and Cromley (2004). In their study, the participants who underwent a 30-minute training session before doing a learning task in hypermedia environment achieved better results compared to the control group (without training). Data collection involved pretests, posttests, and verbal protocols. Comparative analysis of pre and posttests showed that the participants in the SRL condition produced complex mental models, thus gaining more conceptual understanding of the topic. Training was also associated with enhanced self-monitoring (feeling of knowing) and more accurate judgment of learning, as well as with greater use of strategies such as drawing, summarizing, taking notes. The authors conclude that training on self-regulation might enhance learning from contents in hypermedia environments, highlighting the implications of these findings for instruction. Yet, it is important to ponder that, in this study, instruction approached general aspects of SRL. It was not tailored to any specific features of hypertext and strategies to cope with these features.

2.4.1 Strategy use in print and digital means

One way to operationalize metacognition is by employing strategies. Indeed, "thinking about one's thinking is at the core of strategic behavior" (Paris; Lipson; Wixson, 1983, p. 295). Strategies are characterized by their deliberate, goal-driven use: they are actions consciously taken by the reader to monitor his/her comprehension. Even when fostered by educators – and instruction is indeed crucial in developing self-regulated behavior – the degree of awareness required to execute a strategy situates it in the realm of SRL. Examples of reading strategies are skimming the text to identify its topic, scanning it to find specific information, guessing the meaning of words by context, highlighting, and taking notes. Although both strategy and skill may refer to aspects of reading behavior, they are distinct in relation to the degree of awareness involved in their application. Skills get more automatized, accurate or complex as practice evolves – which is desirable in terms of cognitive efficiency. On the other hand, strategies are the part of processing that remains at a conscious level, monitoring comprehension (Gagné *et* al, 1993; Manoli; Papadopoulou, 2012; Veenman, 2015).

Strategies are selected considering the reader's purpose (e.g., for study, for entertainment); the reading situation (e.g., reading the newspaper to get updates on politics, reading a scientific article to write a paper) (Lorch; Klusewitz; Lorch, 1995); the text type and structure (e.g., narrative, expository), and the task demands. Thus, the development of an expert reading behavior involves mastering declarative, procedural, and conditional knowledge (Paris; Lipson; Wixon, 1983). Declarative knowledge (or knowledge of "what") comprises knowing about the text structure and about one's own goals and skills. Procedural knowledge (or knowledge of "how") is the awareness on the steps needed to execute a strategy. The third type, conditional knowledge, places emphasis on the reader's ability to judge when it is appropriate to apply strategies, considering his/her motivation and adjusting behavior according to task difficulty. Teachers play an important role in fostering students' strategic behavior (Paris, Lipson; Wixson, 1983). To support these processes, they can get students to think about their own strategies by modeling strategic behavior, like verbalizing the steps taken during reading – to mention one example of how metacognition and instruction can go hand in hand. Motivation stands out as another relevant component of strategic reading because, as Paris and colleagues (1983, p.298) put, "learners not actions are strategic because it is their decisions, purposes, and efforts that determine their behavior".

In other words, strategy use will vary according to the degree of cognitive engagement employed – or, as previously said, the reader's standards for coherence (Van Den Broek *et al*,

2011). Reading a text to understand its content might involve the use of comprehension strategies, if processing problems arise. Differently, reading a text to learn its content (and eventually be able to use it in novel situations) will require a greater degree of engagement – which means more cognitive effort and also more time spent on the task (Just; Carpenter, 1987; Tomitch, 2012). Study strategies such as highlighting, annotating in the margins or taking notes separately, writing summaries, and constructing charts or tables help learners to reorganize textual information in a way that facilitates retrieval of the content and use in new contexts. Their use is particularly beneficial among less skilled readers (Spring, 1985). Research reviewed by Baron (2021) points to retrieval practice (e.g., self-testing) as an effective strategy to study texts, followed by summarizing, highlighting and rereading. Drawing from the declarative/procedural model of memory, Ullman and Lovelett (2016) list techniques for second language learning. They highlight the positive effects of spaced repetition (distributing the study sessions about a topic across time) and retrieval practice (testing what one recalls about the content without resorting to the study material) on L2 vocabulary learning, including classroom settings. In sum, the more the reader engages with the material, the better the learning outcomes are.

Digital reading builds upon comprehension skills in print and is similarly influenced by individual differences in prior knowledge, working memory, and motivation. The strategies used to read in the digital medium are also transferred from the traditional print form, although some strategies need to be adapted for use online. A number of factors interact with strategy use onscreen – and the main concerns the medium itself. Baron (2021) demonstrates that readers do not use as many strategies for digital texts as they do when reading in print. In fact, undergraduate students reported that if the cost were the same, they would prefer to read on paper, the medium they can focus better. This difference in behavior between print and digital stems from the type of reading that is usually performed onscreen: users often quickly scroll down (on social media apps, for instance) without further examination of the content. This fast, shallow processing requires little effort and might be transferred to other reading situations performed on the same device. In addition, learners may rely too much on the internet as a readily available source of knowledge. Another factor that interferes with the application of strategies when reading digital texts concerns familiarity with the tools at disposal such as digital highlighting, annotation or bookmarks.

In discussing strategies to be used by school-age students when reading onscreen, Baron (2021) highlights the role of focused reading, active engagement with the content, and the importance of balancing the use of screens with print material. In the context of multiple-text

reading, the aforementioned competencies of navigating, evaluating and integrating (Salmerón *et al*, 2018c) are regarded as central. Her tips are summarized in table 2 (using the same informal tune):

Table 2 - Sumary of the main strategies for reading onscreen

Single texts	**Multiple texts**
- Adjust font size and line spacing - Adapt modality to text length: students usually prefer to read longer texts in print - Think about your learning goals, that is, what you need to remember, and for how long – and use strategies accordingly. Reading to write an essay will require more engagement compared to reading to participate in a discussion - Keep track of your comprehension (am I understanding this?) - Avoid distractions such as notifications from the device you are using as well as from all others (keeping them far and silent is a good idea) - Multitasking (e.g., opening dozens of tabs in your browser as you read) also counts as distraction. - Take your time: the idea that faster reading is more efficient is a myth. If you are reading online, space out your scroll down movements. - Read carefully and mindfully, taking notes and making pauses to think about what you read. - When you finish (or at the end of each passage, for longer texts),ask yourself questions to check comprehension or make summaries to elaborate on what you read in your own words. - Make the most of digital annotation tools, concept maps and platforms of collaborative work. - Combine modalities (e.g., reading onscreen and taking notes on paper)	- When browsing through a Google results page, avoid clicking on the first page without carefully inspecting your search results - When accessing a page, don't get straight to the text – evaluate the quality of the page first. Finding trustworthy sources requires attending to source features such as the website domain (.com/.edu), text author, his credentials, the organization/institution represented, date of publishing, the stance (especially when reading about opposing perspectives) - Read *laterally,* i.e., make parallel searches to verify the credibility of the main source - When the text has hyperlinks, access only the ones you consider most relevant to your goal - Professionally-looking design is not a good evaluation criteria - Use concept maps or take notes to compare and integrate information from the different sources read - Mind possible information bias and your own prior beliefs

Source: Baron (2021)

Another influential factor that mediates strategy use onscreen is L2 reading, since low level of level can increase cognitive load. Do Amaral, Torres and Tomitch (2018) reviewed studies on strategic behavior in the digital environment in English as an L2. They found that

although many strategies used when reading online texts in L2 are transferred from print (Taki, 2015; Park; Kim, 2011, 2017), more strategies are used only when reading online (Gilbert, 2017; Usó-Juan; Ruiz-Madrid, 2009; Zaki; Hassan; Razali, 2008). Furthermore, online reading demanded the use of a specific set of strategies related to computer skills and navigation, such as accessing webpages, navigating through hypermedia, and using computer applications and accessories (Park; Kim, 2011, 2017; Park; Yang; Hsieh, 2014). Glossaries and information displayed in pop-up windows have proven to be a useful resource in L2 lexical processing and for prior knowledge activation (Akyel; Ercetin, 2009). Noteworthy, many of the strategies observed in these previous studies were associated to reading tasks carried out on the internet: using hypermedia, using computer applications and accessories, accessing a webpage, using computer skills and devices, locating information from multiple online resources; critically evaluating information online; and synthesizing information online (Coiro; Dobler, 2007; Park; Kim, 2011; 2017; Park *et al*, 2014). In relation to evaluation strategies, studies contrasting L1 and L2 reading indicate that English is perceived as a source characteristic, i.e., an indicator of trustworthiness (Karimi; Richter, 2021; Taki, 2015).

In the attempt to identify the strategies used by students when reading online, reading behavior has been traced by surveying the readers' metacognitive awareness of the strategies they used. In the online setting, the first study of perceived strategy use among L2 readers was carried out by Anderson (2003) with 247 participants students of English (L2) from English language centers in Costa Rica and in the U.S. The instrument used was the Online Survey of Reading Strategies (OSORS), which was adapted from the Survey of Reading Strategies (Mokhtari; Sheorey, 2002). Results indicated that the majority of the strategies used were Problem Solving Strategies: adjusting reading rate, rereading difficult text, and pausing to think about what one is reading. The researcher highlighted the importance of fostering readers' metacognition in online reading, especially for second language learners, and the important role of L2 reading instruction. In this scenario, teaching students online reading strategies might enhance their online experience and lead to improved learning outcomes.

More recently, the OSORS has been subject to criticism. Li (2020) pointed to the limitations of Anderson's (2003) adaptation of Mokhtari and Reichard's Metacognitive Awareness of Reading Strategies Inventory (MARSI) (2002). A relevant problem concerns the lack of validation of the new instrument after items were added. Another criticism is the mere addition of the term "online" to most of the survey items, disregarding the specificity of online reading– that is, in a faster manner compared to print, since readers often scan the pages rather than reading in a focused, in-depth manner. One example of such mistake, as identified by Li,

was in the item “I read slowly and carefully to make sure I understand what l am reading *on line*” (my emphasis). Another item seemed to pertain to speaking rather than reading: “I participate in live chat with native speakers of English”. Having these issues in mind, Li (2020) developed and validated the Second Language Online Reading Strategies Inventory (SLORSI) to account for the complexity of reading behavior in this scenario. In addition to the traditional strategies which are transferred from print reading, specific strategies were included that are used when reading non-linear texts online such as engaging in collaborative work, evaluating the pages visited (contrasting information across pages), looking for different perspectives on the same issue, selecting relevant hyperlinks, using navigation tools such as overviews and menus (Li, 2020).

Under a more intervention-oriented nature, studies aiming at optimizing readers’ web search and navigation skills have explored the effects of instruction by using a variety of methods, from think-aloud protocols (Gerjets; Kammerer, Werner, 2011) to written instructions (Mason; Junyent; Tornatora, 2014), self-generated judgments of source quality, and interviews (Macedo-Rouet; Potocki; Scharrer; Ros; Stadler; Salmerón; Rouet, 2019).

Gerjets and colleagues (2011) compared think-aloud protocols with regular thinking-aloud instructions to thinking-aloud with instructions so as to explicit webpage evaluation criteria. In this study, the instructed evaluation condition was linked to more verbalization of quality criteria, although it did not affect the number of items attended in the search page nor fixation time. Mason and colleagues (2014) conceived an instructional intervention (with a non-instruction control group) aiming at developing ninth-graders’ declarative knowledge when evaluating online sources. Ninth-graders read about how to evaluate sources and then performed a navigation task consisting of an inquiry task (evaluating which webpages were the best sources to answer a question about the use of mobile phones and health), and a source evaluation task (ranking the websites based on their reliability, justifying their ranking). A transfer task was also applied a week later to check whether students were able to use previously learned evaluation strategies in a novel context. Students in the instruction condition made fewer visits to less reliable websites and spent longer in reliable ones, performed better in the ranking task and justified their ranking in a more sophisticated manner compared to the control group.

In a study targeting the development of the evaluation competence, adolescents were given an assessment form and asked to rate the quality of each page and its usefulness to the task (Macedo-Rouet *et al*, 2019). The documents had either source issues such as non-expert author or outdated, or content-related issues such as topic mismatch and poor readability.

Overall, participants failed to identify these issues. Evaluation was problematic: participants failed to detect content mismatches between topic and text and ignored source cues, rating all texts as useful. In the second experiment, they were interviewed and prompted to elaborate about the relevance of the information to the assignment before completing the assessment form. The hypothesis was that these prompts would enhance the detection of content issues but not of source issues, since they are very related to the reader's competence. Results indicated that prompting had a positive effect among high-school students, but not with middle schoolers (Macedo-Rouet *et al*, 2019).

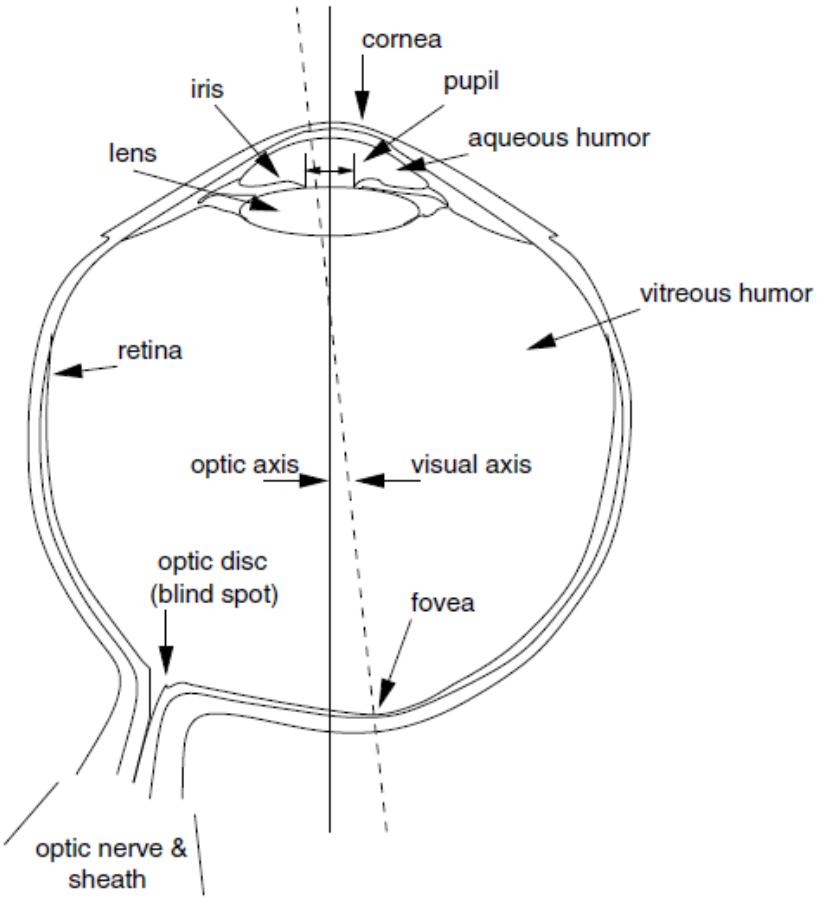
The identification of strategies and ways to foster self-regulation processes in onscreen reading have been extensively investigated by using tools such as instructional interventions, surveys, and verbal protocols. Notwithstanding, other measures such as the eye tracking methodology have also become an increasingly common online[9] method to investigate digital reading behavior – as discussed in the next section. In addition, eye-movement modeling examples (EMMEs) are presented and examined in their potential to foster attention to processing and learning from digital texts.

2.5 EYE TRACKING IN DIGITAL READING

The human brain processes visual input through the light-sensitive cells in the retina. First, light is focused into the eye by the cornea. It passes the pupils (which regulate how much light enters) and lens (more focus) and is sent to the retina, where photoreceptors change light into energy and transmit it to the brain through the optic nerve. There, in the back of the eye is a depression named fovea, which is the center of our visual field; it is where vision is most accurate, but it is very small (see figure 1). Outside the foveal region is our peripheral vision, where clarity decreases. Thus, to see in detail, the eye must move. These movements are captured by the eye-tracker.

[9] In reading research, the term "online" refers to the methods used to investigate reading as it unfolds, involving behavioral data (e.g. verbal protocols), and physiological data (e.g., fMRI, EEG, and eye movements). It contrasts with "offline" methods (e.g., comprehension questions). Each method unveils a different approach to reading: the former sees it as a process, while the latter, as a product. Yet, they can – and should – be combined and compared (TOMITCH, 2008).

Figure 1 - Anatomy of the eye



Source: Duchowski (2007 p.19) Adapted from Visual Perception, 1st edition, by Cornsweet (1970)
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The eye tracking methodology has been extensively used in its potential to investigate online language processing; it enables the measurement of overt attention during cognitive tasks such as reading (Rayner, 2009). Eye tracking is a non-intrusive technology that records the position and movement of the eyes as they process input (usually presented onscreen). Eye trackers work by shedding infrared light on the pupil and capturing its reflection on the cornea with an infrared camera. These data enable the algorithms to delimit the center of the pupil and determine gaze direction and eye movements (Eyeware, 2022). Although visual behavior data have been used in everyday technology such as elevators, security devices, and inclusive applications, Maia (2022) warns about the possible downsides of its misuse such as problems with data safety (i.e., use of eye data to trace consumer profiles) and increased civil surveillance. For this reason, the researcher defends that researchers should explore the potential benefits of the eye-tracking technology for educational purposes as an important step towards ensuring democratic applications of this tool.

As we read, our eyes either stand still (*fixations*) or move between chunks of information (*saccades*). We also make *return sweeps* at the end of the line to the next one below, and *regressions* (backward movements to previously read words) if comprehension problems arise. When analyzing word processing, the most common eye movement measures are *first fixation duration* on a word, *gaze duration* (sum of all fixations made on a word prior to moving to a next word)*, total fixation duration* (sum of all fixations including regressions). *Mean fixation duration* is considered an inaccurate measure since it disregards differences in fixation between specific words. At the sentence level, the measure usually used is *first pass time,* which is the sum of fixations on a region before moving forward (Rayner; Juhasz; Pollatsek, 2005).

The eye-tracking technology enables the researcher to determine whether, for how long, and in which order the reader attends to each piece of information (Scheiter; Van Gog, 2009). Besides, it sheds light on cognitive processes that are unconscious to the reader and thus, unlikely to be verbalized (in verbal protocols, for instance) nor evidenced in offline comprehension measures such as essays or comprehension tests. Longer fixation duration on a word has been traditionally interpreted as an indicator of comprehension difficulty (Rayner, 1998; Rayner; Chace; Slattery; Ashby, 2006; Schotter, Tran, & Rayner, 2006). At the paragraph or text level, longer fixations can be an indicator of increased attention and strategic processing.

Scheiter and Van Gog (2009) write the introduction of a thematic issue of Applied Cognitive Psychology on the use of eye tracking to analyze processing of informational and instructional media. The researchers argue for eye tracking as a means to investigate the processing of information conveyed in multi-representational sources. The eye-mind assumption (Just; Carpenter, 1980) is the underlying theory in their work (and others following the same line of research): it postulates that what is fixated by the eyes is being processed by the brain. Eye tracking data can also be used to foster the reader's metacognitive processes.

Using the eye tracking methodology, an exploratory study with 6th-grade Finnish students identified the strategies used to inspect and evaluate results in a search engine page (Hautala; Kiili; Kammerer; Loberg; Hokkanen; Leppänen, 2018). Because the components of Google-like search results can be used strategically in search, three areas of interest (AOIs) were established: title, URL and snippet. Results showed that the strategy of looking at titles and snippets was used by half of students; few examined all three components. Students who focused only on the titles made more inspection errors.

Researchers in Brazil have shown increasing interest for the possible interface between psycholinguistics and the problems faced by schools in the task of educating for full literacy. In the words of Maia (2018), once the diagnosis of the educational needs is done, the challenge

is to "(…) seek to develop practical activities to be adopted by the schools aiming at boosting structural knowledge, developing students' reading and writing competence." (p.128, my translation). His message is clear: not only should researchers in the field of psycholinguistics investigate language processes directly in the school setting, but also – and crucially – work on the results of these investigations, creating materials and interventions that be both scientifically grounded and pedagogically oriented.

The laboratory of electrophysiology and eye tracking (Laboratório de Eletrofisiologia e Rastreamento ocular da linguagem – LER) from the Federal University of Rio de Janeiro (UFRJ) led by professor Marcus Maia, started their intervention in a public school in Niterói/RJ in 2017. Their focus was on the processing of subordinate clauses among two groups of eight-grade students. Data was collected using psycholinguistic measures such as eye tracking, electroencephalogram (EEG), self-monitored reading and cloze tests. Eight-grader's performance in subordinate clauses reading was compared to a group of undergraduate students (proficient readers). Eye tracking data of the two groups was compared, revealing that the undergraduate students made longer fixations in the main clause and more *lookbacks*, while the elementary school students tended to fix their gaze for longer periods in the beginning of the sentence, disengaging as reading unfolds. These results demonstrated a more structured reading pattern in the proficient group, who was better able to identify the main clause, knowing it would not necessarily be presented at first; differently, the younger readers simply followed the linear order, being unable to identify the perspective in the sentence and the hierarchy between the subordinations.

With the results of these psycholinguistic measures in hand, the researchers identified students' weaknesses and devised interventions that focused on developing their awareness on the structure of the period. To that purpose, a year later, they returned to the school in Niterói and carried out a series of workshops with one of the groups that had been previously tested. In the posttest phase, both groups were retested to check for the effect of instruction. Overall, the workshops were reported to be successful in developing students' metacognitive awareness and active engagement with their own learning process. Noteworthy, their approach bears some resemblance to the eye movement modeling examples (EMMEs) used in the present study – which will be discussed in the next section.

In the L2 context, studies employing the eye tracking methodology have approached the acquisition of new grammatical features (Fourcart; Frenck-Mestre, 2012) And Vocabulary (Kang; Kweon; Choi, 2020; Tham; Chau; Thang, 2020), the processing of phrasal verbs (Wisintainer; Mota, 2017), syntactic violations in word order (Tunietti; Warren; Tokowicz,

2015), and the prediction of implicit causality during sentence processing (Contemori; Dussias, 2019). Yet, there is a research gap regarding how the new digital competencies are operationalized when reading L2 texts online. As we can see, many studies in the L2 context followed an L1/L2 comparative paradigm and focused on more elementary levels of reading comprehension (e.g., vocabulary acquisition, comprehension of metaphors, sentence processing). To the best of our knowledge, no study insofar has used the eye tracking methodology to analyze navigation behavior and source evaluation in L2 reading. Furthermore, this data will enable an analysis of the effects of metacognitive instruction with eye movement modeling examples – which is the focus of the present study.

2.5.1 Eye movement modeling examples

As previously stated, the eye tracking methodology has been widely used in education research to investigate learners' online processing of information. Yet, its use as an instructional tool to foster students' metacognition is less spread (Mason; Pluchino; Tornatora, 2016). Similarly, Maia (2022, p.13) argues for the educational use of eye movement data as "an epistemic tool" to foster students' language awareness – which in turn can help them develop analytic skills and scientific reasoning (Maia, 2019).

Eye-movement modeling examples (henceforth EMMEs) is one of the terms used in educational sciences to refer to video models, although its use extends to medical education, ergonomics, computer sciences, and business. This video modeling technique is employed for different goals depending on the area of expertise. For instance, in sports and aviation, their use is associated with strategy development, while studies in medicine and STEM (Science, technology, Engineering and Math) areas use EMMEs to guide attention, e.g., showing procedural steps to surgeons (Emhardt; Kok; Van Gog; Brandt-Gruwel; Van Marlen; Jarodzka, 2023).

EMMEs are videos that show the gaze path of an expert as he/she is processing visual stimuli or performing a (problem-solving) task onscreen. The premise is that presenting EMMEs to other learners can model their behavior, signaling which information are relevant and should be fixated longer, or showing the steps on how to solve a problem (Krebs; Schüler; Scheiter, 2019; Emhardt *et al,* 2023). By modeling how a stimulus is processed at an optimal level, this video has the potential to develop the reader's metacognitive awareness – which can be used in similar learning tasks to come (Scheiter *et al*, 2018). In addition, EMMEs might enhance traditional instruction since eye movements provide the learner with visual input,

although the main reason for its recently increased use is the demand for video-based instruction, which has risen during the COVID-19 pandemic (Tunga; Cagiltay, 2023).

In general, the findings from previous studies regarding the effectiveness of EMMEs on attentional guidance and visual search are positive. A meta-analysis (Xie; Zhao; Deng; Peng; Wang; Zhou, 2021) has shown that EMMEs have increased attention (as measured by first fixation times and fixation duration) – although not necessarily to task-relevant items – and increased cognitive performance in subsequent learning tasks, especially in non-procedural tasks involving classification or strategy use, in which the model does not interact with the material. While there is mounting evidence of the positive effects of EMMEs on online processing, its influence on learning outcomes is less well-established and dependent on prior knowledge, with learners with high prior knowledge performing better in recall tasks (Scheiter *et al*, 2018; Xie *et al*, 2021). In the study of Krebs and colleagues (2019), participants with lower prior knowledge had longer fixation time, while participants with high prior knowledge were not affected. In addition, the effect of EMMEs on learning depends on the type of task proposed. In their systematic literature review, Emhardt and colleagues (2023) found more studies showing effects of EMMEs on visual classification, visuo-monitor tasks, and text processing/comprehension. Its positive effect in problem-solving tasks was corroborated by fewer studies.

The first study to use gaze replays was done by Van Gog and colleagues (2009), who conceived a problem-solving situation to guide participants' attention while showing them worked examples before task performance. The assumption was that showing the eye movements together with the expert's resolution and verbalizations could enhance the effectiveness of the examples and, as a result, aid problem solution. No participants in the no-guidance (control) condition could solve the problem compared to participants in the experimental groups, which shows an overall effect of the worked examples. On the other hand, attention guidance combined with eye movements had a detrimental effect on learning. Researchers explain the results in terms of possible redundancy effects as well as difficulty attending to eye movement and verbal input simultaneously (Van Gog, Jarodzka, Scheiter, Gerjets, And Paas, 2009). Differently, Jarodzka and colleagues (2013) found a positive effect of EMMEs on the interpretation of visual information (speed and length of fixation on relevant areas), and also on learning outcomes (measured by a visual search test and an ability test). That is, participants were able to transfer a coherent visual path to a novel situation and answer multiple choice questions (Jarodzka; Van Gog; Dorr; Scheiter; Gerjets, 2013).

In multimedia learning, eye movement modelling has been used to foster metacognition, integration, and learning from text (Mason; Pluchino; Tornatora, 2016; Scheiter; Schubert; Schüler, 2018). With a sample of seventh-grade students, Mason and colleagues (2016) found a positive effect of EMMEs on text-picture integration (as measured by longer fixations on the pictures while rereading) and on deeper processing (as measured by a transfer task) – especially among students with low comprehension skills. With university students, Scheiter and colleagues (2018) investigated the effect of EMMEs as a means to promote self-regulation strategies when learning from text and pictures. The group exposed to the EMMEs had longer fixations in the pictures and made longer transitions between text and picture (an evidence of integration processes). However, EMME had no effect on learning outcomes: students with low prior knowledge showed poorer recall, while the recall of students with high prior knowledge was not affected by EMMEs.

In the context of hypertext reading, Salmerón and Llorens (2019) used eye movement modelling examples with case contrasts in order to develop ninth-graders self-regulation strategies. In their study, the videos of a reader's movements were shown together with his/her verbalizations during task to model expert behavior. In addition, the case contrasts required that participants compared two EMMEs to analyze the strategies used in the video when reading conflicting information. One EMME presented a student using optimal strategies and the other, less refined ones. The controls were given a written version of the cases. In both pre- and posttests participants read hypertext and answered open-ended questions – only the topic was different in each phase. Results showed that the experimental group outperformed the control group at posttest comprehension scores. Nonetheless, the difference in navigation behavior favoring the experimental group was time spent on the main page, meaning that researchers found little behavioral change in posttests. This finding was explained in terms of the complexity of developing evaluation strategies in hypertext reading, which also requires inferential processing. To conclude, the authors put that future research could enhance the effectiveness of EMMEs by dividing the visual components (gaze plots) from the auditory part (thought verbalizations) so as not to overload participants with information.

Another example of the use of EMMEs to inform instruction in hypertext reading is explored in the study of Salmerón, Delgado and Mason (2020). The recordings of the eye movements made by expert readers while browsing through hypermedia were showed to participants to model what an optimal navigation path would look like. The researchers' goal was to foster critical reading when dealing with conflicting information in an online learning situation. Results showed that, after intervention, participants attended more carefully to

information, considering issues of authorship while browsing and citing the sources used in post-tests.

All that said, the present study aims at extending current research on the use of EMMEs to foster integration processes (Mason *et al*, 2014), self-regulation in the evaluation of online sources, and navigation strategies (Salmerón; Llorens, 2019; Salmerón; Delgado; Mason, 2020) to the L2 setting. Our main goal is to check the effect of EMMEs on navigation, source evaluation, and misconception change among undergraduate students speakers of English as a second language.

3. METHOD

Learners should develop and have the will to exercise effective means for self-directing their learning, whether that be in social-collaborative contexts or in contexts of chosen or forced solitude.

Winne, *Inherent details in self-regulated learning*

The present chapter is divided into six sections and begins by presenting the research questions and hypotheses devised for this study. Next, the profile of the participants (mean age, origin, and educational background) and the context in which the study took place are described. Section 3.4 details the ethical procedures that were done, since the study involved human participants. Section 3.5 describes all the instruments selected and adapted for this study as well as the materials developed, followed by information about how each type of data was analyzed. Section 3.6 explains the procedures adopted for data collection, and section 3.7 provides information about the pilot study and how it informed the main study.

3.1 RESEARCH QUESTIONS

This work aims at investigating the effect of EMMEs (videos of eye movement modeling examples) as a tool to foster self-regulation processes when reading multiple online documents in English (L2) that present opposing perspectives about the Learning styles (LS) misconception. We also hypothesize an indirect effect of EMMEs on the identification of opposing perspectives and misconception change. The population investigated were European university student speakers of English as L2.

Misconceptions about LS were identified on a pretest. Navigation and source evaluation were measured by fixation duration on the selected areas of interest (AOIs) within the webpages (a Google-like page showing search results about the topic Learning styles and its six related webpages). Participants' L2 level and self-reported strategic behavior when reading digital texts in English (L2) were also controlled. After reading, they wrote an essay, a source-memory task, and answered multiple-choice posttest to check for misconception update. The study followed a mixed-methods approach (Dornyeil, 2007), since the quantitative data was combined with a qualitative analysis of the essays to enable a better understanding of these data. To accommodate these objectives, a few research questions are proposed:

3.1.1 Regarding the effects of EMMEs on processing

RQ1a Do EMMEs affect navigation across the results of a search engine research page (SERP) in English (L2), measured by fixation duration on the webpage headers and snippets of each result within the SERP?

RQ1b Do L2 level (measured by scores on LexTALE) and self-reported behavior (measured by scores on the Second Online Reading Strategies Inventory) mediate the effect of EMMEs on navigation in L2?

RQ2a Do EMMEs affect attention to sources and content evaluation of multiple online documents in English (L2) that either endorse or refute the Learning styles (LS) misconception, to be analyzed by the contrast between fixation duration on reliable versus non-reliable pages, and on fixation duration on the source features (website banner and author's name and occupation)?

RQ2b Do L2 level and self-perceived strategic behavior mediate the effect of EMMEs on source evaluation of multiple documents in L2?

3.1.2 Regarding the effect of EMMEs on learning outcomes

RQ3a Do EMMEs affect argumentative reasoning, as measured by argumentation scores on an essay writing task?

RQ3b Do English level, navigation and evaluation behavior mediate the effect of EMMEs on argumentation score?

RQ4a Do EMMEs increase memory for the sources when reading multiple documents?

RQ4b Do English level, navigation and evaluation behavior mediate the effect of EMMEs on memory for the sources?

RQ5a Are EMMEs linked with updating of misconceptions about Learning styles, to be measured in a pre/posttest?

RQ5b Do English level, navigation, and evaluation behavior (including memory for the sources) mediate the effect of EMMEs on misconception change?

3.2 HYPOTHESES

The hypotheses underlying this study have been conceived by observing prior studies as well as the theoretical constructs that follow. First, considering that reading comprises lower levels (decoding and literal comprehension), and higher levels (inferential comprehension and comprehension monitoring), (Gagné, Yekovich, Yekovich, 1993), and that lower levels are the basis upon which higher levels are built, then low L2 level might interfere with the development of new digital competencies. Second, it is known that strategic behavior can be transferred from L1 to L2 reading (Taki, 2015; Park, Kim, 2011, 2017). Third, regarding the effect of EMMEs, Salmerón and colleagues (2020) found a link between EMMEs and increased attention to SERP features and information about authorship as well as decreased time reading pages that were less trustworthy. Last, Schwartz and colleagues (2004) found that individual differences in metacognition affect hypertext reading: participants' self-rating of their metacognitive skills predicted performance in complex navigation tasks. All this considered, we propose the following hypotheses:

3.2.1 Regarding the effects of EMMEs on processing

Hypothesis 1 Instruction with EMMEs increases navigation, evidenced by longer total fixations on the search engine results page (SERP) features, particularly web page name and snippets, in English (L2).

Hypothesis 2 Instruction with EMMEs increases attention to sources and evaluation of content of content reliability when reading multiple online documents in English (L2). The EMME group will read the reliable pages more carefully, while the pages with less reliable content will be only strategically scanned. The control group will read all texts from beginning to end, resulting in little to no difference in fixation times between reliable and non-reliable pages. Participants in the EMME condition will examine source features (banner, author's name and occupation) for longer compared to the control group.

Hypothesis 3 L2 level mediates the effect of EMMEs on navigation (fixation on the SERP) and evaluation (fixation on source features). Readers with higher L2 level will benefit more from the EMMEs intervention compared to lower-level readers.

Hypothesis 4 Self-reported strategic behavior mediates the effect of EMMEs on navigation (fixation on the SERP) and evaluation (fixation on source features and on reliable and non-reliable webpages). Participants who report a high frequency of strategy use in the survey are likely to benefit more from the EMMEs, attending more to navigation features and evaluating the sources and content credibility more accurately compared to the participants who report a low frequency of strategy use.

3.2.2 Regarding the effects of EMMEs on learning outcomes

Hypothesis 5 If EMMEs enhance navigation (measured by total fixation on the SERP) then their effect will extend to the learning outcomes, with the experimental group (EMME) achieving higher argumentation scores in the essays, higher scores in the source-memory task, and greater misconception change (evidenced by the difference between pretest and posttest scores) in comparison with controls.

Hypothesis 6 If EMMEs enhance evaluation (measured by total fixation on the source features), then their effect will extend to the learning outcomes, with the experimental group (EMME) achieving higher argumentation scores in the essays, higher scores in the source-memory task, and greater misconception change (evidenced by the difference between pretest and posttest scores) in comparison with controls.

Hypothesis 7 English level mediates the effect of EMMEs on learning, with the participants in this group with higher L2 level achieving higher argumentation scores in the essays, higher scores in the source-memory task, and greater misconception change (pretest/posttest) in comparison with controls.

3.3 PARTICIPANTS

An a priori power analysis was done using the *pwr* package in R, showing a minimum of 55 participants needed to achieve statistical relevance using linear models. Undergraduate students from psychology, speech therapy, and teaching were personally invited during class time with the consent and collaboration of the professors, who also sent invitations for participation online. In order to achieve the number of participants needed, by the end of the data collection phase, 10 euros were offered to students (n=6) in a second call in return for their participation. Participants from this second batch were paid by the Research Unit on Reading (Estructura de Recerca en Lectura – ERI Lectura), in which data collection was taking place.

A total of 59 students participated in the study: 57 undergraduate students from psychology, speech therapy, and teaching courses, and 2 graduate students from veterinary and politics of equality. Except for the two graduate students who were from Honduras and Guatemala, participants were either Spanish or from other European countries (Germany, Romenia, and Italy). The foreign students were from programs of academic mobility such as Erasmus (European Union) and Carolina Foundation (aimed at fostering academic cooperation between Spain and Iberian-American countries). University of Valencia commits itself to internationalization by offering courses in English as well as opportunities for collaboration in research projects. One person has withdrawn her consent during participation and the gaze data of participant 43 was not valid, totalizing 57 participants (50 female, $M = 20.5$ years old, $SD = 3.04$). Participants had normal or corrected-to-normal vision. All of them were speakers of English as an L2 who were studying at a large Spanish university at the time of data collection. Additionally, at the time of recruiting, students were asked to present a certificate of minimum B1 level as a requirement to participation. Participants were randomly assigned to one of two conditions: experimental (EMME) or control (an instructional video without EMMEs). There were 29 students in the experimental group and 28 students in the control group.

3.4 ETHICS REVIEW BOARD

In accordance with Spanish research regulations, all studies with humans must be submitted to analysis by an ethics committee to protect participants and ensure studies are following all the ethical procedures. The present study was approved by the Ethics Committee of Research in humans of the Ethics Commission in Experimental Research of University of Valencia – registration number 1822514 (appendix A). Prior to participation, all students were

informed about the study objectives, its possible risks and benefits, and the possibility of withdrawing their participation at any time (appendix B). Their anonymity was preserved and they were informed that participation was voluntary.

3.5 INSTRUMENTS AND MATERIALS

3.5.2 Self-reported behavior

The Second Language Online Reading Strategies Inventory - SLORSI (LI, 2020) was the survey used to identify participants' self-perception of their strategic behavior when reading digital texts for academic purposes in English as an L2 (Appendix D). In the present study it was employed in its original version and language (English). The SLORSI has been validated via second-order confirmatory factor analysis to certify the validity of the new reading strategies proposed in relation to the strategies used when reading in print. This survey comprises 29 items divided into 9 factors: inferring meaning, skimming, and translating, locating information, synthesizing, saving on device, navigating, critically evaluating and communicating online to solve problems. As for its dimensions, the survey encompassed inferring, skimming and translating as traditional cognitive strategies; locating, synthesizing, saving and navigating fit the dimension of new cognitive strategies; while evaluating and communicative strategies were two independent dimensions related to both in print and digital reading. Participants rated each statement on a 5-point Likert scale ranging from 1, meaning "I strongly disagree with this statement" to 5, meaning "I strongly agree with this statement."

The answers to the Online survey of reading strategies (OSORS) were analyzed by calculating the total score each participant obtained item and dividing the result by the total number of items in the survey to obtain an average score for the entire inventory ranging from 1-5 (LI, 2021). Scores were interpreted according to the three levels of language learning strategy usage proposed by Oxford (1990): mean of 3.5–5 for "high", mean of 2.5–3.4 for "medium" and mean of 2.4 and lower for "low" levels of strategy use.

3.5.3 Prior beliefs test

According to the Learning styles theory, a student will learn better if the material to be learned matches his/her preferred mode of information presentation (e.g. visual, verbalizer, kinesthetic). As foretasted, criticism of this theory points to the absence of an explanation of its

cognitive underpinnings as well as problems with measurement and validity. Even though it lacks empirical evidence, this misconception remains popular and pervasive among students and teachers at all levels of education (An; Carr, 2017; Pashler *et al*, 2008). Thus, we have also investigated a possible misconception change as a result of intervention. Prior beliefs were measured through a multiple-choice test at T1 (pretest) and T2 (posttest).

A section of the Misconceptions about Multimedia Learning Questionnaire – MMLQ (Eitel; Prinz; Kollmer; Niessin; Russow; Ludäscher; Renkl; Lindner, 2021) was used to control for prior beliefs about Learning styles. The original questionnaire was devised to investigate the pervasiveness of misconceptions about multimedia learning among a group of teachers and student teachers. Participants in the present study rated the four statements that comprised the section related to LS in the original study. These four items in the LS section were constructed to account for two beliefs: 1) that students had either a visualizer or a verbalizer style and 2) that instruction should be tailored to students' LS (Eitel *et al*, 2021). No changes were made in the phrasing of the statements; the language of the instrument has also been maintained as in the original (English).

Each of the four statements that comprised the section about learning styles represented an inaccurate view of learning based on the theory: LS1: Performance is decreased when visual learners study with text or when verbal learners study with animations or diagrams. LS2: Performance is better when students work with materials that are constructed to match their learning style. LS3: A necessary condition for good teaching is to know the students' learning style (visual, verbal, kinesiological). LS4: Whether students learn better with visual or verbal materials depends on their learning style (Appendix E). Procedures were the same as the original study: participants were first asked to agree/disagree with each statement and then rated the certainty of their answer ("How certain are you?") on a five-point scale ranging from "very certain" to "very uncertain".

Following the same procedures for analysis adopted in the original study (Eitel *et al*, 2021), the Learning styles questionnaire was first inspected in relation to the agreement rates with the misconception ("I agree" = 1, "I do not agree" = 0). Second, scores were calculated by combining agreement and response certainty: agreement with a misconception item was coded -1, and disagreement with +1. These values were multiplied by the certainty rating (coded from 0 = very uncertain to 4 = very certain) for the respective misconception item. Participants' high agreement with a false statement was interpreted as an indicative of strong belief in that misconception. "Very uncertain" answers scored 0 even if they were correct since they were

more likely to be a product of guessing. Stronger misconceptions were coded as negative scores, resulting in values ranging from –4 to +4.

In addition, pre- and posttests were contrasted to check for misconception change and learning. The same test was used at two moments: prior to intervention, as a pretest to control for participants' knowledge on the topic to be read about, and as a posttest, to check for any update in relation to the misconception. Thus, a mixed-effects model was run with T1 as pretest and T2 as posttestst.

3.5.4 English level test

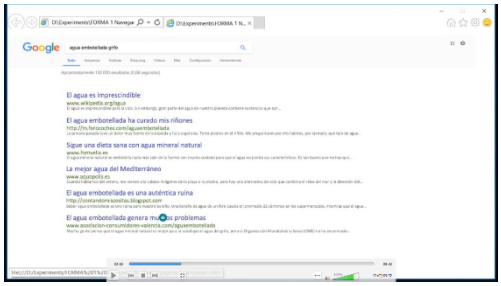
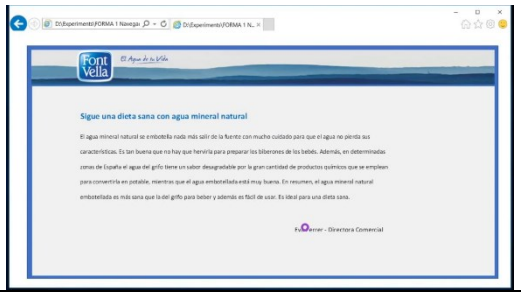
LexTALE was used to control for participants' English level. It is "a test of vocabulary knowledge for medium to highly proficient speakers of English as a second language" (https://www.lextale.com/whatislextale.html). This test has been validated by previous research (Lemhöfer; Broersma, 2012) and consists of a quick lexical decision task in which the participant reads strings of letters and decides whether each string is an existing English word or not. Participants were instructed that if they were sure the word existed but did not know its exact meaning, they could still respond "yes", but if they did not know whether it was an English word, they should answer "no". The stimulus comprises 40 low-frequency words and 20 nonwords, totalizing 60 trials. The test took approximately 4 minutes; after finishing, participants were asked to send the results by email to the researcher. In addition to the test, at the time of recruiting, participants were told that they should hold a minimum B1 level, which they reported in the identification form.

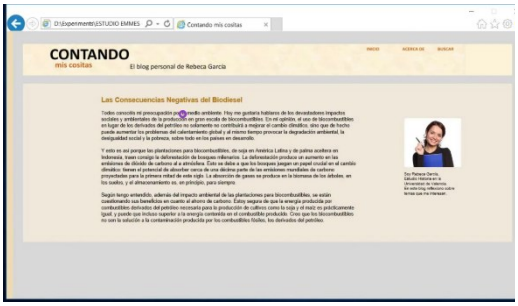
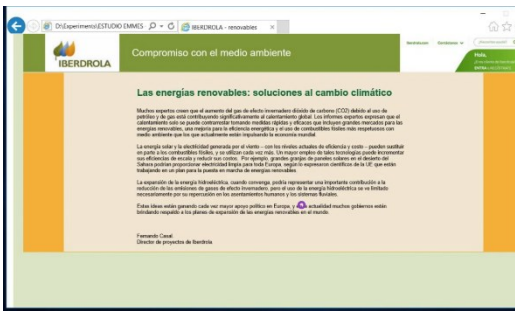
3.5.5 Eye movement modeling examples (EMMEs)

Eye tracking tools capture the reader's eye movements while processing a text onscreen. Eye movement modeling examples (henceforth EMMEs) are selected parts of these eye movements manipulated by researchers that were recorded by an eye tracking software. The EMMEs used in this study were a modified version of the stimuli developed in the study by Salmerón, Delgado e Mason (2020). The first version of the EMMEs showed only the behavior of students who perform well in the reading task. We extended this material to also encompass the recording of less optimal students; this change was based on the assumption that these contrasting cases would foster metacognitive processing, following previous research in the L1 context (Salmerón; Llorens, 2019). The final product was a 9'32-minute video that showed the

eye movements of eight students – five who performed well and three who did not perform so well (table 3). The video can be accessed via this link: 5_EMME estudio Juliana.mp4

Table 3 - Overview of the EMMEs

EMME	Strategy modelled	Description	Screenshot	Time
Students who do well the task				
#1	SERP inspection	A student types keywords on Google, inspects a SERP page from top to bottom, reading at a normal pace all the page titles and some information from the snippets. The student ends up clicking on a relevant page at the bottom of SERP after a review of the SERP titles		57’
#2	Identification of source information	A student looks at the webpage logo, reads the text once at normal pace, and finally reads the author information provided below the text		52’
#3	Deep reading of trustworthy and relevant pages	A student looks at the webpage logo (institutional page), reads the text twice at normal pace, and finally reads the author information provided below the text		77’

#4	Skimming of less trustworthy and irrelevant pages	A student looks at the web page logo (popular forum) and user's information located at the left of the text, and quickly skims the text.		29’
#5	Quickly abandoning topically unrelated pages	A student looks at the webpage logo (commercial service unrelated to the task) and abandons the page without reading the text.		18’
	Students who do not perform well			
#1	SERP inspection	Student clicks on the first website without previously inspecting the other search results		20’
#2	Identification of source information	Student starts reading the webpage from the title of the text without looking at the banner, logo nor author information		1’19
#3	Deep reading of trustworthy and relevant pages	The student looks at the webpage banner but does not fully read the text even though it is reliable		27

Source: the author (adapted from Salmerón, Delgado and Mason, 2020)

After watching each student, participants were instructed to pause the video and answer the following questions: A) What does this student do? and B) On a 5-point scale, how do you rate this students' reading and analysis of the material? Justify your answer (Appendix D). No time constraints were imposed and participants could pause the video and retrocede as many times as they needed.

3.5.6 Eye-tracker apparatus

The stimuli consisted of a Google-like search engine results page showing six results and the six related web pages (described in the following section). Participants read the web pages while their eye movements were recorded. The stimuli were displayed on a 22’ screen at a resolution of 168x1050. A laptop Lenovo ThinkPad Intel Centrino 2 with Windows XP 2002 as the operational system that was used to run the SMI RED (SensoMotoric Instruments) eye tracking softwares. IView X RED controlled the eye tracker and captured the eye movements at a sampling rate of 250 Hz; Experiment Center 3.6 was used to create and run the experiment, and BeGaze 3.6 was used to visualize the fixations and generate the output. Total fixations (event duration) was the eye tracking measure extracted from the software to be analyzed since this method is frequently employed in the investigation of eye-movement modeling examples (EMMEs) as a dependent variable (Tunga; Cagiltay, 2023). The minimum threshold for a fixation to be detected as an event was set to 80 ms following previous studies on eye tracking in L2 (Tuninetti; Warren; Tokowicz, 2015; Tham; Chau; Thang, 2019).

The eye tracking data set extracted from BeGaze comprised Participant, AOIs, and Event Duration (ms). The data was analyzed in relation to the total fixation duration (in milliseconds) per word within each of the selected Areas of Interest – AOIs (appendix I). In the search engine results page, the AOIs established comprised the webpage title and snippet of each of the six results. Longer total fixation duration on the AOIs within the SERP was interpreted as optimal navigation behavior, since it indicates a more careful inspection of the results (as opposed to quickly clicking on the first link provided).

Two measures were used to trace participants’ evaluation behavior. the first, Fixation on source features, comprised the AOIs related to the banner and the author’s name and occupation. Longer total fixation duration on these AOIs was interpreted as an index of attention to source characteristics, evidencing evaluation competence. The second, reliability, consisted of the AOIs equivalent to the title and the body of the text. This data was divided into fixation on reliable and non-reliable pages. Longer total fixation duration on reliable pages was

defined as an indicator of strategic allocation of attention, whereas fixation on the non-reliable pages was interpreted as poor allocation of attention and failure to properly evaluate content trustworthiness. Only the movements of the right eye were used.

3.5.7 Webpages

The search engine results page (SERP) as well as the six webpages that comprised its results were researcher-generated. The webpages presented two opposing perspectives about the Learning Styles misconception: three of them defended that LS were important for learning and teaching, while the other three brought evidence of its ineffectiveness. They were displayed interspersed in the search engine page (appendix H). Information in the search page included the text title, webpage address, and snippet (a brief summary of the website content).

The texts developed for the eye-tracking experiment conveyed opposing perspectives about Learning styles. The six texts ranged from 365-394 words, had author name and occupation, and were manipulated to contain only one main idea each. Importantly, the texts that were favorable to LS were not as reliable: either the website was commercial or the authors were not authorities in the field. For example, the first text was favorable to the idea of LS, but it was a commercial website aimed at selling homeschooling courses and its author was the sales manager of the company (table 4).

Table 4 - Summary of the texts features

Text title	**Webpage**	**Type of document**	**Stance**	**Author's occupation**	**Length**
"Learning Styles and homeschooling"	www.homeschoolyourchild.com/learning-styles (commercial website)	Commercial	Favorable	Sales Manager	422 words
"Learning Styles – Ineffective for learning and teaching"	www.universityofkansas.edu/learning-styles-what-teachers-need-to-know	Scholar opinion article	Contrary	Professor at the Department of Education	400 words (411 with references)
"Learning Styles: How to accommodate students' diversity"	www.teacherchristinemalvik.blogspot.com (personal blog)	Blog post	Favorable	Primary school teacher at Collegis School	408 words
"Learning Styles – why are they so popular?"	www.journaleducation.edu/articles/learning-styles-preferences/	Academic article	Contrary	PhD candidate in Education (Vandervilt University)	404 words (609 with references)
"What are the four Learning Styles in education?"	www.infoedu.com/learning-styles (information website)	Informative text	Favorable	Staff writer at infoEdu	402 words

"Are Learning Styles harmful?"	www.educationnext.org/learning-styles-harmful/	Popular science article	Contrary	Science Journalist	388 words

Source: the author

3.5.8 Essay writing task

The integration across multiple documents read on the same issue is usually assessed either through an essay writing task or by answering open-ended questions. Yet, since these types of task not only require participant's reading but also writing skills, caution should be taken so as to measure them independently (Mccruden; Braten; Salmerón, 2022).

In order to assess the quality of the evaluation of the pages, participants wrote an essay about the topic *Learning styles* in a Word document. No time constraints were imposed. Instructions and procedures were similar to the study of Andresen *et al* (2019); "The texts you have just read presented different perspectives about learning styles. Now, please write a short essay stating your informed opinion on the topic you just read about by describing and evaluating these different perspectives, supporting your arguments based on the webpages you have just visited. Write your answer in a concise and elaborate manner, using approximately half a page. Give your text a title." The essay was written in English and once again, no time constraints were imposed.

The rubric used to analyze the level of argumentative reasoning in the essays was adapted from Anmarkrud, Braten and Stromso (2014). This instrument was an appropriate tool because it tackles specifically essays approaching opposing perspectives. A score ranging from 1-7 were assigned to each essay according to the rubric (table 5). The adaptation made in the rubric consisted of lowering the minimum number of arguments for each score. In the original rubric, participants scored 2 if the position on the issue weas supported by fewer than four reasons, and 3 if four or more reasons were provided. In our version, essays were scored as 2 if only one argument was provided, 3 if two arguments were provided, and 4 if three or more arguments were provided. Criteria for scoring 5, 6, and 7 were not altered.

The rating process followed these steps: we first coded the number of arguments given to support the position. Essays that did not state a position on the issue scored 1(e.g. "I strongly believe that learn (sic) different kind of learning skills is important to know that there are a lot of different ways to study and don't feel stressed about it. Who knows?"). Second, we considered mentions to the opposing perspectives and the level of elaboration employed to discuss these perspectives.

Table 5 - Rubric for scoring the essays for argumentative reasoning

Score	Description
7	The essay contains five argument components: positions, supporting reasons, opposing reasons, elaborations, and rebuttals. There is a consistent discussion of opposing perspective(s) and the unsettled nature of the issue. The essay is well-structured and focused. No irrelevant information is included, repetition is low.
6	The essay states a clear position on the issue supported by elaborated reasons. There is a consistent discussion of opposing perspective(s) and the unsettled nature of the issue. The essay is well-focused.
5	The essay states a clear position on the issue supported by three or more elaborated reasons. There is some consideration of alternatives of chosen position and the unsettled nature of the issue, but it is not well-developed. There is little or no attempt at reconciling the alterative positions in own argumentation. The essay may contain irrelevant or repetitive information.
4	The essay contains a position on the issue supported by three distinct or elaborated reasons. Alternative perspective(s) and the unsettled nature of the issue may be mentioned but are not discussed.
3	The essay contains a position on the issue supported by two distinct or elaborated reasons. Alternative perspective(s) and the unsettled nature of the issue are not mentioned or discussed. There is a lot of irrelevant and/or repetitive and/or inconsistent information.
2	The essay contains a position on the issue supported by one reason. The reasons are not elaborated. Alternative perspective(s) and the unsettled nature of the issue are not mentioned or discussed.
1	The essay is underdeveloped, and it is not possible to identify a position on the issue. The essay may contain irrelevant information. Alternative perspective(s) and the unsettled nature of the issue are not mentioned or discussed.

Source: the author (adapted from Anmarkrud, Braten and Stromso, 2014).

All the essays were scored by the PhD candidate herself. A highly qualified second rater scored a randomly selected subset of 15% of the essays using the same rubric. Interrater reliability was high (Pearson's r= .928, R^2=.86). Disagreements were solved through discussion.

3.5.9 Source memory task

The source memory task was adapted from the study of Salmerón, Gil and Braten (2018). We changed presentation to a table format including the title of each page. Instructions were as follows: "please write down all information you remember about each page you just read. For each text, include information about the type of document (article, magazine...), information source (type of the webpage, institution...), name and occupation of the author or any other information you think is relevant." Another adaptation consisted of suppressing the source features "date of publication" and "publisher", since they were not present in the texts manipulated for this experiment. To facilitate retrieval, the table included the names of all webpages accessed. For each page, participants filled in the table with the following pieces of information: type of document, information source, name of the author, occupation of the author, and "other" (appendix K). They were informed that task time was estimated in 4 minutes, but no time constraint was set, following the same procedure as the original study.

Answers to the Sourcing task followed a similar coding process to the one used by Salmerón, Gil and Braten (2018). For the six texts, we coded the possible answers to each of the five source features (type of document, information source, name of the author, occupation of the author, extra information). Thus, the maximum possible score was 24 (if all the required items were recalled) up to 30 (if valid extra information were included). The answers that would not be accepted were also registered in the rubric. For each source feature, the answers were coded as either "valid" (score = 1) or wrong (score = 0).

All the SMTs were scored by this PhD candidate as well as by a second rater who scored a random sample of 15% of the SMTs. Interrater reliability was high (Pearson's r= .982, R^2=.96).

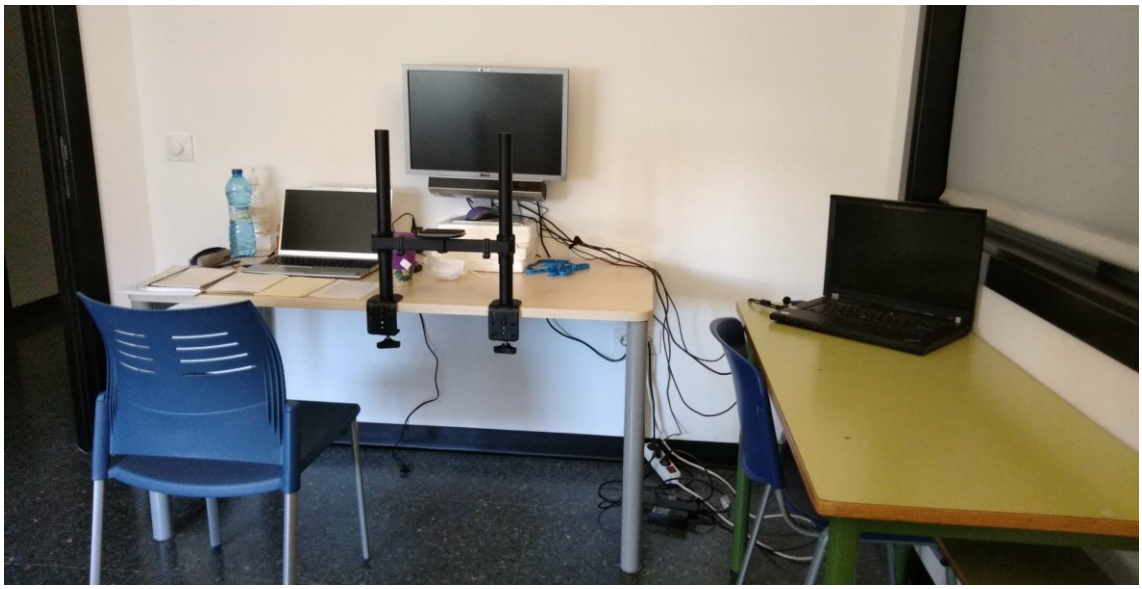
3.5.10 Posttest

Last, participants retook the Misconceptions about Multimedia Learning Questionnaire – MMLQ (Eitel *et al*, 2021), presented again as a Lime Survey questionnaire. The second time (T2) of testing aimed at checking for any update in participants' position in relation to T1 as a function of the intervention.

3.6 PROCEDURES

All data collection procedures were done individually in a quiet room. Since the experiment was carried out during the COVID-19 pandemic (October 2021 – February 2022), participants and researcher were wearing a mask during the entire data collection session and followed all the COVID-19 sanitary protocols; participants were also provided with hand sanitizer and the surfaces and equipment were cleaned after the end of each session (figure 2). For each task, both oral and written instructions were given, either in Spanish or in English – in the case of non-Spanish speakers (appendix K). The researcher and/or a research assistant monitored each participant during his/her entire participation, clarifying any questions that could arise.

Figure 2 - The laboratory room used for data collection with SMI the eye tracker apparatus (center screen)



Source: the author

At arrival, participants were informed about the study, signed the consent form and showed their certificate of proficiency to the researcher or the research assistant. Afterwards they were randomly assigned a condition (control or experimental) and started answering the Lime Survey with demographics, the Second Language Online Reading Strategies Inventory (SLORSI), and the prior beliefs measure (misconceptions about learning styles). Next, they underwent the L2 level test (LexTALE). Both Lime survey and LexTALE were online.

Afterwards, participants in the experimental condition received instructions for the EMMEs video task. They first watched one example of an EMME to become familiar with its format. After each student showed in the video, they made the pauses indicated and answered the questions in the worksheet provided (appendix F). In the control condition, participants watched a YouTube instructional video about Online reading strategies (https://www.youtube.com/watch?v=Gvdxke1s0-I) and answered three comprehension questions: 1) What are the differences between evaluating the reliability of a source in print and online?; 2) How do the multimodal features of online texts affect reading? Is this influence positive or negative?; and 3) Why is online reading described as non-linear? What are the consequences of this non-linearity? (Appendix G). The tests and tasks in this first phase were carried out on a computer with a mouse.

During the eye tracking phase, direct sunlight to the screen was restricted to avoid distorting reflections. Participants sat approximately 60 cm from the eye tracker screen with their heads resting on a chin rest. Their eyes were calibrated with a 9-point calibration task at normal speed to ensure reliable eye tracking data collection. Calibration was repeated up to four times until a deviation value > 0.5° was achieved in the "y" axis or when the lowest possible value was achieved given the calibration difficulties of each participant (for example, in the cases of participants who were wearing glasses or contact lenses).

After calibration, specific task instructions were given: participants were told they would read the results of a Google-like search about Learning styles, a very controversial topic in educational psychology. They were instructed to access all the pages and carefully evaluate their content in order to prepare for writing an essay about the topic and answering a task about the sources they had just had access to. The pages could be visited in their preferred order and also revisited and reread. All the texts were presented integrally onscreen to avoid scroll-down movements which could affect eye and head movement. No time constrains were imposed; participants were asked to let the researcher know when they finished. At last, participants returned to the laptop computer and received instructions to write the essay followed by the sourcing task and the posttest. The experiment design is summarized in table 6.

Table 6 - Summary of the experiment design

Part 1	Part 2	Part 3
1) Informed consent 2) Demographics 3) Second language online reading strategies inventory (SLORSI) 4) Prior beliefs test 5) English level test 6) EMMEs task (experimental) / video task Online reading strategies (control)	7) Reading of the webpages in the eye tracker	8) Essay writing 9) Sourcing task 10)Prior beliefs posttest

Source: the author

3.7 THE PILOT STUDY

A pilot of the experiment was conducted between the last week of October and the first week of November, 2021. It aimed at assessing the adequacy of the instruments to be used in the study and to estimate the time participants would need to perform all the tasks. Seven master and doctoral students and one undergraduate student participated in the pilot study (n=8). Participants in the pilot study were personally invited to collaborate with the piloting as volunteers, to which they kindly agreed.

Data analysis of this pilot study confirmed that the instruments provided an accurate measure of the variables to be accounted for in the present experiment. Participants did not report comprehension difficulties; the texts were perceived as relatively easy to read, Nonetheless, the session was longer than predicted, lasting on average 140 minutes). This has led researchers to make changes in order to reduce experiment time.

We first decreased the number of surveys in the first phase from three to only one. That is to say, besides the Second Language online reading strategies (SLORS), other two surveys were part of the first phase of the study in its initial version: the Online Learning motivated Attention and Regulatory Strategies Scale and the Online Information Searching Strategy Inventory — Quick Version (Burek; Martinussen, 2020). These two other surveys were excluded due to time constraints.

In general, participants in the pilot study spent too long trying to recall details during the source memory task. Thus, another adjustment made to decrease experiment time consisted of including both written and oral information about the time estimated to complete the source

memory task (4'). All these changes made it possible to maintain all the tasks with no time pressure.

A change was made regarding task order. In the pilot, participants first answered the sourcing task, followed by the essay and the posttest. Yet, because the source memory task was cued, and to avoid testing effects, we changed the order of the tasks to have participants first writing the essay, then source memory task, and last Posttest). Last, the test on Learning styles misconceptions, used initially only as a measure of prior beliefs, was included as quantitative measure to contrast performance in the pre- and posttests, enabling the identification of possible misconception change.

4 RESULTS AND DISCUSSION

Students who have their own learning goals,
who own their questions and are not merely responding passively
to what they perceive as arbitrary and irrelevant teacher demands,
tend to be active learners who are not satisfied with superficial understanding.

Kintsch, *Comprehension: Paradigm for Cognition*

This chapter presents the results of the statistical analyses followed by a discussion of the findings under the light of the relevant literature. The first section briefly introduces the concept of mediation analysis and its application in the social sciences, explaining a few important statistical concepts to be dealt with. Section 4.2 is a preliminary analysis aimed at describing the treatment of outliers and the tests of normality and data transformation. Section 4.3 comprises the main analysis of the study.

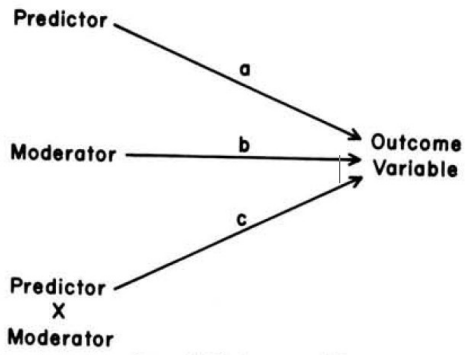
In a nutshell, to answer RQ1a we investigated the effect of group (EMME – experimental /VIDEO – control) on navigation (fixations on the SERP) – and whether English level and self-reported behavior mediated this effect (RQ1a). In RQ1b we explored an effect of group on 1) fixations on reliable/non reliable pages and 2) fixations on source features (banner and author's name and occupation), and a possible mediating effect of English level and self-reported behavior. The research questions 2a, 2b and 2c were more product oriented, i.e., the response variables were data collected after intervention. RQ2a was approached by first inspecting the effect of group on the essays and adding L2 level, navigation and source evaluation as mediators. Similarly, RQ2b investigated if source memory was affected by group and if L2 level, navigation and source evaluation mediated this relation. Last, we considered a possible effect of EMMEs on misconception update by examining the effect of group on pre/posttests as mediated by L2 level, navigation, source evaluation, and source memory (RQ2c).

4.1 MEDIATION ANALYSIS IN SOCIAL SCIENCES RESEARCH

Mediation analyses explain the mechanisms underlying a causal effect. (Tingley; Yamamoto; Hirose; Keele; Imai, 2014). As the name suggests, this type of analysis enables the identification of a variable that mediates the effect of a predictor variable on a response variable, offering a finer-grained picture of the process instead of a bivariate correlation.

In a highly influential article, Baron and Kenny (1986) make an important distinction between moderator and mediator variables. Moderators can either be a categorical variable (e.g., gender, nationality, social status) or quantitative data (e.g., level of proficiency) that influences the direction and/or strength of the effect of the predictor on the response variable (figure 3). A moderation analysis informs about the existence of an effect under the given conditions (Hayes; Scharkow, 2013).

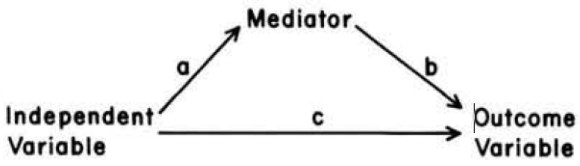
Figure 3 - Moderator model



Source: Baron and Kenny (1986)

Differently, to be a mediator, a variable (Z) must explain how the predictor variable (X) affects the response variable (Y) in a causal chain, i.e., X causes Z and Z causes Y (Mackinnon, 2008) – see figure 4. In sum, "whereas moderator variables specify when certain effects will hold, mediators speak to how or why such effects occur" (Baron; Kenny, 1986, p.1176).

Figure 4 - Mediation model



Source: Baron and Kenny (1986)

A mediation analysis comprises the following statistical procedures: first, the total effect of the predictor variable on the response variable is estimated by running a simple linear regression analysis. If an effect is found, in the second step we test the effect of the predictor variable on the mediator variable by doing another simple linear regression. Third, a linear model is created to check the effect that the predictor and the mediator variables onto the

response variable; the premise is that the mediator must explain more the variance in the response variable than the predictor variable alone. Last, causal mediation analyses are run to compare direct and indirect effects (Renard, 2022). Notwithstanding, more modern approaches to mediation analyses defend that even at the absence of a direct effect of the predictor on the response variable, it is possible to check for indirect mediation effects (Hayes, 2009). This was the rationale followed for each of our research questions. The *lm* function was used for the models with no mixed effects; mixed effects models were run using the *lme4* package in R (Bates *et al,* 2015).

4.2 PRELIMINARY ANALYSES

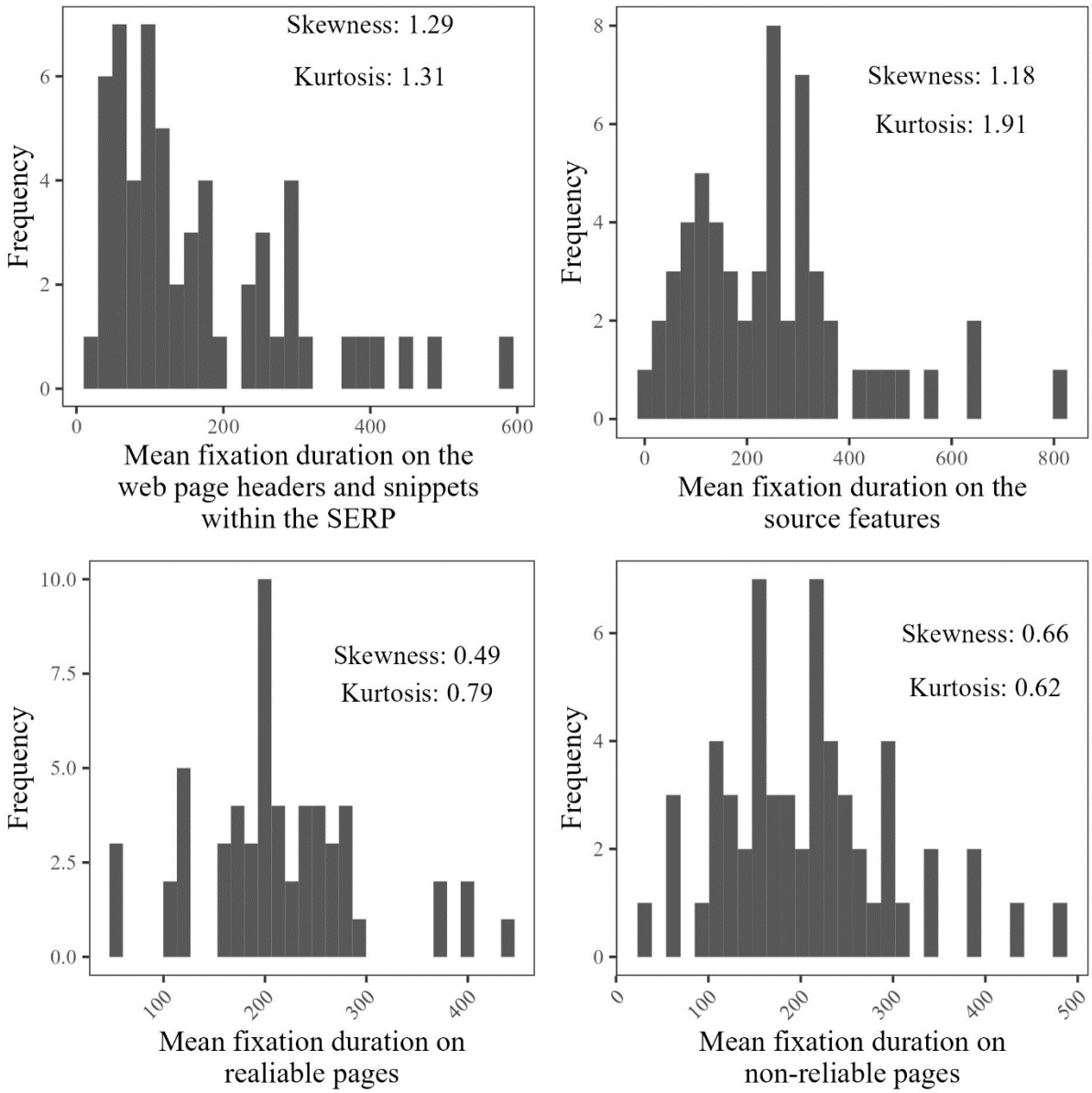
4.2.1 Outliers Detection and Replacement

Prior to the main analysis, eye movement data was inspected to check for outliers; the other datasets went through graphic inspection of distribution. Individual fixations that lasted two standard deviations above or below each participant fixation duration mean were considered outliers and were replaced by the participant fixation duration median (see Salmerón; Delgado; Mason, 2020, p. 1045). Outliers represented 4.56% of the durations.

4.2.2 Tests of normality and data transformation

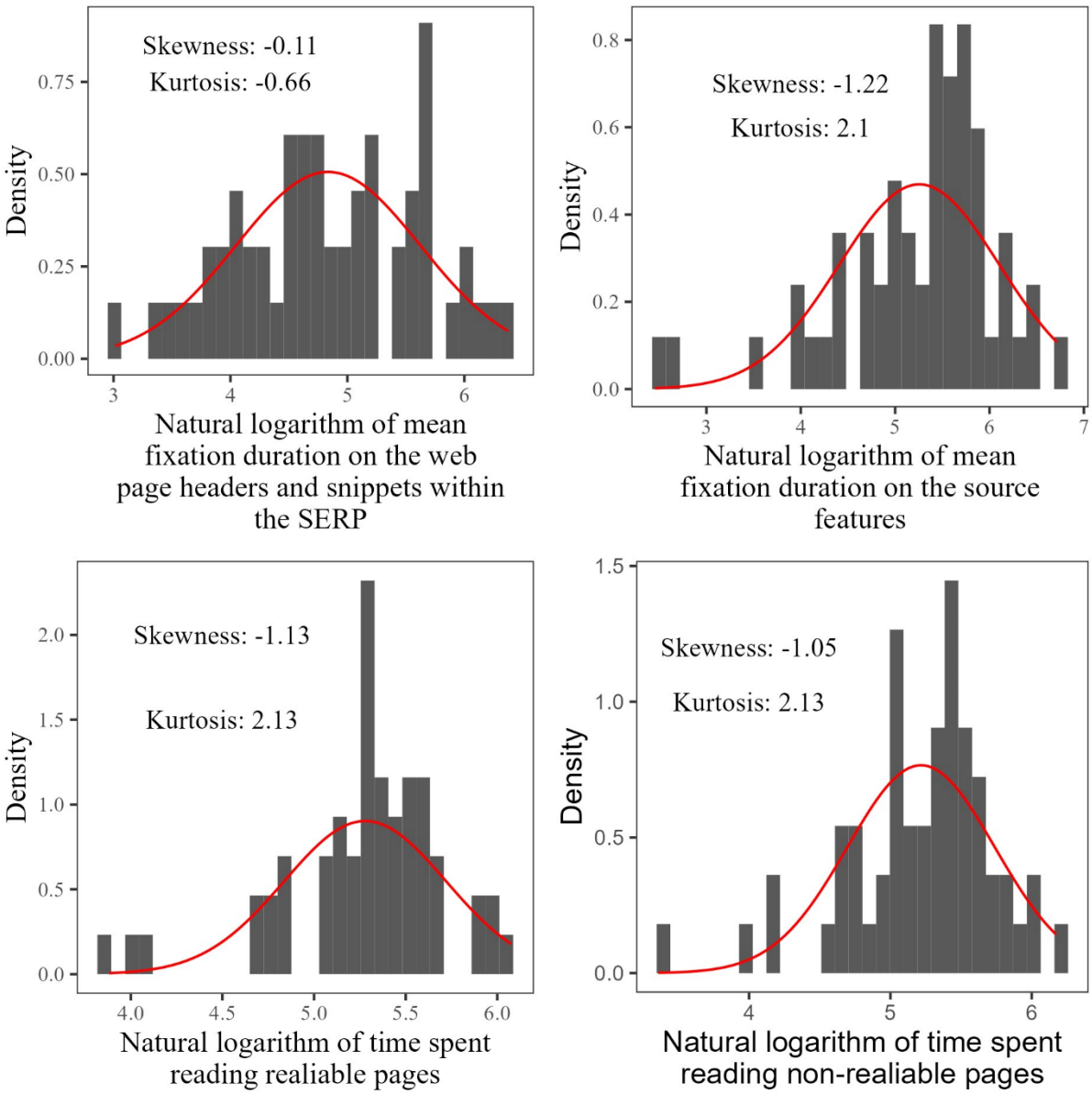
Skewness and kurtosis were calculated using the datawizard package in R (Patil *et al*, 2022). Figure 5 shows the frequency distributions of the time variables used in the study. Apart from mean fixation duration on reliable pages, all distributions have skewness values higher than 0.5, being right-skewed, as it is commonly observed with time variables. The variables were log-transformed to be better approximated to a normal distribution. The log-transformed variables are shown in figure 6 with their theoretical probability distributions. Transformation resulted in improved skewness values for two of the four variables, namely, total fixation duration on SERP and total fixation duration on source features. Thus, the log-transformed variables were used for these two variables (see Salmerón *et al*, 2020, p. 1047).

Figure 5 - Histograms of time variables



Source: the author

Figure 6 - Histograms of transformed time variables with theoretical probability distributions



Source: the authors

4.2.3 Descriptive statistics

The descriptive data for all the variables measured in this study are presented in table 7. The data are divided between experimental (EMME) and control (VIDEO) conditions, enabling the comparison between groups. The groups did not differ in terms of English level scores (EMME M = 70.06; SD = 8.76; Control M = 68.86; SD = 9.07) and prior beliefs, measured by the Learning styles pretest (EMME M = -1.99, SD = 1.34; Control M = -2.25; SD = 1.34).

Table 7 - Descriptive statistics

		Mean	Std. Deviation	Skewness	Kurtosis	Shapiro-Wilk	P-value of Shapiro-Wilk	Minimum	Maximum
Fixation on SERP (ms per word)	**EMME**	5.17	0.64	-0.38 (0.43)	0.51 (0.84)	0.96	0.36	3.40	6.37
	CONTROL	4.48	0.78	0.42 (0.44)	-0.42 (0.85)	0.96	0.56	3.01	6.12
English level (LexTALE scores)	**EMME**	70.06	8.76	0.71 (0.43)	0.72 (0.84)	0.93	0.09	55.70	91.25
	CONTROL	68.86	9.07	0.89 (0.44)	1.55 (0.85)	0.93	0.08	56.25	96.25
Behavioral survey (SLORSI)	**EMME**	3.47	0.38	0.13 (0.43)	-1.12 (0.84)	0.95	0.23	2.89	4.17
	CONTROL	3.61	0.38	0.69 (0.44)	0.70 (0.85)	0.95	0.24	2.93	4.55
Fixation on source features (ms per word)	**EMME**	221.33	91.98	0.47 (0.43)	0.44 (0.84)	0.97	0.57	73.59	471.25
	CONTROL	281.62	216.56	0.74 (0.44)	0.00 (0.85)	0.93	0.06	11.62	823.48
Argumentation scores	**EMME**	2.55	1.68	0.82 (0.43)	-0.60 (0.84)			1	6
	CONTROL	2.36	1.89	1.24 (0.44)	0.03 (0.85)			1	6
Source memory scores	**EMME**	3.98	3.20	1.06 (0.43)	1.14 (0.84)	0.90	0.01	0.00	13.00
	CONTROL	5.37	4.57	2.12 (0.44)	7.45 (0.85)	0.81	< .001	0.00	23.00
Learning styles beliefs Pretest	**EMME**	-1.99	1.34	1.66 (0.43)	2.41 (0.84)	0.79	< .001	-3.50	1.50
	CONTROL	-2.25	1.04	0.39 (0.44)	-0.26 (0.85)	0.92	0.04	-3.75	0.25
Learning styles beliefs Posttest	**EMME**	-0.89	2.65	0.51 (0.43)	-1.35 (0.84)	0.85	< .001	-4.00	3.75
	CONTROL	-1.55	2.29	0.79 (0.44)	-0.39 (0.85)	0.88	.005	-4.00	3.25

Source: the author[10]

[10] The tables and graphs from chapter 4 – Results and discussion – were created by the Davi Alves de Oliveira, member of NEL study group responsible for providing technical support in statistical analysis. Since they are the author's property, the source will be regarded as "the author".

4.3 EFFECTS OF EMMES ON PROCESSING

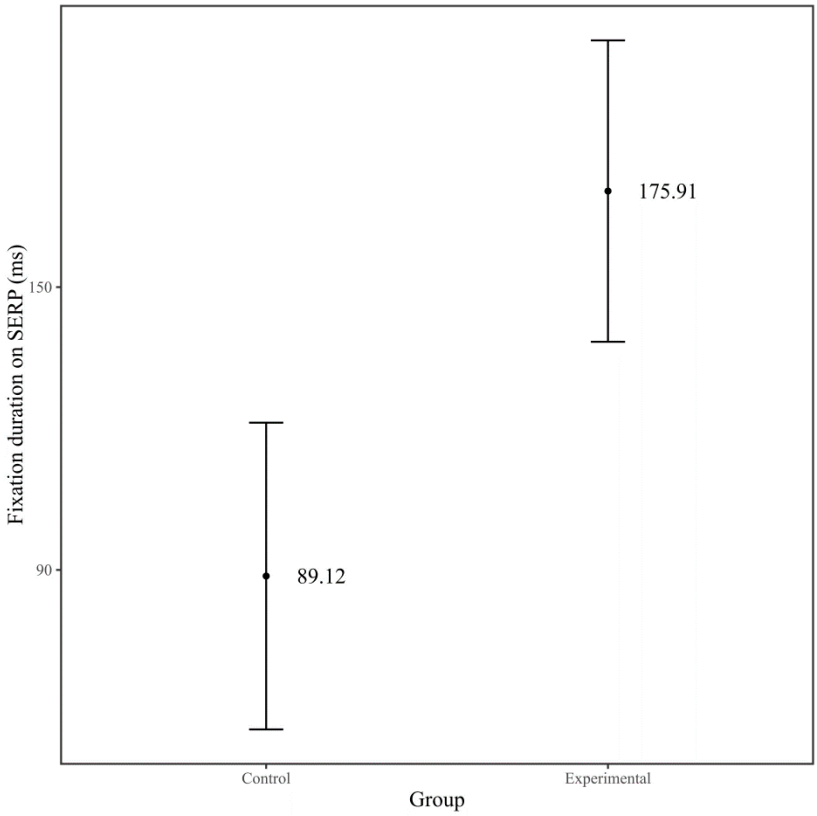
RQ14.3.1 Research question 1a

To answer the research question RQ1a "Do EMMEs affect navigation across the results of a search engine research page (SERP) in English (L2), measured by fixation duration on the webpage headers and snippets of each result within the SERP?", a mediation analysis was conducted. First, a simple linear regression model was fit with fixation duration per word on the SERP (log transformed) as response and Group – divided into two levels: Control (instructional video about online reading strategies) and Experimental (EMME) – as predictor. This model shows a statistically significant effect of Group ($\beta = 0.68,\ p = .001,\ 95\%\ CI = [0.30, 1.06], R^2 = .19, Adjusted\ R^2 = .18$). The coefficient of determination (R^2) indicates that our predictor (Group) accounted for 18% of the variance in navigation (fixation times on the SERP).

As represented in figure 7, participants in the experimental group spent 175,91 milliseconds per word analyzing the SERP, while the control group spent 89,12 milliseconds[11] per word. That is, in the navigation task, the participants in the EMME condition had longer fixation times per word on the webpage headers and snippets within the SERP compared to the control group, indicating a positive effect of the EMMEs intervention. In addition, a positive slope can be drawn from the control to the experimental conditions representing a difference of 86,79 milliseconds.

[11] The log values were exponentiated to retake the value in ms, i.e., Control group: $e^{5.17}$ = 175.91ms. Experimental group: $e^{4.49}$ = 89.12ms.

Figure 7 - Effect of Group (control/experimental) on Navigation (fixation on the SERP)



Source: the authors

4.3.2 Research question 1b

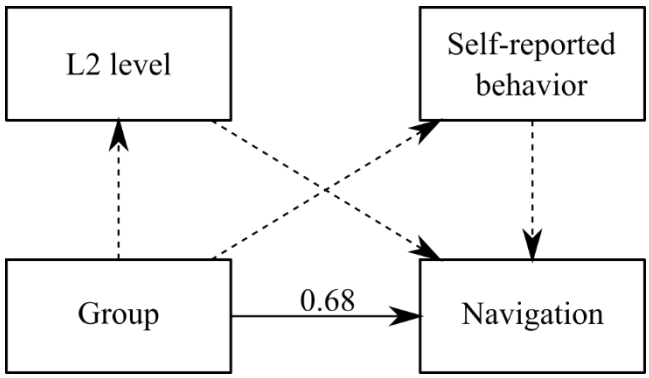
To answer research question 1b "Do L2 level (measured by scores on LexTALE) and self-reported behavior (measured by scores on the Second Language Online Reading Strategies Inventory – SLORSI) mediate the effect of EMMEs on navigation in L2?", two linear models were fit, both with Group (control/experimental) as predictor and each one with a mediator as response. The models show no group differences in terms of L2 level ($\beta = 1.20, p = .614$, 95% $CI = [-3.54, 5.93], R^2 = .005, Adjusted\ R^2 = -.01$) nor Self-reported behavior ($\beta = -0.14, p = .179,$ 95% $CI = [-0.34, 0.06,\ R^2 = .03, Adjusted\ R^2 = 0.02]$).

Additionally, we tested whether L2 level and self-reported behavior would predict Fixation duration on SERP in two linear models, both with total fixation per word on the SERP as response, and L2 level and self-reported behavior as predictors. The model shows no statistically significant effects (L2 level: β = -0.00, p = .946, 95% CI = [-0.02, 0.02], R^2 = 0.00, Adjusted R^2 = -0.018; Self-reported behavior: β = -0.25, p = .364, 95% CI = [-0.80,

0.30], R^2 = 0.015, Adjusted R^2 = -0.003). Thus, it is possible to affirm that the effect of EMMEs was not mediated by English level nor self-reported behavior on the navigation task.

In a nutshell, analyses of research questions 1a and 1b showed that the effect of EMMEs on navigation found in RQ1a was not mediated by any other variable controlled for in this study (figure 8). In other words, EMMEs were the single, most important predictor of navigation behavior (measured by fixation times on SERP).

Figure 8 - Mediation model with effect of Group on Navigation (in bold line)



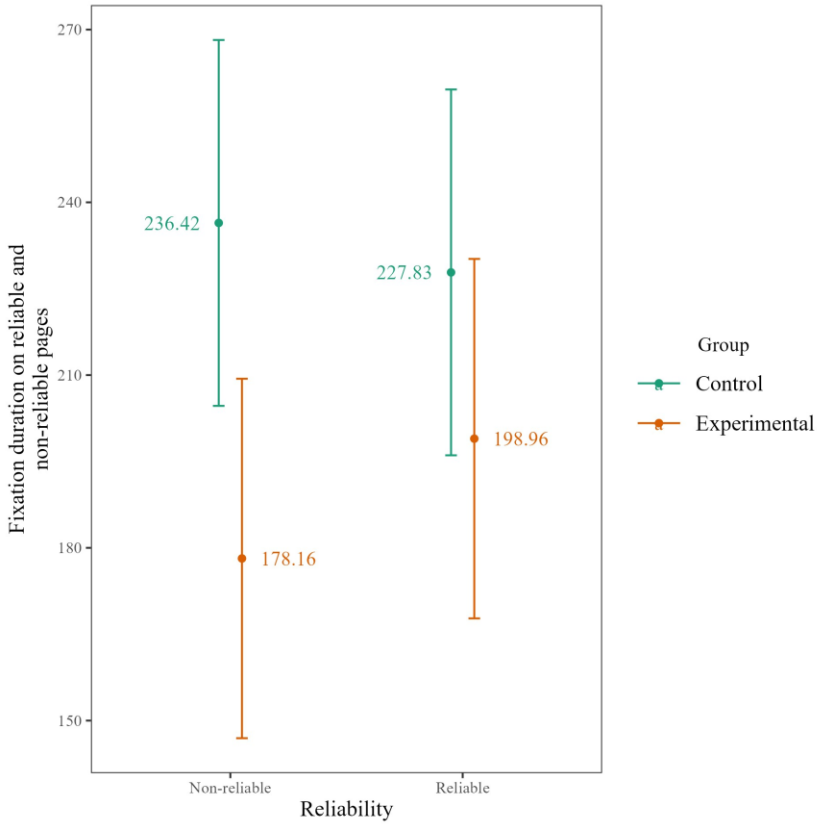
Source: the author

4.3.3 Research question 2a

To answer the research question RQ2a, "Do EMMEs affect attention to sources and content evaluation of multiple online documents in English (L2) that either endorse or refute the Learning styles (LS) misconception, to be analyzed by the contrast between fixation duration on reliable versus non-reliable pages, and on fixation duration on the source features (website banners and author's name and occupation)?", a multiple linear mixed-effects model was fit with Fixation duration on reliable and non-reliable pages as response, reliability (two levels: Reliable and Non-reliable), Group (two levels: Control and Experimental) and their interaction as predictors and random intercepts for participants. The model shows a statistically significant effect of Group ($\beta = -43.57, p = < .05$, $CI = [-85.99, -1.16]$, $Marginal\ R^2 = .07$, $Conditional\ R^2 = .83$), but not of Reliability ($\beta = 6.37, p = .369$, 95% $CI = [-7.63, 20.36]$). The negative slope represents a descending line from the control to the experimental groups; that is, fixation on the pages has decreased 43,57 ms/word as a function of Group. Noteworthy, the model accounted for 83% of the variance in fixation on the pages (considering both fixed and random effects).

The effect of Group shows that participants in the control group had longer total fixation times per word on the webpages compared to the experimental group. Nonetheless, we found no statistically significant effect of reliability (the difference between fixation on reliable and non-reliable pages). As represented by the green bars in figure 9, the control group had more fixations on non-reliable than on reliable content. That is, the control group had longer total fixation times on the two types of pages, but this time was not strategically allocated to skipping irrelevant information and more carefully inspect only the webpages that were reliable. In the experimental group this difference was more pronounced, resulting in longer times reading the reliable than the non-reliable pages (represented by the orange bars in figure 9). Although the difference between fixation times on reliable and non-reliable pages among participants in the same group was not statistically significant ($\beta = 6.37, p = .369,\ 95\%\ CI = [-7.63, 20.36]$), the comparison indicates increased evaluation skills and strategic allocation of attention among participants in the EMME group.

Figure 9 - Effect of Group on fixations on reliable and non-reliable pages



Source: the author

The model also reveals a statistically significant interaction between Group and Reliability ($\beta = 29.39,\ p = .034,\ 95\%\ CI = [2.26, 56.52]$). The control group fixated the non-reliable pages for 58,26 ms/word longer compared to the experimental group. In reliable pages, the difference between groups has decreased with the control group spending 28,87 ms/word longer on reliable webpages than the experimental group. This decrease resulted in groups performing similarly when reading reliable content, as can be seen by the overlap in the error bars above the "reliable" label in figure 9. The effect of reliability on fixation will be further approached in the discussion section.

Last, another linear model was fit with Fixation duration on source features as response and Group as predictor. The model shows no statistically significant effects of Group (β = -60.29, p = .174, 95% CI = [-148.07, 27.49], R^2 = 0.03, Adjusted R^2 = 0.02), demonstrating that EMMEs did not affect fixation times on the source features (website banners and author's name and occupation) of the webpages designed in the study.

4.3.4 Research question 2b

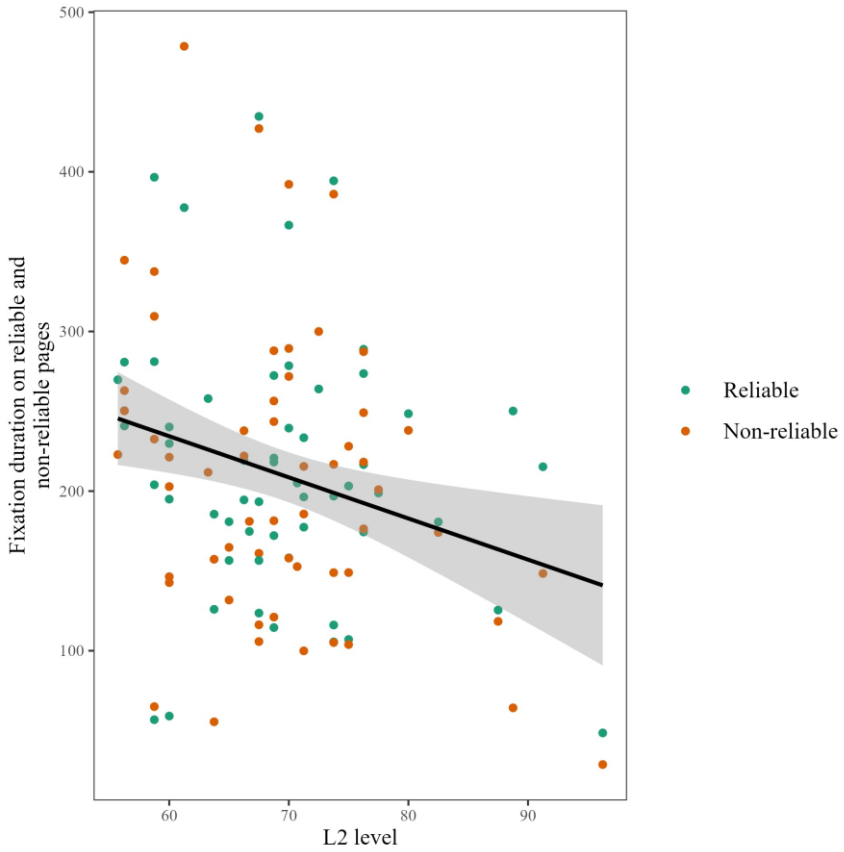
As reported in RQ1b, L2 level and self-reported behavior were similar across control and experimental groups (L2 level $\beta = 1.20, p = .614,\ 95\%\ CI = [-3.54, 5.93], R^2 = .005, Adjusted\ R^2 = -.01$; Self-reported behavior: $\beta = -0.14, p = .179,\ 95\%\ CI = [-0.34, 0.06,\ R^2 = .03, Adjusted\ R^2 = 0.02]$). RQ2a checked for a direct effect of EMMEs on evaluation. An effect of Group was found as well as an interaction between Group and Reliability.

To answer research question RQ2b, "Do L2 level and self-perceived strategic behavior mediate the effect of EMMEs on source evaluation of multiple documents in L2?", mediation analyses were performed. Two additional models were fit to test for effects of L2 level and self-reported behavior onto Fixation duration on reliable and non-reliable pages, both with random intercepts for participants. The first model shows a statistically significant effect of L2 level (β = - 2.58, p = .036, 95% CI = [-4.98, -0.17], Marginal R^2 = .07, Conditional R^2 = .82). The negative slope shows a decrease in fixation times as a function of proficiency: for each increase in L2 level scores, reading times decreased 2.58 ms. The model accounted for 82% of the variance, which indicates its robustness. Nonetheless, the second model has shown no statistically significant effect of self-perceived behavior (β = 9.22, p = .752,95% CI = [-48.40, 66.85], Marginal R^2 = .002, Conditional R^2 = ,82). Because of the significant effect of L2 level,

two additional models were fit with the addition of the interaction of this variable with Reliability and Self-reported behavior as predictors, but these models showed no statistically significant interaction (Reliability: β = 0.11, p = .262, 95% CI = [-0.09, 0.31], Marginal R^2 = .07, Conditional R^2 = .82; Self-perceived behavior: β = 0.02, p = .954, 95% CI = [-0.77, 0.82], Marginal R^2 = .07, Conditional R^2 = .82).

As we can see in figure 10, L2 level is a significant predictor of evaluation behavior (as measured by the difference in total fixations per word on reliable and non-reliable pages, represented by the AOIs comprising the title and the body of text within each webpage), although its effect did not interact with Reliability nor self-reported behavior. In other words, participants with high scores in the LexTALE also made shorter fixation times on the web pages but this effect of L2 level was isolated, i.e., neither page reliability nor self-reported behavior interfere with fixation times among more proficient readers.

Figure 10 - Effect of L2 level on Fixations duration on reliable and non-reliable pages



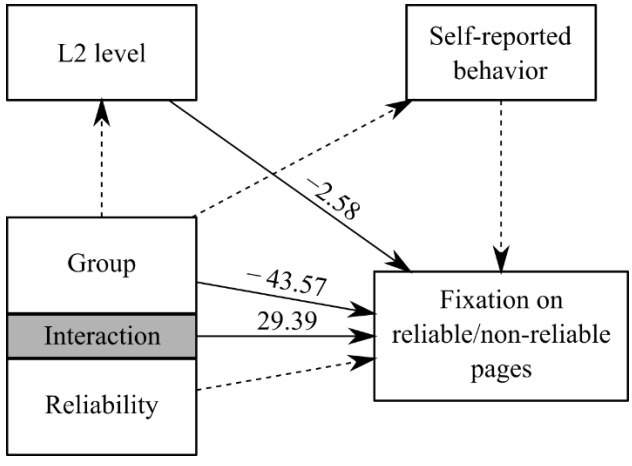
Source: the author

As already reported in RQ2a, EMMEs did not have an effect onto fixation duration on source features (β = -60.29, p = .174, 95% CI = [-148.07, 27.49], R^2 = 0.03, Adjusted R^2 =

0.02). Even so, to further investigate the mediational relations between the variables, two additional models were fit to test for effects of L2 level and Self-perceived behavior onto Fixation duration on source features and they showed no statistically significant effects (L2 level: β = -0.06, p = .980, 95% CI = [-5.15, 5.02], R^2 < .001, Adjusted R^2 = -0.02; Self-reported behavior: β = 15.95, p = .785, 95% CI = [-101.02, 132.99], R^2 = 0.001, Adjusted R^2 = -0.017). Thus, fixation on source features was not explained by neither L2 level nor self-perceived strategic behavior.

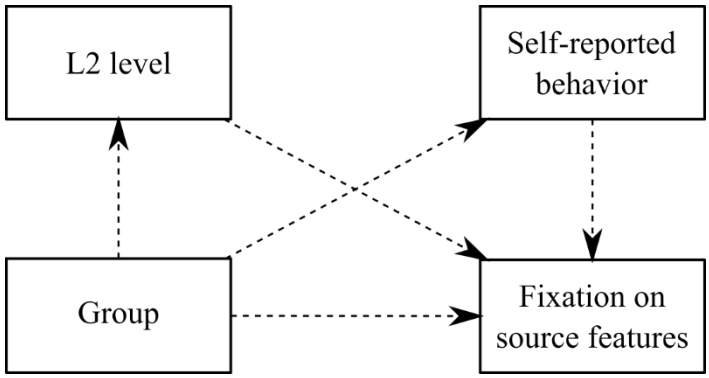
In sum, in RQ2a our first measure of evaluation (fixation per word on reliable and non-reliable pages) was affected by group. That is, the control group made more total fixations per word on the webpages compared to the experimental group, evidencing poor evaluation. As summarized in the mediation model (figure 11), evaluation was affected by the interaction between group and page reliability, with the less reliable pages being read for longer by controls and shorter by the experimental group; the more reliable pages being read at a similar pace across conditions. In RQ2b, participants with higher L2 level had lower fixation time per word on reliable and non-reliable pages compared to participants with low L2 level, who fixated the webpages for longer (figure 10 and negative slope on figure 11). However, our second measure of evaluation – Fixation per word on source features – was not affected by any of the variables controlled for in this study, namely Group, L2 level, nor self-reported behavior (figure 12).

Figure 11 - Mediation model



Source: the author
The diagram shows all the analysis that were done (in dotted arrows), with significant effects in bold lined arrows and beta values for the significant effects

Figure 12 - Mediation model



Source: the author

The diagram shows all the analysis that were done (in dotted arrows)

4.4 EFFECTS OF EMMES ON LEARNING OUTCOMES

This section is dedicated to analyzing the possible effects of EMMEs on the learning outcomes measured in this study: the argumentation scores from the essays, the source memory task, and the difference between pretest and posttests in the Misconceptions about Multimedia Learning Questionnaire – MMLQ (Eitel *et al,* 2020), used to measure prior beliefs. In addition, a qualitative analysis is performed in the essays to identify patterns of argumentation. The results of a post-hoc exploratory analyses of the positions stated in the essays is also presented.

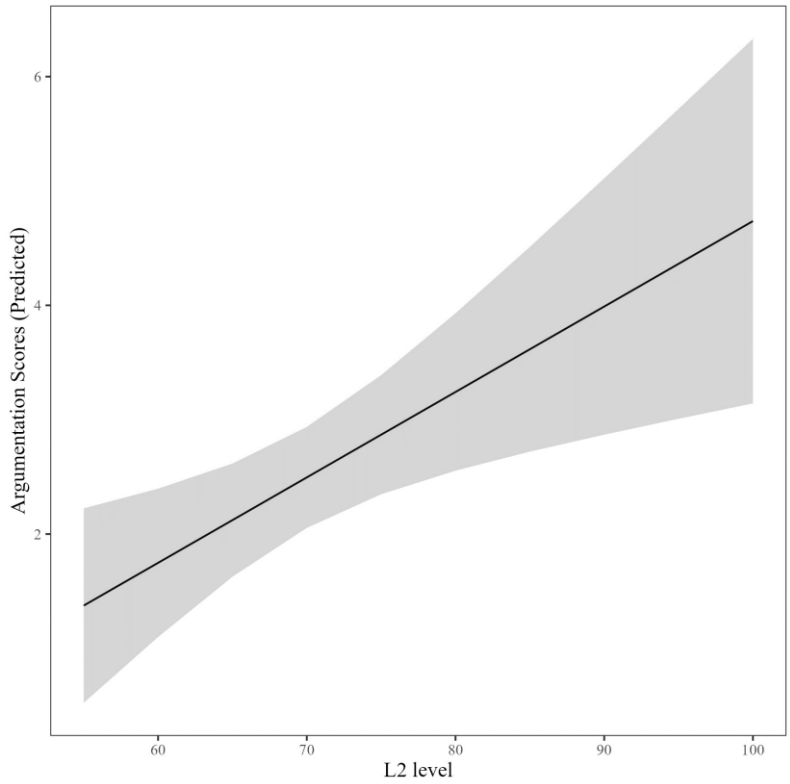
4.4.1 Research question 3a

RQ3a investigated a possible effect of EMMEs on argumentation scores on an essay writing task. The 57 essays were on average 260.23 words long (*SD* = 64.98). In general, scores in the essay task were low (Control group: M = 2.55, min. 1, max. 6, *SD* = 1.68; Experimental group: M = 2.36, min. 1, max. 6, *SD* = 1.89). To answer the research question RQ3a "Do EMMEs affect argumentative reasoning, as measured by scores on an essay writing task?", a mediation analysis was performed. A linear model was fit with argumentation scores on an essay writing task as response and group as predictor. No effect of Group was observed (β = 0.19, p = .683, 95% CI = [-0.75, 1.14], R^2 = .003, adjusted R^2 = -.015), meaning that the instruction with EMMEs had no direct influence on the development of participants' argumentative writing skills.

4.4.2 Research question 3b

For the mediation analysis of RQ3b "Do English level, navigation and evaluation behavior mediate the effect of EMMEs on argumentation score?", three additional models were fit to test for the effects of L2 level, navigation (fixation duration per word on SERP) and evaluation (fixation duration on source features) on argumentation. The evaluation measure of fixation on reliable and non-reliable pages is a repeated one and thus its effect on argumentation could not be verified in linear models. Only L2 level had a statistically significant effect (L2 level: β = 0.07, p = .004, 95% CI = [0.02, 0.12], R^2 = .14, Adjusted R^2 = .12; Navigation: β = -0.18, p = .553, 95% CI = [-0.79, 0.43], R^2 = .006, Adjusted R^2 = -.01; Evaluation: β = 0.00, p = .449, 95% CI = [- 0, 0], R^2 = .01, Adjusted R^2 = -.008). As our β value indicates, for each increase in L2 level score, argumentative scores increased 0.07 (figure 13). Since we found a significant effect of L2 level, an interaction model was fit with argumentation scores as response and Group, L2 level, and their interactions as predictors. There were no effects of Group nor a statistically significant interaction between Group and L2 level, but L2 level remained statistically significant (Group: β = 2.11, p = .557, 95% CI = [-5.05, 9.27]; L2 level: β = 0.09, p = .0.017, 95% CI = [0.02, 0.16]; Interaction: β = -0.03, p = .574, 95% CI = [-0.13, 0.07], R^2 = 0.14, Adjusted R^2 = 0.10.

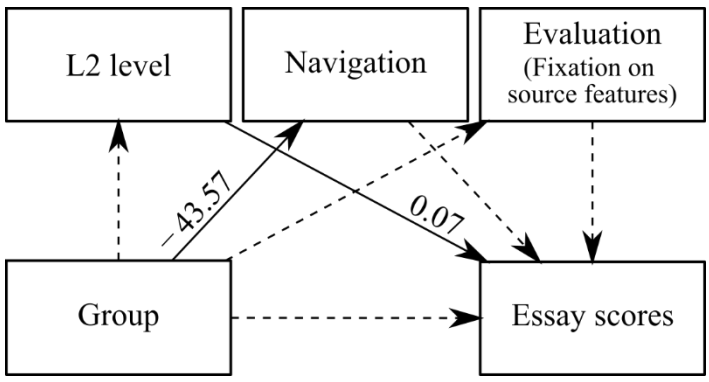
Figure 13 - Effect of L2 level on Argumentation scores



Source: the author

Simply put, we found no effect of the processing measures Navigation (fixation on SERP) nor of Evaluation (measured by fixation on source features) on Essay scores. On the other hand, as per our hypothesis, L2 level was found to be a significant predictor of performance in the essay writing task (figure 14).

Figure 14 - Mediation model



Source: the author

The two next sections extend the analysis and discussion of the quality of argumentation in the essays through qualitative procedures. We approach issues of sourcing, the confusion between the use of the terms "styles" and "strategies", and the (mis)interpretation of the Learning styles theory as one suitable for learners – and not for teaching.

4.4.3 Sourcing and patterns of argumentation

When constructing arguments based on the source information of the webpages that had been read, participants often misjudged author expertise. For example, a commercial website written by a sales manager who was selling a homeschooling course and a testimony written by a primary school teacher and published in a personal blog were considered reliable sources and used to justify a pro-learning styles stance in the essays, as argued by participants 06, 14, 20, 46 (experimental group), and 05, 19, 39, 51 (control group).

Participant 51	(…) many people that (sic) these learning styles are helpful. For example, homeschooling pages inform about the helpfulness of different teaching styles (including advices (sic) for the parents and some tips to improve their children's learning. In some blogspots, there is information about the different teaching styles (VARK) in which student is one of them with their characteristics and the resources that can be applied to them).

Indeed, epistemic beliefs related to sourcing influence the evaluation of multiple documents. A more skilled evaluative behavior is characterized by 1) belief in knowledge as transmitted by authorities, 2) doubt of one's own opinion, and 3) careful consideration of the content when a source seems reliable (Braten; Britt; Stromso; Rouet, 2011). On the other hand, the belief that knowledge is constructed by "the self", that is, through the accumulation of isolated concepts, negatively affects source evaluation (Braten *et al*, 2011). In the excerpt above, the sources cited (homeschooling page and blog) were not reliable because they represented commercial interests and personal, non-scientific views. Thus, the participants' poor sourcing skills and epistemic beliefs about knowledge as formulated by individuals (rather than resulting from systematic, critical investigation) have definitely played a role in accepting the validity of these claims.

Another sourcing pattern found consisted in judging the validity of the arguments from the texts in comparison with one's own opinion – which was based on experience rather than backed up by reliable sources. This evaluation procedure has resulted in the maintenance of an

LS-favorable stance among participants 20, 26, 42 (experimental group), and participants 5, 27, 37 (control group), as illustrated by the excerpts below:

Participant 25	I'm not a segregationist of the science evidence, but I'm twenty years old and in my student life I have discovered that the information channel presentation is very important to memorize it to the exam. For this reason, I believe in the different types of learning styles to memorize information.
Participant 20	The article written by the teacher, in her blog, even if it's not supported by evidence, has some right. The best way to get all the students to learn well is to use all of the learning styles by matching them.
Participant 27	I agree with the existence of such differences in understanding; in my personal experience while studying with friends, I always need to draw ideas visually while my partner needs to write them in a short description.
Participant 37	I believe in people that said these is real, because I need kinesthetic and visual methods to learn and study; for me listening and reading a lot and making papers are a little bit difficult.

Again, belief in the misconception persisted even when participants were confronted with robust evidence. This argumentative behavior corroborates our claim that readers believe in knowledge as a personal construction instead of the product of systematic work done by experts (Braten *et al*, 2011). The primacy of opinion/experience over scientific data in argumentation has been reported in previous studies. In this line, Menz and colleagues (2020) found a prevalence of educational misconceptions among preservice teachers: presenting them with empirical evidence did not suffice to change their beliefs in educational misconceptions. These misconceptions stem from either personal or peer teaching experiences and go against the principles of evidence-based practice. For instance, preservice teachers find it more reliable to trust knowledge derived from experience than scientific data (Braten; Ferguson, 2015).

Another pattern of argumentation has arisen when students interpreted the arguments contrary to Learning styles. In weighing the validity of the LS theory, some participants referred to the argument that learning styles were not effective for learning given the difficulty of implementation imposed by this approach in schools – which is accurate, according to the information provided. Nevertheless, this argument was used to create a false dichotomy to defend that LS should orient learning rather than teaching practices, being employed by participants 34 (experimental group), 33, 35, 39, 41 and 57 (control group).

Participant 35	I think that there are different types of learning styles, and they are really important for students because they may help you a lot to understand why you are not understanding some thing (sic), but I don't think that they have

	to be really important into teaching, because when someone teach something has to thing (sic) in the best way to explain that.

This distinction is not present neither in the sources favorable nor the ones contrary to the LS theory. It seems participants have attempted to reconcile the opposing perspectives by situating LS in the realm of learning techniques, decreasing the cognitive dissonance caused by the contradiction between belief in the misconception and evidence. Another evidence that participants have tried to come to terms with the two perspectives comes from participant 49 (control group), who raised the question: "What if both sides are right?"

This doubt might be explained by the fact that participants read strong arguments refuting LS, and many cited these arguments in the essay even when stating a stance favorable to the theory (e.g., participant 26, experimental group). Fourteen participants have not stated a clearly identifiable position in their essays (neither for nor against the LS theory, not even regarding it as an unsettled issue). As discussed in the literature review, epistemic beliefs influence the selection of arguments and the definition of a stance when reading multiple conflicting documents (Braten; Britt; Stromso; Rouet, 2011). In the essays, participants had trouble from this early stage of argument selection; they could not decide which side was right nor what to believe.

In the framework proposed by Braten and colleagues, certainty beliefs range between two opposite dimensions: from perceiving knowledge as tentative and evolving, to seeing knowledge as immutable. A downside of believing in knowledge as tentative and evolving is overreliance on one's capacity to process the arguments presented, simply weighing them as pros and cons of the topic. An example of such is participant 40 (experimental group), who states:

Participant 40	Some people believe that everybody has a method that best suits their learning process, while others think that everyone should use the same strategies for learning.

This view of the Learning styles debate demonstrates that the reader could not identify the theory as a misconception. In the webpages, the arguments contrary to Learning styles provided mounting evidence against its effectiveness, while the favorable pages conveyed biased, non-scientific information; in other words, they were not merely "two sides of the same coin", as implied by the participants aforementioned.

4.4.4 Styles or strategies?

As discussed in chapter 2 section 2.2.1, learning styles are a case in point in the field of educational psychology given its broad diffusion and intrinsic relation with prior beliefs. Despite its strength, the student's preferred modality does not necessarily yield the best learning results; instead, it might be detrimental to the learner who attempts to use the same style in all learning situations. Yet, interest and strategy use are student characteristics that should be carefully attended (Dinsmore; Fryer; Parkinson, 2022). Learning is a complex process involving depth of processing and the selection of metacognitive strategies according to the material to be learned and the students' goals considering the task at hand. Cognitively demanding tasks such as writing the final term of a course will require a careful reading of the bibliography as well as active engagement with these readings through the application of more laborious strategies such as taking notes or constructing a diagram depending on the content. Other put, "strategies are not fixed or biological, rather they are dynamic and change based on the situation—such as an individual's expertise level and what types of task they are engaging in" (Dinsmore *et al*, 2022, p.7).

That said, in some of the essays the participants have experienced difficulty distinguishing between the terms "learning styles" and "strategies", using both interchangeably, as exemplified by the excerpt below:

Participant 25	Firstly, it is important to know the main reasons why learning styles started to be important. The first reason would be social labels, which allowed people to differentiate socially from the rest regarding their own learning style, and the other reason are metacognitive strategies (…) The main cognitive strategies are visual strategies such as pictures in the whiteboard, videos, visual and interactive images, then, auditory strategies such as audios, music, or different things which have acoustic features that could help to learn better.

Similarly, participant 27 (control group) used the term "cognitive strategies" to refer to "visual strategies such as pictures in the whiteboard, videos, visual and interactive images, then, auditory strategies such as audios, music, or different things which have acoustic features that could help to learn better". Other comparable instances of learning styles being referred to as synonyms of strategies were found in the essays either to endorse the theory (participants 06,

12, 18, 40 – experimental group; participants 25, 27, 29, 41, and 49 – control group) or to refute it (participant 24 – experimental group; participants 7, 13, and 15 – control group).

Even participants like 6 (experimental group), who demonstrated knowledge about metacognition and self-regulated behavior by making use of these terms in the essay has failed to distinguish LS and strategies:

Participant 06	(…) learning styles have also proved to be present as a systematic way of understanding the strategies the students might rely on when searching and understanding information.

Interestingly, a few participants (8, 10 and 16 – experimental group) seem to acknowledge the difference between styles and strategies:

Participant 08	I thought we were talking about learning strategies and I know that some work better than others.
Participant 10	an advice for teachers would be to look for evidence-based learning strategies instead of learning styles which are not clear to be useful.

From the above stated, it is possible to affirm that the stance constructed by participants in the essays was influenced by their conceptual gaps (i.e., difficulty distinguishing between styles and strategies), inaccurate judgment of source credibility, misinterpretation of the LS theory as not related to teaching, and the strength of participants' epistemic beliefs in knowledge as a personal construction stemming from one's prior beliefs and experiences rather than an accumulation of the work of experts. These patterns of argumentation illustrate the complexity involved in the task proposed as the readers engaged in integrating prior knowledge, prior beliefs, and the opposing perspectives within the webpages read in the attempt construct an accurate mental representation of the topic in the essays (Stadler; Bromme, 2014).

4.4.5 Research question 4a

RQ4a has dealt with the effects of EMMEs on memory for the sources. In the source memory task, participants demonstrated difficulty remembering the four source characteristics (type of document, information source, name of the author, her/his occupation) of each of the six texts that had been read and simply left them blank. Mean score in the task was low (max. = 24) and strongly varied among participants (EMME M = 3.98, SD = 3,20; Control M = 5,37, SD = 3,96).

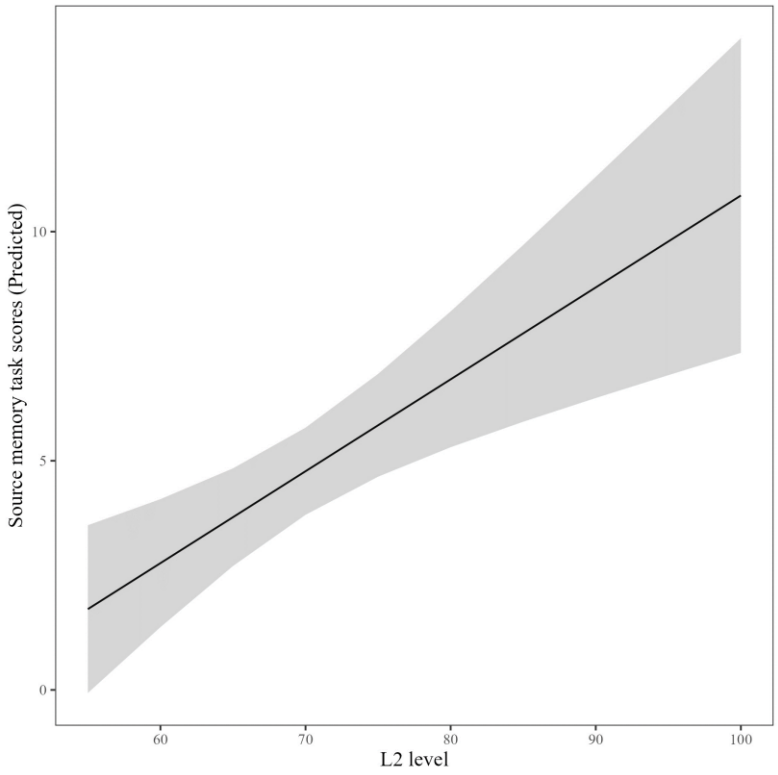
To answer research question RQ4a "Do EMMEs increase memory for the sources when reading multiple documents?", a mediation analysis was done. A linear model with Source memory task scores as response and Group as predictor. No direct effect of Group was observed ($\beta = -1.39, p = .187, 95\%\ CI = [-3.48, 0.70], R^2 = .031, Adjusted\ R^2 = -.014$).

4.4.6 Research question 4b

RQ4b "Do English level, navigation and evaluation behavior mediate the effect of EMMEs on source memory?" was answered by fitting three additional models to test for possible effects of L2 level, Navigation (Fixation duration on the SERP) and Evaluation (Fixation duration on source features) on Source memory task scores.

As verified in RQ4a, no direct effect of Group on source memory was found. In RQ4b, the processing measures (Navigation and Evaluation) did not affect scores in the source memory task. Only L2 level had a statistically significant effect on memory for the sources (L2 level: β = 0.20, p = <.001, 95 % CI = [0.09, 0.31], R^2 = .20, Adjusted R^2 = .19; Navigation: β = -0.23, p = .740, 95% CI = [-1.58, 1.13], R^2 = .002, Adjusted R^2 = -.02; Evaluation: β = 0.00, p = .189, 95% CI = [-0, 0.01], R^2 = .03, Adjusted R^2 = .01). That is, participants with higher L2 level scores tended to also achieve higher scores in the source-memory task (figure 15).

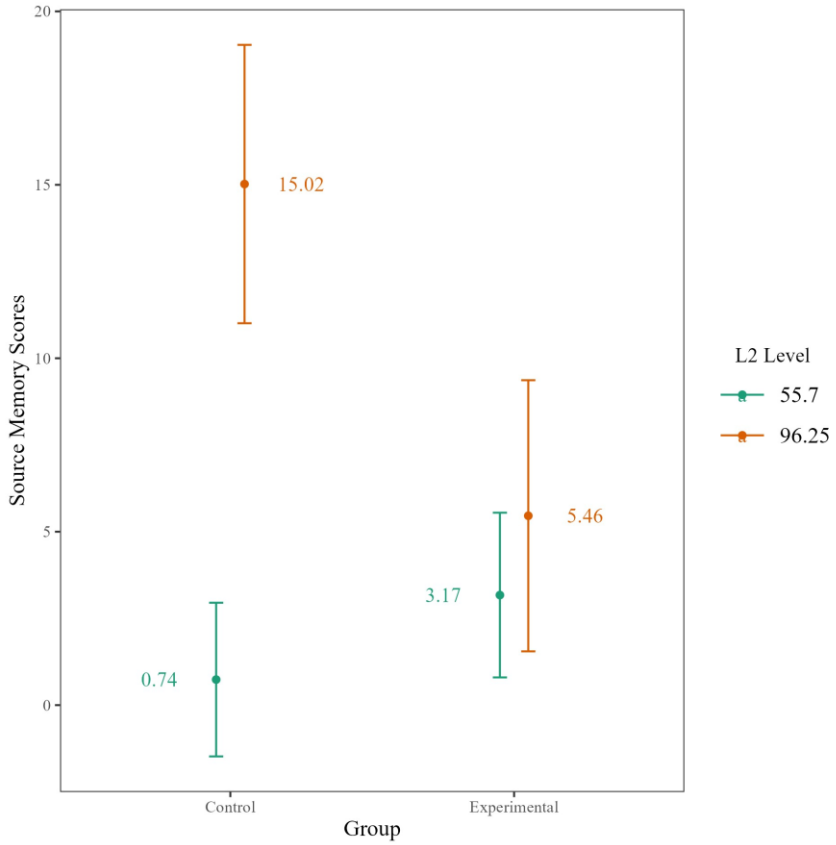
Figure 15 - Effect of L2 level on source memory scores



Source: the author

Since we found a significant effect of L2 level on source memory scores, an interaction model was fit with source memory scores as response and Group, L2 level, and their interactions as predictors. There were statistically significant effects of Group, L2 level, and their interaction (Group: β = 18.92, p = .009, 95% CI = [5.00, 32.84]; L2 level: β = 0.35, p <.0.001, 95% CI = [0.21, 0.49]; Interaction: β = -0.30, p = 0.004, 95% CI = [-0.49, -0.10], R^2 = 0.35, Adjusted R^2 = 0.32). As represented in figure 16, higher L2 levels correlated with higher scores in the source memory task particularly for the control group. In the experimental group, differences between low and high L2 level have not resulted in such a marked difference in the SMT scores.

Figure 16 - Effect of Group on source memory scores



Source: the author

In sum, L2 level as well as its interaction with Group were the only variables to significantly predict scores in the source-memory task; navigation and evaluation were not strong predictors.

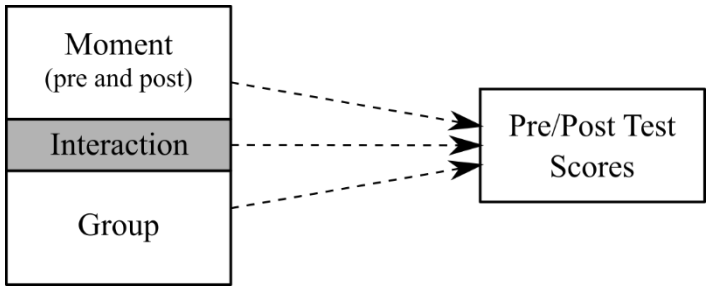
4.4.7 Research question 5a

Hypothesis 5a tested misconception update from pre to posttests. On average, at pretest participants correctly rejected only 0,71, (*SD* = 0.79) of the 4 misconception items (17,62%). At posttest, this medium has risen to 1,34 (*SD* = 1,44) (33,67% of agreement). In addition, certainty ratings were above the mean of the scale (0-4) for all the items, ranging from 2,53 to 3,37, showing that participants were rather certain about their answers to each misconception item.

To answer research question RQ5a "Are EMMEs linked with updating of misconceptions about Learning Styles, to be measured in a pre/posttest?", a mediation analysis was performed. A linear mixed-effects model with Scores on pre and posttest of misconceptions

about learning styles as response and Group, Moment (difference between pre and posttests) and their interaction as predictors, and random intercepts for participants. No effects of Group (β = 0.66, p = .207, 95% CI = [-0.37, 1.68], Marginal R^2 = .07, Conditional R^2 = .42), Moment (β = -0.71, p = .09, 95% CI = [-1.52, 0.11]), nor statistically significant interactions were observed (β = -0.39, p = .502, 95% CI = [-1.53, 0.76]), although there was only an apparent decrease in misconception belief from pre to posttest, as evidenced by the negative slope in Moment (β = -0.71) . That is, EMMEs did not have a direct effect misconception update (figure 17).

Figure 17 - Mediation model



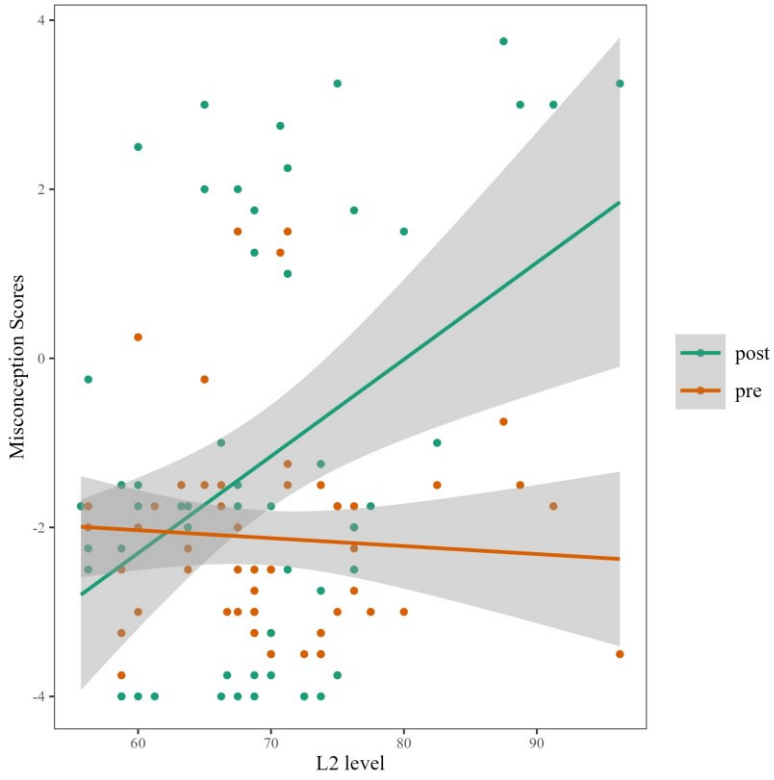
Source: the author

4.4.8 Research question 5b

To answer RQ5b "Do English level, navigation, and evaluation behavior (including memory for the sources) mediate the effect of EMMEs on misconception change?", three additional models were fit to test for possible effects of L2 level, Navigation (Fixation duration on SERP) and Evaluation (Fixation duration on source features) on the scores on the pre and posttests, all three models having the interaction with Moment (difference between pre and posttests) as predictor.

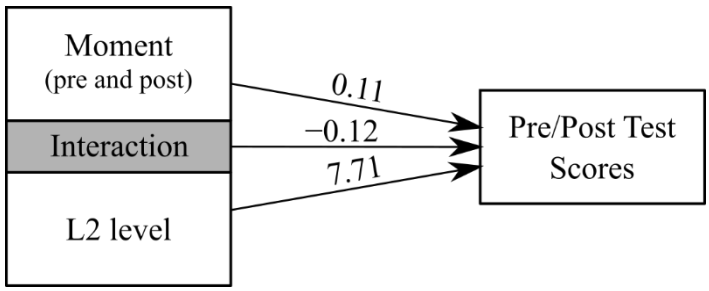
The first model showed a statistically significant effect of L2 level on Scores on Pre and Post tests (β = 0.11, p < .001, 95%, CI = [0.06, 0.17], Marginal R^2 = .18, Conditional R^2= .56), (figure 18), an effect of Moment (β = 7.71, p < .001, 95% CI = [3.76, 11.66]), and a statistically significant interaction between the two (β = -0.12, p < .001, 95% CI = [-0.18, -0.07]). We added Group to the model, but there was no difference in terms of interactions nor main effects. In sum, participants with higher L2 level scored higher in the LS questionnaire at posttest (thus showing weaker belief in the misconception after the intervention), which explains its interaction with moment (figure 19).

Figure 18 - Effect of L2 level on Misconception scores



Source: the author

Figure 19 - Mediation model

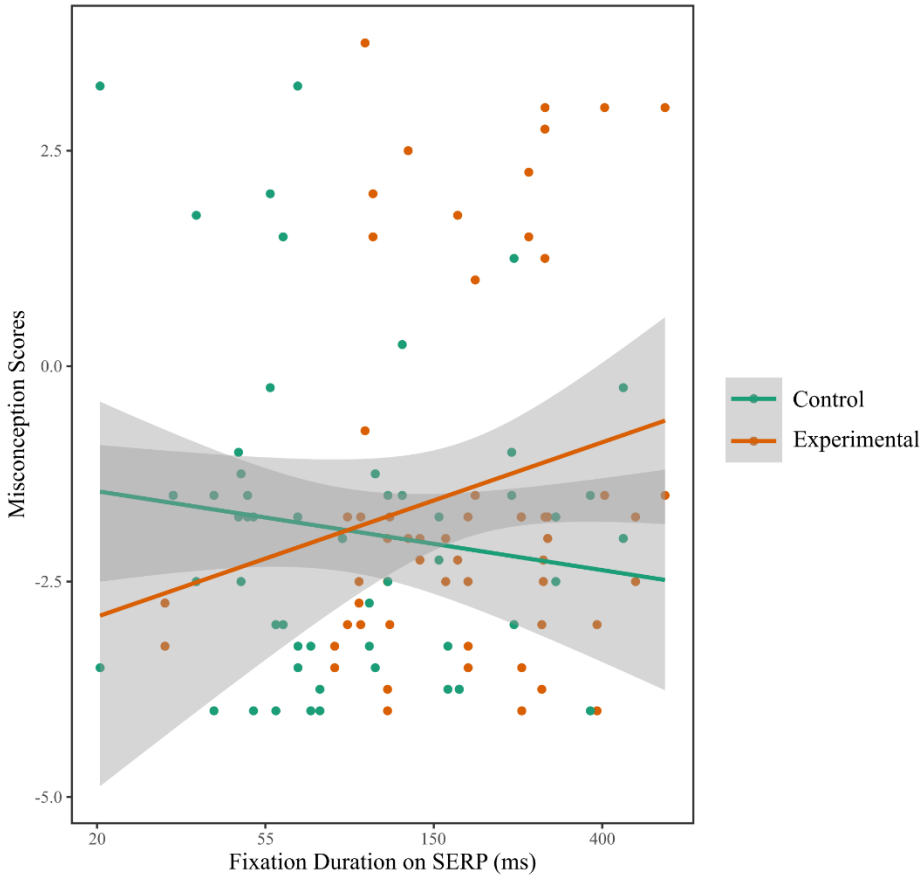


Source: the author

The second model showed no statistically significant effect of Navigation (Navigation: β = 0.22, p = .502, 95% CI = [-0.43, 0.88], Marginal R^2 = .06, Conditional R^2 = .41; Moment: β = -0.79, p = .667, 95% CI = [-4.39, 2.82]; nor Interaction: β = -0.02, p = .948, 95% CI = [-0.76, 0.71]). However, adding the Group variable in the model resulted in a statistically significant effect of Group (β = -7.55, p = 0.042, 95% CI = [-14.82, -0.28]) and a statistically significant interaction between Group and Navigation (β = 1.67, p = 0.026, 95% CI = [0.20,

3.14]. That is to say, Navigation (fixation on the SERP) alone did not account for a contrast between pre- and posttest. Differences are only noticed when adding the Group variable, as can be seen by the crossing lines in the graph (figure 20) which demonstrates that the groups behaved in opposite pattern. The misconception scores of the control group have not changed substantially as a function of Navigation (total fixation per word on the SERP). Differently, among participants in the experimental group navigation times were linked with higher misconception scores.

Figure 20 - Effect of Group and Navigation (fixation duration on SERP)
Misconception scores

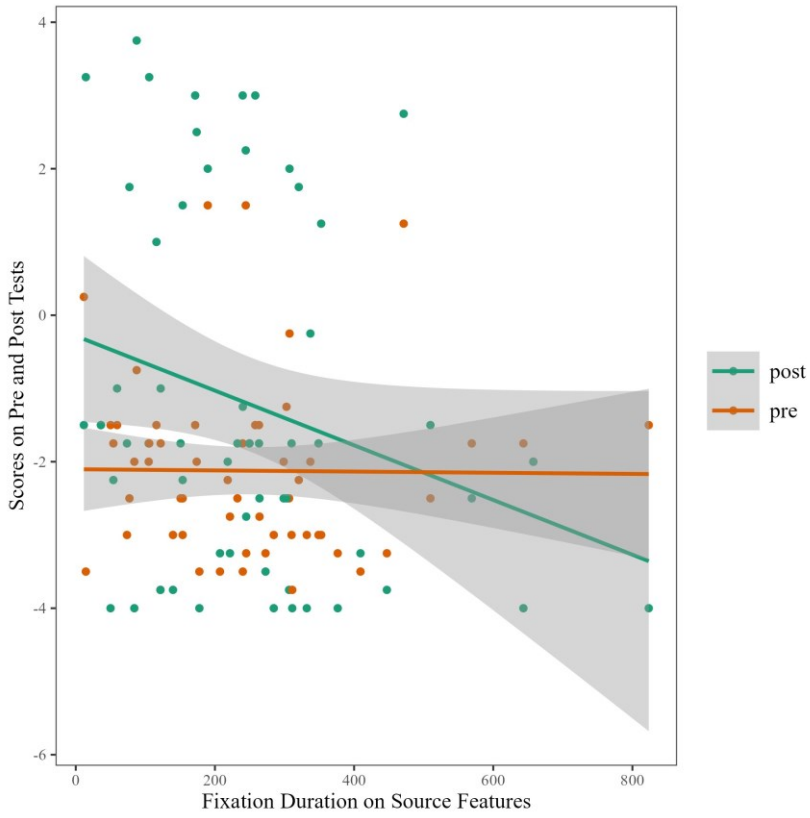


Source: the author

The third model showed a statistically significant effect of Evaluation (total fixation duration on source features per word) (β = -0.00, p = .017, 95% CI = [-0.01, -0.00], Marginal R^2 = .10, Conditional R^2 = .49), Moment (β = -1.82, p < .001, 95% CI = [-2.82, -0.82]) and a statistically significant interaction between the two (β = < 0.01, p = .032, 95% CI = [0.00, 0.01]). The effect of Fixation on source features was not significant at pretest which functioned as a baseline; at posttest, participants who had fixated the sources for shorter also achieved

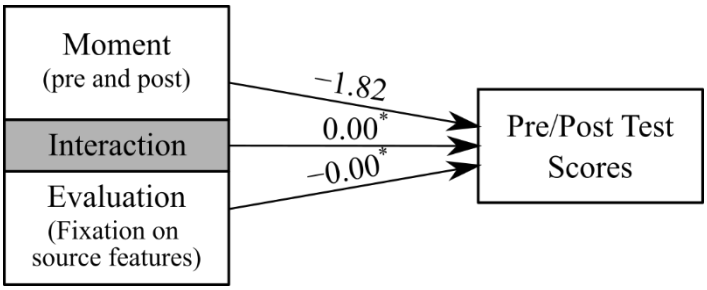
higher scores in the LS questionnaire. As can be seen in figure 21, only four students who scored -2 or -4 in the posttests (evidencing strong persistence in misconception belief) had more fixations (over 300ms) on the source features. In the upper right quartile there were only two observations (corresponding to more fixations and higher scores). As we can see, observations were concentrated on the left side of the figure, and did not vary much as a function of increased fixation duration on the source features. In a nutshell, evaluation was a predictor of performance in the posttest as well as its interaction with Moment, although in the opposite direction we had hypothesized (represented by the negative effect sizes figure 22).

Figure 21 - Effects of evaluation (fixation duration on source features) on scores on Pre and posttest



Source: the author

Figure 22 - Mediation model



Source: the author

In sum, misconception update happened as a function of L2 level, navigation (measured by fixation on the SERP) – among the experimental group, and evaluation (measured by fixation times on source features) – although not in the expected direction.

4.4.9 Post-hoc exploratory analyses

In the process of answering the research questions initially proposed for the present study, a few other hypotheses have arisen. In particular, we wanted to further investigate other aspects of the essays beyond quality of argumentation as grasped by the rubric used, extending our analysis to the position stated towards the Learning styles theory. The first exploratory hypothesis concerns a possible correlation between participant's position and argumentation skills. The second tested the effects of prior beliefs (as identified in the pretest) and position in the essays. These two exploratory hypotheses were tested using linear models and the results are presented and discussed in the next lines.

4.4.9.1 Exploratory analysis 1

A post-hoc exploratory analysis investigated the relationship between argumentative scores and the participant's stance towards the LS theory in the essays. The exploratory hypothesis assumed a positive correlation between argumentation skills and the endorsement of a position contrary to the LS misconception. To analyze the effects of Position on the Argumentation Scores a linear model was fit with Argumentation Scores as response variable and Position (4 levels: Contrary, Endorsing, Unclear and Unsettled, with Contrary as the intercept) as predictor. The model shows statistically significant effects of Position on argumentation scores (table 8), with the Contrary Position distinguishing from all the others, as

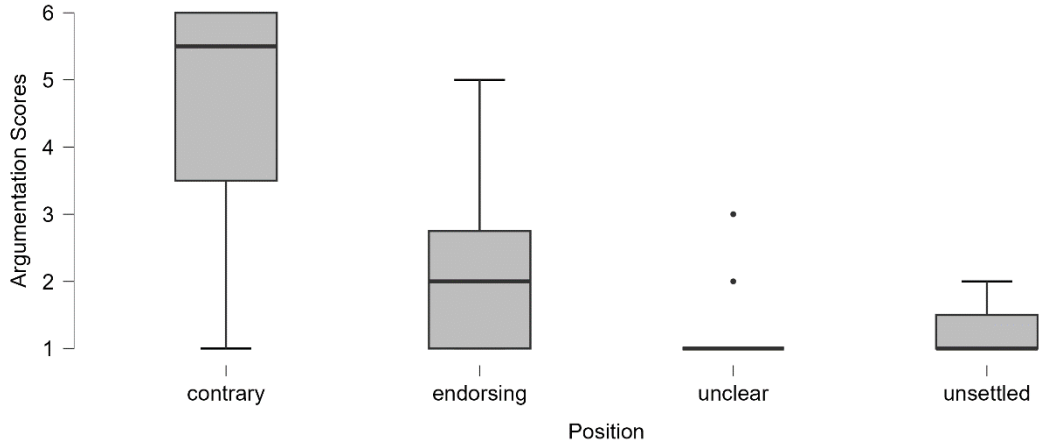
shown in figure 23. This result indicates a link between the capacity to state an informed position when writing about the Learning styles misconception and good argumentation skills.

Table 8 - Descriptive Statistics of Argumentation Scores by Position categories

	Argumentation Scores			
	Contrary	**Endorsing**	**Unclear**	**Unsettled**
Valid	14	26	14	3
Missing	0	0	0	0
Median	5.50	2.00	1.00	1.00
Interquartile range	3.5-6.0	1.00-2.75	1.00-1.00	1.00-1.50
Mean	4.71	2.04	1.21	1.33
Std. Deviation	1.73	1.11	0.58	0.58
Minimum	1.00	1.00	1.00	1.00
Maximum	6.00	5.00	3.00	2.00

Source: the author

Figure 23 - Argumentation Scores in relation to position in the essays



Source: the author

Table 9 - Coefficients of the linear model

Model		***β***	**Standard Error**	***t***	***p***
H_0	(Intercept)	2.456	0.235	10.456	< .001
H_1	(Intercept)	4.714	0.318	14.844	< .001
	position (endorsing)	-2.676	0.394	-6.793	< .001
	position (unclear)	-3.500	0.449	-7.793	< .001
	position (unsettled)	-3.381	0.756	-4.472	< .001

Source: the author

Indeed, endorsing a position on an issue based on solid arguments is a sophisticated argumentation skill; for this reason, it was used as the main criteria in assessing the essays. In addition, this finding informs about the participants' epistemic reasoning since the essays unveil their beliefs in knowledge as a complex process consisting of interrelated concepts that are subject to update. In this line, the integration competence, that is, the capacity to make connections across multiple sources, has also played a major role (Jacobson; Spiro, 1995; Rukavina, Daneman, 1996; Braten; Britt; Stromso; Rouet, 2011).

4.4.9.2 Exploratory analysis 2

As discussed in the literature review, people tend to attach greater value to information that is consistent with their prior beliefs and experiences – a behavior known as search for confirmation bias. On the other hand, when the information presented contradicts one's prior beliefs, it is perceived as implausible or dubious even when it is backed by scientific evidence (e.g. participant 26 – experimental group). As a consequence, "readers with strong prior beliefs about a controversial issue tend to construct stronger mental representations for belief-consistent textual information compared with belief-inconsistent information" (Richter *et al*, 2021, p.3).

As forestated, in the first exploratory analysis participants' position correlated with argumentation scores. Yet, it was not clear whether this position either represented a maintenance of a previous LS-contrary stance or pointed to misconception update from a LS-favorable stance. For this reason, another post-hoc analysis was performed to identify whether prior beliefs in Learning styles (as measured at pretest) affected the position stated in the essays. We hypothesized that, if prior beliefs were favorable to the LS theory, misconception change would be hindered, resulting in the essays maintaining the inaccurate view. On the other hand, if participants had already shown prior beliefs contrary to the LS theory, the essays would follow the same stance.

To analyze effects of Prior Beliefs on Position, the variable Position was binarized, such that "endorsing" was coded as 0, "contrary" was coded as 1 and scores with the other positions ("unclear", "unsettled") were removed from the analysis (17 data points were removed and 40 were kept). A logistic regression model was fit with Position (binarized) as response and scores on the pretest (Prior Beliefs) as predictor. The model shows no statistically significant effect of prior beliefs on position ($\beta = 0.184, p = 0.461$). The fact that prior beliefs did not predict the

position stated contrasts our rather negative assumptions and can be interpreted as evidence for misconception change. That is, while at first participants have shown stronger agreement with the misconceptions, they changed their stance after reading the webpages.

In a nutshell, the results from these exploratory analyses demonstrate that argumentation skills play a key role in the construction of a stance contrary the Learning styles theory. In addition, prior beliefs in the topic do not determine the position stated in the essays, which can be changed by reading texts in the topic – and as forementioned, refutation-style texts seem to be particularly promising in this endeavor.

4.5 DISCUSSION

This section presents the discussion of the hypothesis underlying the research questions of this study. We retake and examine the results in light of the relevant literature and contrast them with previous studies in the same line of research. The qualitative data and the post-hoc exploratory analyses are also approached and discussed.

4.5.1 Effects of EMMEs on processing

The results of the analyses related to research questions 1a, 1b, 2a and 2b provided evidence for an effect of the eye movement modeling examples (EMMEs) on the processing of online texts in L2. In the lines that follow, these results are discussed in relation to their underlying hypotheses and related previous studies.

4.5.1.1 Hypothesis 1

Our hypothesis 1 posited that instruction with EMMEs increases Navigation, i.e., attention to SERP features (web page name and snippets) in English (L2). This hypothesis was built from the results of a study in the L1 context (Salmerón; Delgado, Mason, 2020). The results of the analysis in RQ1a demonstrated that the EMME group fixated the SERP for longer compared to the control group. This fixation pattern indicates that the participants who watched the EMMEs were able to employ one of the strategies modelled in a novel context by carefully inspecting all the results within the Google-like results page and thus avoided clicking on the first link of the list. This behavior is described by Wineburg and McGrew (2017) as *click restraint* and was identified as a trace of expert navigation (i.e., fact checkers) in determining

content reliability. In contrast, participants in the control group fixated the SERP for less total time compared to the experimental group. Thus, our hypothesis 1 was confirmed.

This finding indicates an effect of EMMEs on processing with enhanced navigation performance in L2 that is similar to what was found by Salmerón, Delgado and Mason (2020) in Spanish (L1), who found an increase in time spent reading the SERP from pre- to posttest. Thus, it is reasonable to affirm that the effect of EMMEs can be extended from navigation tasks in L1 to the same tasks in English (L2).

This result is also in consonance with the meta-analysis carried out by Xie and colleagues (2021), who argue that EMMEs are an effective metacognitive tool. These authors argue that using eye movements from experts as models to demonstrate the steps of optimal information processing can be effective in guiding attention and enhance performance in cognitive tasks (XIE *et al*, 2021).

4.5.1.2 Hypothesis 2

For RQ2a "Do EMMEs affect attention to sources and content evaluation of multiple online documents in English (L2) that either endorse or refute the Learning styles (LS) misconception, to be analyzed by the contrast between fixation duration on reliable versus non-reliable pages, and on fixation duration on the source features (website banners and author's name and occupation)?", we hypothesized that participants in the EMME group would read reliable pages for longer and only scan the less reliable ones. In contrast, the control group would read all texts at a similar time, resulting in no difference between fixations on reliable and non-reliable pages. Similarly, we expected to identify longer fixations on the source features among participants in the EMME condition compared to controls.

Our hypothesis regarding the effect of EMMEs on evaluation (measured by fixation on reliable versus non-reliable pages) was partially confirmed: participants in the control group had longer total fixation times per word on the webpages compared to the experimental group. Nonetheless, this group fixated both reliable and non-reliable pages for longer. Differently, the experimental group fixated both types of webpages for less time, although the reliable pages were fixated for longer compared to the unreliable ones – but this difference was not statistically significant, as pointed by the lack of an effect of Reliability in the model. This means that the effect of group found corroborated our hypotheses: participants in the experimental group had shorter total fixation time because they allocated their time more efficiently (i.e., by spending less time on non-reliable pages and more on the reliable ones). Differently, in the control

condition participants read all pages for long regardless of their reliability. The longer total fixation time added to the little difference in fixation times on reliable and non-reliable pages in the control group might be explained, as predicted in our hypothesis, by a more laborious, non-strategic processing of information, in which all the pages were fully read regardless of their content trustworthiness.

These results are aligned with Salmerón *et al* (2020), who has also found increased reading times of reliable pages among participants in the EMMEs group, while such difference was not apparent in the control group. In addition, according to a recent meta-analysis on video modelling, longer fixation times did not correlate with increased attention to task-relevant elements (Xie *et al*, 2021), which explains the pattern of results found among participants in the control group: longer total fixations were not related to attention to content reliability. Indeed, a core aspect of the development of the evaluation competence concerns not only attending to relevant information but suppressing irrelevant information from the mental representation that is being built (Gernsbacher, 1997). Yet, the question remains as to how readers identify relevant information to better allocate their cognitive resources.

According to the CSI model (Stadler; Bromme, 2014) the first step of conflict processing – conflict detection – is triggered by text coherence and reading goals. In the same line, Kozyreva, Wineburg, Lewandowsky and Hertwig (2022) highlight critical ignoring as a key competence for citizens to be able to select content online. One possible explanation for the similarity in fixation times on reliable and non-reliable pages in the control group is that these readers may not have identified the Learning styles issue as a conflict, since they did not strategically allocate their time among the sources that were reliable (and thus should be attended for longer) and sources that were non-reliable (and should be ignored). As a result, evaluation processes such as attention to the sources were hindered.

We also found a significant interaction between Group and reliability: the experimental group has spent less time on non-reliable content compared to controls – which indicates that participants in the experimental group were better able to identify and ignore content that was not trustworthy. The reliable pages were also read for longer by controls than by the experimental group, albeit the difference was less pronounced. This result partially confirms our hypothesis 2, which stated that the pages identified as reliable would be read more carefully, while non-reliable pages would be more quickly scanned – a difference that would be more pronounced in the experimental group.

Contrary to our hypothesis 2, however, EMMEs did not affect attention to sources neither directly nor indirectly (mediated by L2 level and self-reported behavior). The

Discrepancy-induced source comprehension model (D-ISC) (Braash; Braten, 2017) argues that documents that present internal or between-text contradictions foster attention to the source features. Although the texts used in the present study follow this structure, our findings do not corroborate this model in an L2 reading situation.

We expected that the experimental group would outperform controls in total fixation time on the reliable pages, but the results have pointed to the opposite direction. Thus, the question remains as to why EMMEs had no effect on increasing reading times on the reliable pages at a statistically significant level, distinguishing from the controls. The fact that both groups performed similarly when reading trustworthy content leads to the assumption of an effect of the structure of the reliable texts used in this study. A plausible interpretation for this finding is that the structure of the reliable pages has reduced the difference between experimental and control groups. We offer an explanation for this effect of reliability in terms of the refutation structure of the reliable pages.

Refutation texts foster the generation of bridging inferences and elaborations for texts approaching misconceptions in biology (Hunsu; Adesope; Mccrudden, 2023), although its use in changing misconceptions in education among preservice teachers has been less effective (Menz *et al*, 2020 but see Lederer, Asberger, Thomm, and Bauer, in preparation). In our study, the reliable pages followed a refutation style: they made the conflict explicit by introducing the Learning styles theory followed by arguments that debunked it. On the other hand, the non-reliable pages (a commercial website of homeschooling platform, a personal blog of an educator, and an informational website) conveyed a LS-favorable perspective and, for this reason, only described the framework and its use. The controversy around the validity of this theory was not mentioned in these pages. Once the text structure of reliable pages helped the reader to identify and analyze the conflict, the evaluative strategies that had been modelled by EMMEs were not as crucial to define the accuracy of information. Thus, it is possible to conclude that the structure of refutation texts might compensate for individual differences in strategic behavior when evaluating the trustworthiness of information from conflicting sources.

In relation to evaluation as measured by fixation on source features we hypothesized that, when accessing each webpage, participants in the EMME condition would examine the webpage banner, the author's name and his credentials for longer, whereas the control group would have shorter and fewer fixations on these source characteristics. Nevertheless, no differences were found between experimental and control groups in terms of fixation on the source characteristics. The fact that the experimental condition was not linked with increased fixation on the sources partly disclaims our hypothesis 2 about the effect of EMMEs on

evaluation. This also deviates from the findings of Salmerón and colleagues (2020) who found longer times spent on source features on posttests (after intervention) compared to pretests. Thus, the question arises to why an effect of EMMEs was observed on the evaluation of content credibility (fixation on reliable and non-reliable pages), but not on fixation on the source features.

The fact that both groups showed little difference in terms of fixation time on the source features might be explained in terms of an effect of the design of the webpages created for this study. Source information was presented in a linear manner: the author's name and credentials appeared right below the title, aligned on the left. This textual organization might have refrained the reader from skipping source data, resulting in no group differences in terms of total fixations on the source features. In comparison, in the study by Salmerón and colleagues (2020) the position of source information was manipulated by presenting a picture of the author and her/his name and credentials either on the left or the right sides of the main text, or at the end of the page – which led to different fixation patterns. This result offers important insights in terms of design influence and the importance of source position to the evaluation of webpages.

A second interpretation draws from the content-source integration model (Stadler; Bromme, 2014), described in chapter 2. The CSI postulates that, once conflicting information is detected, the reader will attempt to restore coherence by a) ignoring the conflict, b) trying to reconcile the propositions by making inferences, or c) by accepting the conflict as due to different sources. Last, to solve the conflict, readers need to position themselves by making "validity judgments" based on prior knowledge about the subject matter (what is true?) as well as on the quality of the sources (whom to believe?). Each alternative has its limitations: while prior knowledge is heavily influenced by one's beliefs and might not suffice to accurately clarify the issue, source scrutiny requires the complex ability of identifying author expertise.

As we can see, the issue of "whom to believe" is an intricate one. In the present study, source evaluation was measured by fixations times a) on source features and b) on reliable/non reliable pages. Fixation on source features tells us whether the reader has attended to authorship; nonetheless, it does not account for the more subtle epistemic reasoning processes discussed above, such as the criteria used for judging source quality. Thus, is seems reliability was a more accurate measure of the evaluation competence compared to fixation on source information, since the webpages (especially the ones following a refutation-style format) gave readers rich subsidy to solve the Learning styles contradiction.

4.5.1.3 Hypothesis 3

We hypothesized that L2 level would mediate the effect of EMMEs on navigation (fixation times on the SERP) and evaluation (fixation on source features). This hypothesis has its roots in the Component processes model in reading, which describes comprehension as involving both lower and higher level processes (Gagné; Yekovich; Yekovich, 1993). Lower processes comprise automated basic skills such as decoding and literal comprehension, whereas higher level processes are inferential comprehension and comprehension monitoring. Decoding involves matching a printed word to its possible meanings in memory, which may include recoding (associating this word to its sound pattern). Literal comprehension entails selecting the interpretation that best suits the context among the meanings that had been activated and linking the meaning of these words into propositions through parsing processes. The text propositions are integrated through inference generation (i.e., identification of pronoun reference, bridging inferences). The reader must also be able to identify the main ideas of the text (summarizing) and elaborate on what is stated by making connections with prior knowledge to facilitate retrieval. At a comprehension monitoring stage, the reader establishes a goal, checks if it is being reached, and (if need be) implements remediating strategies. Readers with low L2 level are less skilled and thus more likely to experience processing difficulties at the decoding level – which in turn might hinder the processes tackled by EMMEs (i.e., navigation and evaluation) and thus fail to apply comprehension monitoring strategies. Following this rationale, participants with higher L2 level will experience less comprehension issues, freeing cognitive resources that can be applied in comprehension monitoring and will thus benefit more from the EMMEs intervention.

Nevertheless, since L2 level was not different across groups, any effect of L2 level on the processing measures could not be traced back to group differences. Thus, Hypothesis 3 cannot be fully confirmed. Our analysis of RQ1b has shown that L2 level did not predict navigation (measured by total fixations on each page title and snippets within the SERP), which disclaims hypothesis 3. A possible explanation for the absence of a mediating effect of English level on navigation is the participant's proficiency in English, which was compatible with the language level required to process the short texts within the Google search page created for the experiment. At the time of recruiting participants had been asked to present a certificate of a minimum B1 level. Because L2 level was similar across the groups, participant's intermediate level of English ensured comprehension and hence did not impose a constraint to the application of high-level self-regulation strategies (Gagné *et al*, 1993).

We also hypothesized that L2 level could predict the effect of EMMEs on evaluation (RQ2b). Again, the groups had similar L2 levels so there were no mediation effects. An effect of L2 level on fixation times on the pages was found: as expected, participants with higher L2 level also had shorter fixation times on the webpages, while the ones with low L2 level had more total fixations on the same amount of text. Fixation duration among high L2 level readers did not differ as a function of whether a page was reliable or not; this hinders the interpretation of L2 level as associated with increased evaluation. Thus, the quicker reading of the webpages among highly proficient participants can be interpreted as evidence for the less effortful (and consequently faster) processing. The fact that the participants in the experimental group read the web pages faster (RQ2a) could be interpreted as an indicator of efficiency since the task required distinguishing between reliable information (which should be focused on for longer) and non-reliable information (which should be quickly discarded). Nonetheless, as forestated, total fixation times on the web pages were not associated with webpage reliability; thus, the longer reading time among participants with higher L2 level cannot be taken as a sign of quick strategic scanning.

In addition, higher L2 level did not correlate with increased fixation on the source features (banner, author's name and occupation). That is, L2 was not a constraint when participants inspected the sentences within the SERP (as verified in RQ1b) nor the words corresponding to source information. Still, it affected fixation duration on longer texts (i.e., the webpages), with shorter total fixation times among participants with high L2 level and longer fixation times among low-level participants.

To sum up, since groups did not differ in terms of L2 level, no mediating effects were found which means that Hypothesis 3 was not confirmed. When analyzing the SERP and the source features within each webpage, L2 level was not a significant predictor. That is, participants' proficiency in L2 has likely sufficed to build and maintain coherence at the level of syntactic structure and enable the development of evaluation processes. Nonetheless, L2 explained differences in terms of total fixation on reliable and non-reliable pages: at the macrolevel, the more proficient L2 readers processed the texts faster. This speed did not translate into more accurate evaluation of text credibility, since no differences were found between reliable and non-reliable pages.

4.5.1.4 Hypothesis 4

Traditionally, questionnaires devised to measure students' use of strategies have identified comprehension and study strategies (Mokhtari; Reichard, 2002), L2 reading strategies (Sheorey; Mokhtari, 2001), online reading strategies (Anderson, 2003), or the two – as is the case of the instrument used in this study. In hypothesis 4, we predicted that self-reported strategic behavior, measured by the SLORSI (Li, 2020), would mediate the effect of EMMEs on navigation (fixation on the SERP) and evaluation (fixation on source features). That is, participants who report a high frequency of strategy use in the survey are likely to benefit more from the EMMEs, attending more to navigation and source features compared to the participants who report a low frequency of strategy use. The hypothesized mediating effect of self-reported behavior is supported by previous studies in L1, which indicate that individual differences in metacognition affect hypertext reading. For example, in the study by Schwartz and colleagues (2004) participants' self-rating of their metacognitive skills predicted performance in complex navigation tasks. Two caveats have to be made regarding the limitations in comparing our findings with the study of Schwartz and colleagues (2004): first, the latter dealt with a small sample (N=15) of another population (10-17 year-olds); second, the metacognitive questionnaire used was different, as well as the navigation measures (in their study, webpage design was manipulated in four conditions: outline, diagram, visual metaphor, and geographic map).

Nonetheless, Hypothesis 4 was not confirmed because no Group differences in terms of self-reported behavior were found. The answers to the Second Language Online Reading Strategies Inventory did not predict fixation times on the SERP (RQ1b) nor on the evaluation measures (RQ1b), namely fixation on reliable / non-reliable pages and fixation on the source features. The absence of an explanatory power of self-perceived strategic behavior on navigation (RQ1b) and on evaluation (RQ2b) can be approached in terms of the hypothesized mediating role of these self-reports. In general, participants reported high frequency of strategy use in the survey; the mean score in the SLORSI was within the "high" range of strategy use for both groups (EMME $M = 3.47$; $SD = 0.38$; Control $M = 3.61$, $SD = 0.38$) – as mentioned before, 3.5–5 were considered "high"; 2.5–3.4 was within "medium", and 2.4 or lower was interpreted as "low" level of strategy use (Oxford, 1990; Li, 2021). Again, although participants reported a high frequency of strategy use, these self-reports did not mediate the effect of the EMMEs on navigation nor on evaluation at a statistically significant level.

This finding suggests that the effect of EMMEs on navigation and evaluation was not constrained to individuals' perceptions of their strategic behavior when reading online texts in an L2. That is, self-reported behavior, navigation, and evaluation were independent constructs, not interconnected by any mediating effect. It bears highlighting that, in the present study, the matter of calibration – the difference between predicted and actual performance (Alexander, 2013; Tarchi; Mason, 2022) – was not a target, although it does deserve further investigation.

In addition, the instrument used, the SLORSI (Li, 2020), albeit validated, does not include items specifically related to attention to source features and content reliability – the measurements used to assess the evaluation competence in our study. Among the 29 items in the survey, three of them approach evaluation: Q8, Q12 and Q29. The eighth (when reading online, "I look for sites that cover both sides of an issue") and the twelfth ("I look for multiple online texts on the same topic") approach multiple documents reading. The last one ("I critically analyze and evaluate the information presented in an online text") is related to evaluation but does not detail the strategic processes used by the reader to analyze the source. Future instruments aiming at measuring the readers' use of online reading strategies in academic contexts could include items related to sourcing strategies such as attending to the type of webpage, date of publishing, author's name, her/his position, and whether s/he represents an institution and its interests.

4.5.2 Effects of EMMEs on learning outcomes

Research questions 3a, 3b, 4a, 4b, 5a and 5b approached data under a product-oriented perspective, investigating a possible indirect effect of the treatment (EMMEs) on the offline learning measures used in this study (essays, source-memory task, and pre/posttest on prior beliefs). The issues raised by the results of these research questions are now discussed together with the results of the qualitative analysis of the essays and the exploratory analyses.

4.5.2.1 Hypothesis 5

In hypothesis 5 we proposed that if EMMEs enhance navigation (measured by total fixation per word on SERP), then their effect would extend to the learning outcomes controlled for in this study. We checked for both direct effects of EMMEs on essay scores (RQ3a), memory for the sources (RQ4a), and misconception change (RQ5a) as well as indirect effects

of EMMEs on the same variables mediated by L2 level, navigation, and evaluation (RQs 3b, 4b, and 5b).

In RQs 3a and 3b, our results showed that EMMEs did not have neither a direct nor an indirect effect (mediated by navigation) on argumentation scores. In relation to this absence of effect of EMMEs on essay writing mediated by navigation, as forestated, argumentation scores were low in both groups (Control group: M = 2.55, min. 1, max. 6, *SD* = 1.68; Experimental group: M = 2.36, min. 1, max. 6, *SD* = 1.89). This demonstrates that the writing task has been challenging for participants, who might have experienced difficulty gathering arguments to support an informed opinion on Learning styles.

Another factor to be considered is that the rubric used to score performance in the essays tackled essentially the participants' argumentation skills; this has led us to propose exploratory hypotheses to account for the positions stated in the essays. The first exploratory hypothesis showed a correlation between high argumentation scores and the endorsement of a position contrary to the LS theory, which demonstrates the adequacy of the argumentation rubric to assess misconception change. Second, we investigated whether the position stated in the essay resulted either from a previous accurate position or represented misconception update. Interestingly, prior beliefs (measured by the four first statements of the MMLQ at pretest) did not predict stance in the essays – a positive finding that points to the possibility of updating a misconception regardless of one's prior beliefs. In addition, some argumentation patterns found the essays were analyzed under a qualitative paradigm. In constructing an opinion about the Learning styles theory, participants were strongly influenced by their epistemic beliefs and prior experiences on the topic. They gave credit to sources that were manipulated to be perceived as unreliable and also attempted to validate the Learning styles theory by situating it into the realm of learning (and not teaching). They also demonstrated difficulty distinguishing styles and strategies. All these argumentation traits are evidence of the many influential factors that underlie reasoning when participants are writing an essay about an educational misconception.

In RQ4a, EMMEs did not directly affect performance in the source-memory task. Nonetheless, an interaction was found between Group and L2, with L2 level significantly predicting better scores in the source memory task among participants in the control group. In the experimental group L2 was not such an influential factor in determining memory for the sources, although participants with higher L2 level did outperform low L2 levels in the experimental condition. From the above stated, we conclude that L2 level was a better predictor than our treatment in explaining memory for the sources.

In relation to the lack of an effect of EMMEs on memory for the sources, Salmerón and colleagues (2020) did not find any effects of EMMEs on increased source citation nor on the quality of the references to the sources (i.e., whether the reference was explicit or embedded) included in the essays. That is, EMMEs do not seem to enhance memory of the sources neither in L1 nor in L2 contexts. An influential factor might have been the fact that EMMEs did not exert neither a direct nor an indirect effect (mediated by L2 level and/or self-reported strategic behavior) on the processing measure Fixation on source features, as evidenced in the analysis of RQ2b. Thus, this lack of an effect on processing resulted in no effects on learning outcomes (i.e., memory for these sources). We explained this result of RQ2b in terms of the design of the web pages created for the experimented, which did not give any typographical nor spatial prominence to source information (see hypothesis 2 for the complete discussion).

In relation to misconception change (measured by the difference between pre- and posttests), EMMEs did not directly affect misconception update, as seen in RQ5a. Interestingly, In RQ5b the interaction between group and navigation predicted a decrease in belief in the Learning styles misconception (measured by the difference between pre- and posttest). That is, participants who watched the EMMEs used the navigation strategy modelled of inspecting all the results of a Google-like results page before clicking (which confirmed our hypothesis 1). This in turn resulted in higher scores on posttests (compared to pretests), evidencing misconception change. It is likely the case that the navigation competence is easier to model through the use of EMMEs (compared to the evaluation competence, as will be discussed in hypothesis 6), and thus its effects extended to misconception change, as evidenced by the increased scores on the pretest.

As discussed in chapter 2, beliefs in the Learning styles misconception stem from a number of factors such as chock with one's personal value systems (Vaughan, 1977), academic background (holding a degree, completing neuroscience courses, and reading peer-reviewed journals), and misunderstanding of the complexity of how learning is constructed (Macdonald; Germine; Anderson; Christidoulou; Mcgrath, 2017). Given its multifaceted nature, this misconception is especially difficult to be updated and very resistant to instruction. In our study, participants' academic background (they were in majority students of psychology, speech therapy, and pedagogy) has not prevented them from believing in the LS misconception. As Menz and colleagues put, "psychological misconceptions have been identified as a widespread issue and that having a background in psychology does not prevent from endorsing psychological misconceptions" (Menz; Spinath; Seifried, 2020, p.2).

Why do courses related to mind and education fail to change belief in neuromyths? One explanation is that students from these areas often bring to the course their previous knowledge and prior beliefs about how the mind works – which might be either (inn)accurate or simply untrue and not supported by empirical evidence (Vaughan, 1977). Similarly, preservice teachers show overreliance on their peers' previous experiences, refuting empirical evidence from studies in educational psychology that contradict experience-based beliefs (Menz *et al*, 2020). Given the pervasiveness of this misconception among the population investigated, our findings point to the importance of discussing and fostering evidence-based education in the academic setting as well as in the schools, since educational psychologists are the ones who orient learning and teaching practices in this context. Likely, researchers in neuroscience and psychology should commit themselves to the diffusion of scientific knowledge, exposing the feebleness of theories such as learning styles. In the same line, practitioners should receive training on how to identify reliable scientific data (Dekker; Lee; Howard-Jones; Jolles, 2012).

In a nutshell, hypothesis 5 was partially confirmed since our results were mixed. There were no direct nor indirect effects (mediated by navigation) of EMMEs on argumentation scores nor on source memory. Yet, we found an effect of Group and an interaction between Group and Navigation on misconception change. That is, participants in the experimental group made more fixations on the source features and scored higher on the misconception tests. Given that EMMEs have the potential to model navigation strategies and that its benefits extended to misconception change, this finding opens new venues for research in further exploring its effects on the other learning measures dealt with in this study – and perhaps others.

4.5.1.5 Hypothesis 6

In hypothesis 6 we proposed that if EMMEs enhance evaluation (measured by total fixation on the source features), then their effect will extend to the learning outcomes, with the experimental group (EMME) achieving higher argumentation scores in the essays, higher scores in the source-memory task, and misconception change (evidenced by the difference between pretest and posttest scores). Our results showed that evaluation did not predict argumentation performance in the essays (RQ3b) nor scores in the source memory task (RQ4b). In relation to misconception change, in RQ5b Evaluation predicted performance at posttest, although not in the direction we expected: at posttest, participants who had fixated the source features for shorter achieved higher scores at posttest (figure 21). Thus, although EMMEs have to some extent affected evaluation (as discussed in hypothesis 2, which was partially

confirmed), its effects did not extend to the learning outcomes, so hypothesis 6 was not confirmed.

Why did the processing measures of navigation (fixation times on the SERP – hypothesis 5) and evaluation (fixation on the webpages) fail to mediate the effect of EMMEs on argumentation scores in RQ3b? As discussed in hypothesis 5, this result might be explained in terms of task difficulty. In addition, EMMEs, navigation and evaluation are, as implied by our study design, processing variables, whereas scores in the essay are a learning measure. Essays have been traditionally used to analyze the construction of an integrated representation from multiple sources. Albeit commonly used to assess learning outcomes, criticism towards its application points to the fact that it strongly requires the student's writing competence. In the present study, the essays were used as a learning measure; that leads to the question: what do we really measure when we require essay writing tasks? In addition, writing an essay about the Learning styles misconception has involved not only stating an informed position grounded on consistent arguments, but also acknowledging that the controversy was due to a misleading theoretical framework who has become widespread. In this complex scenario, navigation and attention to sources (the processing measures modelled by EMMEs) play a minor role.

Similarly, neither navigation (hypothesis 5) nor evaluation mediated the effect of EMMEs on source memory. The lack of an effect of EMMEs on memory for the sources in the present study provides more evidence on the impact of this type of metacognitive intervention on online strategic processing (as opposed to learning). In a systematic literature review aimed at categorizing the effect of EMMEs, Emhardt and colleagues (2023) draw a distinction between process and learning outcomes: the former refers to measures collected as participants watched the instructional video, while the latter accounts for tasks carried out after watching the EMMEs. According to the authors, the fact that EMMEs enhance attention when processing visual stimuli does not ensure its effect on participant's subsequent learning tasks; thus, our results are in accordance with the literature.

In relation to misconception change, as per our analyses in RQ5b, the effect of evaluation was significant at posttest, where (contrary to expected) shorter fixations on source features were associated with more pronounced differences between pre- and posttest. The effect of moment (posttest) provided data on how participants changed their stance towards the Learning styles misconception. If such update has not occurred as a function of the treatment (EMMEs), then where does it stem from? One possible explanation is, as previously mentioned, the use of a refutation style in the texts, which might have triggered a more careful analysis of the divergent perspectives.

As expected, participants have to a certain extent changed their beliefs in learning styles after reading the texts that comprised the navigation task. This misconception change indicates that being confronted with opposing perspectives was associated with updating participants' representations about learning styles. As discussed in the literature review, refutation-style texts can play an important role in reducing misconceptions in educational psychology (Menz; Spinath; Seifried, 2020). In our study, participants read texts presenting opposing perspectives that either corroborated or debunked the LS theory. The reliable pages followed a refutation format by explicitly stating the theory as a misconception and then providing arguments to support this position. This was especially beneficial to the participants who believed in the misconception. Thus, our finding is in consonance with Menz and colleagues (2020) who found a positive effect of reading texts in a refutation format on misconception change for topics in educational psychology (learning styles, class size and multiple intelligences) among preservice teachers, although their study has dealt with a single text reading situation. Similarly, Dersch and colleagues (2022) found a positive effect of refutation texts on misconception change among in-service teachers.

In sum, in RQ5b we found an effect of EMMEs on Navigation (fixation on the SERP) which in turn resulted in misconception update and partially confirmed hypothesis 5. However, the effect of our treatment mediated by Evaluation (fixation on sources) was not as clear, as discussed in hypothesis 6. Thus, no generalizations can be drawn in terms of an effect of EMMEs on misconception change. Nonetheless, figures 18 and 20 show a clear change in stance from pre- to posttests, which signals that participants updated their prior beliefs in Learning styles after having read refutation-style texts. More research is needed to understand how video models can be adapted to serve different learning purposes such as awareness on educational misconceptions – and including eye-movement data on the processing of refutation texts seems to be a particularly promising venue. In addition, more studies are needed to investigate the possible effect of EMMEs on the development of the evaluation competence (particularly on fixation on source features), and how this effect can be assertively measured on an online reading task. This will in turn allow an investigation of its potential learning benefits.

4.5.1.3 Hypothesis 7

Last, we hypothesized that English level would mediate the effect of EMMEs on learning, with the participants in this group with higher L2 level achieving higher

argumentation scores in the essays, higher scores in the source-memory task, and greater misconception change (pretest/posttest) in comparison with controls. Our results indicated that L2 was a robust variable in predicting learning outcomes. L2 level predicted argumentation scores (RQ3b), although this effect did not interact with Group. That is, L2 did not mediate the effect of EMMEs on argumentation. L2 level also predicted memory for the sources (RQ4b), and adding Group to the model resulted in a statistically significant interaction between Group and L2 level: in the control group, participants with higher L2 scores also performed better in the source memory task, while in the experimental group the same advantage for high L2 students was observed, only smaller. Last, L2 level affected misconception change, although adding Group to the model did not result in significant interactions nor main effects (RQ5b). These results indicate that the treatment with EMMEs was not such a significant predictor of memory for the sources as was L2 level; thus, hypothesis 7 was not confirmed.

In general, the fact that higher L2 levels were linked with increased fixation times on source features, higher scores in the essay, in the source memory task, and on pre- and posttests (and the difference between them) is in line with our assumption of L2 level as a strongly influential variable in both learning outcomes in any language task. In relation to processing, Navigation and Fixation on source features were the only variables not explained by L2 level. This finding highlights the significance L2 proficiency as a necessary condition for text comprehension, evaluation of content trustworthiness, argumentation, memory for the sources, and misconception update. Crucially, in our study, participants with high L2 levels were able to update their misconceptions, while among low-level participants this process was hindered. Thus, from a processing perspective, proficiency is a requirement (or a limitation?) for the higher cognitive processes involved with misconception update to take place.

Last, this result gives further validation to the instrument that was used to measure L2 level – LexTALE (Lemhöfer; Broersma, 2012) in the context of mostly Spanish speakers of English (L2). Albeit being a quick lexical decision task, it was accurate enough to enable the identification of low and high levels of proficiency among the sample analyzed.

5 FINAL REMARKS

Faz-se necessário e urgente que os alunos da educação básica possam ter acesso a estratégias de ensino diferenciadas, que tenham como objetivo o desenvolvimento da metacognição e, com isso, o empoderamento do seu próprio pensar.

Silvano; Maia, *Psicolinguística e metacognição na escola*

The present study investigated the effect of videos of eye movement modeling examples (EMMEs) as a tool to foster the use of navigation (measured by the total fixation duration on the search engine results page – SERP) and the evaluation of source features (measured by the total fixation duration on the banner and the author's name and occupation within each web page), and content reliability (measured by the total fixation duration on the reliable and non-reliable pages) when reading webpages in English as an L2 that either endorsed or refuted the learning styles misconception. We also hypothesized an indirect effect of EMMEs on learning mediated by navigation and evaluation, resulting in enhanced argumentation (measured by scores on an essay task) and memory for the sources (measured in a source memory task). Last, we also investigated an effect of EMMEs on misconception change towards the Learning styles theory to be checked by analyzing the difference between scores on pre- and posttests.

To answer these questions, a 9'32-minute instructional video (EMME) was developed comprising the eye movements of competent readers as they performed navigation tasks. It extended on the version conceived by Salmerón, Delgado and Mason (2019) by including the eye data of less skilled readers. Participants in the control condition watched an animated video about online reading strategies. The LS misconception was approached in a hypertext reading task: a Google-like search engine results page (SERP) was created comprising six webpages that interleaved sources that were either favorable or contrary to the LS theory. As participants carried out this reading task, their eye movements were recorded. After reading the pages, participants wrote an essay, answered a sourcing task, and a posttest to check for misconception update. L2 level and prior beliefs about LS have been controlled for at a pretest stage.

The next two sections retake and summarize the findings of the study.

5.1 ON THE EFFECTS OF EMMES ON PROCESSING

In relation to the effect of EMMEs on processing, we hypothesized increased fixation duration on the SERP (hypothesis 1), increased time reading the web pages that were reliable as well as decreased time reading non reliable pages, and more time spent processing source features – website banner, name of the author and her/his occupation (hypothesis 2). A mediating role of English level (hypothesis 3) and self-reported strategic behavior (hypothesis 4) was also hypothesized.

In general, the results of the mediation analyses performed demonstrate that eye-movement modeling examples (EMMEs) had an overall effect on the development of the digital competencies investigated. In RQ1a, EMMEs were found to positively affect navigation (measured by fixation times on the SERP). That is, participants who watched the EMMEs also spent longer inspecting the SERP features, which can be interpreted as evidence for increased navigation behavior. These findings corroborate our hypothesis 1 that EMMEs have the potential do foster self-regulation strategies in navigation tasks, extending the results of Salmerón and colleagues (2020) to the L2 reading realm. It also adds to the existing body of evidence indicating that strategic behavior is transferred from L1 to L2 reading (Park; Kim, 2011; 2017; Taki, 2015; Chen, 2015). Nonetheless, findings from RQ1b revealed that this effect of EMMEs on navigation was not mediated by L2 level nor self-reported strategic behavior – which partially disclaims our mediating hypotheses (3 and 4).

Research question 2a investigated a possible effect of EMMEs on evaluation, measured by fixation on reliable and non-reliable pages and fixation on source features. In our results, participants in the control condition have shown increased total fixation times on all the webpages but these fixations did not differ between reliable and non-reliable pages.; Participants in the control group failed to ignore non-reliable content. Differently, the experimental group displayed more fixations on reliable and less fixations on non-reliable pages which evidenced a more efficient strategic allocation of time, although this within-group difference in reliability was not statistically significant. Of note is the statistically significant interaction between group and reliability: the experimental group made shorter fixations on non-reliable pages compared to controls; yet, the reliable pages were inspected by the two groups by an identical amount for time. This was explained in terms of the refutation structure of the reliable pages, which made explicit the inconsistencies of the Learning styles theory. Last, EMMEs did not affect

fixations on the source features; this finding was explained in terms of task design. From the above stated, our hypothesis 2 which argued for an effect of EMMEs on evaluation was partially confirmed.

Research question 2b sought for mediating effects of L2 level and self-reported behavior on evaluation. First, higher L2 levels were linked with a decrease in fixation times on the web pages which confirms hypothesis 3, albeit there was no statistically significant difference between the fixations on reliable and non-reliable pages. Second, self-reports did not predict fixations on the web pages, disclaiming hypothesis 4; this result was explained in terms of the survey used to trace participants' strategies when reading online texts in L2, which may not have accurately grasped the aspects of behavior dealt with in the present study (i.e., attention to sources and content reliability). Furthermore, the absence of a mediating effect of self-reported behavior might simply indicate that these constructs are not codependent. Last, our second measure of evaluation, fixation on source features, was not predicted neither by L2 level (hypothesis 2) nor by self-reported strategic behavior (contrary to what was proposed in hypothesis 4).

5.2 ON THE EFFECTS OF EMMES ON LEARNING, MEMORY FOR THE SOURCES, AND BELIEF CHANGE

Research questions 3a, 3b, 4a, 4b, 5a and 5b approached learning measures and misconception change. We hypothesized that if EMMEs enhance navigation (hypothesis 5) and evaluation (hypothesis 6), then their effect could extend to learning, with participants in the experimental group outperforming controls in argumentation scores in the essay, memory for the sources in the source memory task, and misconception change (difference between pre and posttest). We also hypothesized a mediating role of L2 level in the forementioned learning measures (hypothesis 7).

In RQ3a we checked for a possible direct effect of EMMEs on learning (as measured by argumentation scores on an essay task), which was not found. The fact that no effect of EMMEs was observed on argumentation scores is evidence of the complexity involved in developing the learner's argumentation skills and the need for instruction-based programs that tackle more specific aspects of these skills.

RQ3b further investigated the variables mediating the effect of EMMEs on the argumentation scores in the essay task, namely L2 level, navigation (measured by fixation

duration on SERP) and evaluation (measured by fixation duration on source features). L2 level was the only variable found to affect argumentation in the essays. This result confirms hypothesis 7 and corroborates the understanding that L2 level plays a major role on both strategic processing (as seen by RQ2b) and learning (RQ3b). Furthermore, it validates the instrument used (LexTALE) among a population of Spanish students speakers of English (L2). The fact that even a simple, short lexical-decision task was able to unveil effects of L2 level on the measures used in this study adds to the reliability of LexTALE, encouraging its use in future studies.

We also analyzed some patterns of argumentation in the essays under a qualitative perspective. Non-reliable web pages such as a commercial website and a teacher's personal blog were sources explicitly cited to justify a stance favorable to the Learning styles theory, demonstrating inaccurate sourcing skills among these participants. Besides, participants often weighed the arguments in contrast with their prior beliefs and personal experiences, even when provided with reliable information. We interpreted this argumentation pattern as stemming from their epistemic beliefs in relation to knowledge as constructed by the self – and not as a collective endeavor from the scientific community (Braten *et al*, 2011). Last, we noticed some attempts to validate the learning styles misconception by situating the theory in the learning (and not the teaching) realm; this interpretation has originated from a misinterpretation of the failure of the theory in classroom settings. Another attempt was to attribute the conflict as a two-sided, open-ended nature. Last, participants seemed to have confounded the terms "style" and "strategy"; this conceptual gap was found in the essays of participants from both groups and was detrimental to the construction of a coherent stance in the essays.

In RQ4a we expected that EMMEs would predict memory for the sources, but this direct effect was not found. RQ4b sought for an indirect effect of the mediating variables L2, Navigation and Evaluation on the same response variable (source memory). Nonetheless only L2 significantly predicted scores in the source memory task. We also found an effect of group and an interaction between group and L2 level, with high L2 level students in the control group remembering significantly more sources than low L2 levels in the same group. In the experimental group higher source memory scores were also observed among participants with high L2 level, although the difference was less pronounced. In short, it was the linguistic level (and not the treatment) the strongest predictor of performance in source memory.

In RQ5a we tested the direct effect of EMMEs on misconception change (difference between pre- and posttest) and no such effect was found. Finally, RQ5b explored mediating variables that might have affected change in stance (i.e., the Moment variable) towards the Learning styles theory. L2 level significantly predicted higher scores in the posttest. Navigation alone did not predict scores in the Leaning styles questionnaire, although its interaction with Group resulted significant: participants in the experimental group who had also made more fixations on the SERP displayed significantly better scores from the pre- to the posttest, whereas in the control group scores have not changed as a function of fixation on the SERP. Last, evaluation (measured by fixation on the source features) as well as its interaction with Moment successfully predicted scores on the misconception tests and the difference between the two, although more fixations on the sources was not linked with higher scores.

5.3 PEDAGOGICAL IMPLICATIONS

It is the ultimate goal of research in psycholinguistics and educational psychology to serve the needs of teachers and students in their diverse contexts. In the next lines we highlight the pedagogical implications of the results of the present study for learning and teaching with focus on multiple documents comprehension, critical reading on the internet, and the use of video models in developing these competencies.

How do Brazilian students construct meaning when reading multiple documents? Not only is this a crucial skill for digital reading, but also a condition for academic success regardless of medium. Traditionally, comprehension questions do not demand from the test taker to integrate information from two or more texts by comparing contrasting or complementary views on the same topic. In Brazil, standardized exams that aim at assessing the quality of basic education do account for multiple text reading, although they do not approach issues of source evaluation and the nature of the conflict in their evaluation criteria. For example, in the Evaluation System of Basic Education (Sistema de Avaliação da Educação Básica – SAEB) the reference matrix for assessment of language skills approaches bias in new reports. A previous version of the same matrix included a criterion about “relation between texts” (D15) that was stated as follows: “To recognize different ways to deal with information in comparing texts about the same topic in relation to the conditions in which it was produced and the ones in which it will be

received" (Matriz de Referência SAEB, 2001, p.6, my translation)[12]. This criterion was no longer present in the 2021 version, which was revised to be in accordance with the new curriculum for the basic education in Brasil (BNCC). Interestingly, as English started to be assessed by the test, two criteria were 1) contrasting different perspectives on the same topic and 2) evaluating the quality and validity of sources[13]. This shows a recent interest in the topic of multiple text comprehension especially among specialists from the field of additional languages (Matrizes de Referência SAEB 2022, p.14, my translation).

The task of integrating meaning from two or more texts becomes more challenging when reading online, since readers often encounter information that is either partial or does not have information authorship, sources nor date of publication. Teaching students how to select reliable content when reading online is part of helping them become citizens, and video models can be used to inform instruction – as we discuss next.

Since the early 80's, studies using the eye-tracking methodology have offered important insights into how readers process text and picture and the difficulties they face during this process. The Eye-mind assumption posited that what is being fixated by the eye is being processed in the mind (Just; Carpenter, 1980; Rayner *et al*, 2006), with longer gaze duration linked with higher cognitive load; later, the same measure has been found to indicate strategic processing depending on the type of reading task (Sheiter; Van Gog, 2009; Xie *et al,* 2021). More recently, eye trackers have been used to investigate specific components of onscreen reading such as evaluation of search engine (Hautala *et al,* 2018). Although these studies have a strong potential to inform pedagogical practices, they seem to be disconnected from the school context.

In this scenario, eye movement modeling examples (EMMEs) arise as a particularly promising resource in bridging the gap between research and the classroom. They have been used in diverse instructional contexts and areas to model procedures and techniques (Emhardt *et al,* 2023). In reading, EMMEs can enhance the evaluation competence by modeling attention to navigation and source features (Salmerón *et al,* 2020). EMMEs do not require any specific training, tool nor platform to be employed; that is, the recordings of gaze displays are video files (e.g., .mp4) that can be easily used by both teachers and students in self-paced learning platforms.

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[12] Reconhecer diferentes formas de tratar uma informação na comparação de textos que abordam o mesmo tema, em função das condições em que ele foi produzido e daquelas em que será recebido.

[13] 1) Contrapor perspectivas sobre um mesmo assunto em textos em língua inglesa.
2) Avaliar a qualidade e a validade das informações veiculadas em textos de língua inglesa, incluindo textos provenientes de ambientes virtuais

Yet, it remains to be thought how teachers should blend EMMEs into metacognitive instruction so as to grasp its full potential without overloading students with procedural information. The development of self-regulated learning also encompasses raising students' awareness about which strategies are the most efficient when learning from text, both in print and online, and balancing their use (Baron, 2022; Do Amaral; Tomitch, 2022). In addition, evaluation strategies used in print should be transferred and/or adapted to digital study situations. Even in more informal contexts of use, teachers should encourage students to keep a skeptical eye on everything they read online.

Last but not least, teachers need to be trained to guide their practice towards an evidence-based approach so that they can in turn teach scientific reasoning and inquiry (Gitlin *et al*, 1999). As the present study has shown, educational misconceptions are extremely pervasive and resistant to change – especially when one holds prior beliefs about the topic (Braten; Ferguson, 2015). Teachers tend to orient their actions based on peers experiences and prior learning situations; they seldom resort to scientific publications or specialists to answer questions about their practice (Allen, 2007; Dekker *et al,* 2012; Macdonald *et al,* 2017; Kirschner; 2017; Menz *et al,* 2020). To this end, texts and lectures using refutation styles have proven effective in updating psychological misconceptions (Menz *et al*, 2021; Dersch *et al,* 2021).

5.4 LIMITATIONS OF THE STUDY AND SUGGESTIONS FOR FUTURE RESEARCH

Despite the rigorous method applied in the study design as well as the strict treatment of the data through statistical procedures of analysis, we acknowledge there are a number of limitations in the present study.

A first limitation regards the use of EMMEs without any type of verbal instruction. The study was purposedly designed in this manner to keep consistency in the application of EMMEs and avoid differences in terms of oral explanations. Yet, a video model by itself might not have accounted for the complexity of the learning measures used, i.e., argumentation, source memory, and misconception change – at least, not in the L2 context. This limitation opens new questions – and hence new possibilities – for research on how EMMEs can be used with oral instructions so as to maximize its potential. Using

verbalizations together with gaze plots was suggested to be overloading (Salmerón; Llorens, 2019); then which instructions should teacher give? And in which order?

A second limitation of our EMMEs is related to the use of both the gaze recordings of students who did well and the ones who did not perform well in a navigation task. This version had built upon a previous EMME which had not included the eye movements of less successful learners. It was unclear though whether adding this type of modeling has had any positive effect. Future studies could explore the effect of adding the two types of performance in separate conditions (e.g., expert only / expert + poor learner) in order to better capture the distinction between them.

A third limitation of the EMMEs used in this study concerns its content. The videos used approached controversial topics such as which water is best to drink (tap or bottled water) and climate change; on the positive side, not attending to content has enabled participants to focus on the procedures. Nonetheless, future studies could develop video models that either overtly tackle educational misconceptions or use texts related to this topic while modeling evaluation procedures. Content-specific instruction with focus on misconceptions in educational psychology has investigated the effectiveness of refutation texts and lectures with positive results for misconception update (Menz *et al*, 2021; Dersch *et al,* 2022); this seems to be another promising future direction.

The fourth limitation of this study is related to calibration; as stated in the literature review, this measure accounts for the (mis)match between self-perceived and actual performance (Alexander, 2013). Although it was out of the scope of the present study, the issue deserves further investigation. American students perceive reading in the digital medium as easier compared to when reading in print (although comprehension scores show the opposite); on the other hand, when asked about their preferred medium, they reported paper as facilitating concentration (Baron, 2022).

Another possible limitation of the study concerns the fact that all the texts were presented as similarly looking web pages that resulted from a Google research. This is justified since professionally-looking design affects the evaluation of web pages(Salmerón *et al,* 2018c). Although all the pages created were controlled for credibility, this similarity in design and lack of *materiality* might have interfered with participants' judgment of source credibility (Salmerón; Gil; Braten, 2018), giving the impression that they all belonged in the same context.

In addition, the experiment mocked a study situation since participants were to write an essay and answer tests from what they read. Nonetheless, one of the participants

in the pilot study said he knew how to properly evaluate the reliability of a source, but he consciously did not do so in participating in the study. He reported thinking it was unnecessary to pay as much attention to sources while browsing on Google page as it usually is when you read articles or book chapters as course assignments; this behavior had a negative impact on memory for the sources. After a whole academic life being told to beware of content published on the internet, readers may (too) easily disregard online sources without properly evaluating them. This testimony also unveils participant's difficulty in effectively engaging in a study situation created for experimental purposes. The ability to evaluate online sources for academic and personal purposes remains an important competence to be developed as well as the upgrades in study design that enable its proper investigation.

It should be acknowledged that time constraints made it impossible for this researcher to analyze parts of the data collected or to make a few desired finer-grained analysis. First, the notes taken by participants in both control and experimental conditions have not been analyzed yet. They seem to hold particularly relevant data about how the EMMEs were interpreted by participants. Second, in RQ4a source memory was not analyzed in relation to webpage trustworthiness, which leads to the question: were the sources recalled reliable? Does the fact that the control group recalled more source characteristics results from memory of untrustworthy sources? Although these questions remained unanswered by the time this dissertation was finished, they are going to be approached in new articles to come.

Last, we highlight the importance of conducting replication studies in order to further test the findings here reported among other populations such as Brazilian students, for instance. Data collection for this study happened in 2021 during the second year of the COVID-19 pandemic. Its execution was only possible in Spain due to the higher vaccination rates in this country, which enabled a reasonably safe return to face-to-face academic activities, following all the sanitary protocols. The delay of the vaccination program in Brazil caused by the tragic management of the pandemic by Bolsonaro's far-right government resulted in more than seven hundred thousand deaths. Most schools and universities remained closed until February 2022. The educational deficits were poorly measured and are still unknown.

Thus, it remains to be seen whether the aforementioned improvements in the EMMEs can actually lead to results in attention to source features, evaluation of content reliability, and a more direct effect on misconception change. In spite of all the limitations

just listed, it is believed that the present study offered an insight into how navigation and evaluation processes in digital reading can be fostered through the use of eye models – including L2 study situations.

This study was a small step towards offering students and teachers an instructional tool to help them develop the digital competences needed to achieve full citizenship, being able to carefully select and evaluate the information sources they find online when reading in L2, integrating opposing perspectives coherently, and ultimately understanding that knowledge is constructed in an intricate way and is heavily influenced by their personal epistemologies and prior beliefs. In this sense, evidence-based educational practices should thus be encouraged among pre- and in-service teachers to foster their scientific reasoning and counteract widespread misconceptions such as the learning styles theory. I wholeheartedly hope this study serves as subsidy to inform not only future research but also classroom practices and political decisions in education in the digital age.

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APPENDICES

APPENDIX A – Ethics Committee approval

El comité Ético de Investigación en Humanos de la Comisión de Ética en Investigación Experimental de la Universitatde València,

CERTIFICA:
Que el Comité d'Ètica d'Investigació en Humans , en la reunión celebrada el día 02 de Diciembre de 2021 , una vezestudiado el proyecto de tesis doctoral : *"La lectura atenta en pantalla "*, con número de registro1822514 .
Cuyo/a responsable es D/Dña.
LADISLAO SALMERON GONZALEZ , dirigida por
D/Dña. LADISLAOSALMERON GONZALEZ
ha acordado informar favorablemente el mismo.

Y para que conste, se firma el presente certificado

Av. Blasco Ibáñez, 13 tel: 963864109
vicerec.investigacio@uv.es València 46010
fax: 963983221 www.uv.es/serinves

Firmado digitalmente por
PEDRO JESUS PEREZ ZAFRILLA
Cargo: Presidente del Comité de Ética de la Investigación en HumanosFecha: 09/12/2021 22:57:06 CET

APPENDIX B – Informed consent

DOCUMENTO DE CONSENTIMIENTO INFORMADO Y COMPROMISO DE CONFIDENCIALIDAD

1.- INFORMACIÓN AL SUJETO DE EXPERIMENTACIÓN.

El proyecto de investigación para el cual le pedimos su participación se titula:
"The attentive online reading: does metacognitive instruction affect navigation and learning from L2 hypertext?"
Para que usted pueda participar en este estudio es necesario contar con su consentimiento, y que conozca la información básica necesaria para que dicho consentimiento pueda considerarse verdaderamente informado. Por ello, le ruego que lea detenidamente la siguiente información. Si tuviera alguna duda exprésela, antes de firmar este documento, al investigador principal del proyecto, bien personalmente, bien a través del teléfono o por correo electrónico. Los datos del investigador principal del proyecto aparecen también en el presente documento.

La información básica que debe conocer es la siguiente:

a) *Objetivo del estudio*:
El objectivo deste estudio es investigar el efecto de instrucción con videos de modelos de movimiento ocular en la navegación y aprendizaje de textos en inglés entre estudiantes universitarios que hablen inglés como L2.

b) *Metodología a utilizar para el estudio, tipo de colaboración que se espera de usted y duración de dicha colaboración*
En primer lugar, usted va a hacer un teste de competencia en L2 para verificar su nivel lingüístico; después, será invitada/o a participar de un taller sobre navegación y movimientos oculares. En seguida, va a hacer una tarea de navegación y una tarea de aprendizaje. El tiempo total que tendrá que disponer estimase en 1h15.

c) *Procedimientos preventivos, diagnósticos y/o terapéuticos disponibles alternativos a los que se investigan con este estudio*: (Se rellenará este apartado si procede por el tipo de estudio a realizar)

d) *Posibles molestias y riesgos de su participación en el estudio*: (Indíquense especialmente los riesgos para la salud, destacando los graves, aunque sean poco frecuentes; los menos graves, cuando sean frecuentes; y los riesgos personalizados)
Su participación no implicará en riesgos de alto nivel, pero usted podrá sentirse ansioso o nervioso como en cualquier situación de teste.

e) *Medidas para responder a los acontecimientos adversos*: (En el caso de que se produzca algún acontecimiento adverso en los sujetos que participen en la investigación, expliquen cómo se responderá)

Los investigadores responsables le acompañarán durante toda su participación. Para ayudarle, usted recibirá instrucciones orales y escritas en todas las fases del experimento.

f) *Medidas para asegurar una compensación adecuada en el caso de que usted sufra algún daño*

Por más que los riesgos sean mínimos, lo garantimos una compensación adecuada por danos ocasionales resultantes de su participación en este estudio. Los investigadores se comprometen a resarcir despesas necesarias para participar como transporte y alimentación, caso necesite.

g) *Beneficios que se espera obtener con la investigación*:

Al final de la investigación, usted será informada o informado sobre los resultados del estudio y su desempeño personal. Los resultados obtenidos podrán traer un incremento en la percepción de su comportamiento lector y las estrategias utilizadas en situaciones de navegación y aprendizaje partir de textos digitales en L2.

h) *Consecuencias de la no participación*: (Debe indicarse que si prefiere no participar eso no afectará a su derecho a la asistencia sanitaria, y que la relación con las personas que le propusieron participar será igual de cordial y dedicada con los que rechacen participar que con los que sí participen).

Usted tiene libertad para negarse a participar. Esta decisión no va a traer consecuencias negativas ni afectará a su derecho a la asistencia sanitaria. Su relación con las personas que le propusieron participar será igual de cordial y dedicada con los que rechacen participar que con los que sí participen.

i) *Posibilidad de retirada en cualquier momento y consecuencias*:

Usted puede retirarse del proyecto en cualquier momento firmando la revocación del consentimiento que se incluye al final del documento. Su retirada no tendrá ninguna consecuencia negativa para usted, y será aceptada sin problemas por el equipo investigador.

j) *¿Quién ha financiado el estudio?*

Este estudio es financiado por la Coordinación de perfeccionamiento personal de nivel superior en Brasil (CAPES) – Código 001.

k) *¿Qué institución lo realiza?*

Se realiza en la Universitat de València.

l) *Gratuidad por la participación*: (Indique que los sujetos de experimentación no obtendrán ninguna compensación económica por la participación en este estudio, o solo compensación por molestias).

Su participación será voluntaria y gratuita, es decir, no habrá compensación económica por su participación en este estudio. No obstante usted recibirá créditos de curso por su participación.

m) *Previsión de uso posterior de los resultados*: (Indique si los resultados se utilizarán con fines de docencia, investigación y/o publicación científica).

Los resultados de lo estudio serán publicados en periódico científico y seminarios de investigación.

n) *Equipo investigador*: (Indique los nombres completos de los miembros del equipo investigador).

Juliana do Amaral (UFSC/PPGI/CAPES-Brasil)

Ladislao Salmerón Gonzalez (Universitat de Valencia/ERI-Lectura-Spain)

o) *Datos de contacto del investigador principal para aclaraciones o consultas*: (Indique nombre y datos completos de localización del Investigador principal en su lugar de trabajo, incluyendo teléfono).

Ladislao Salmerón Gonzalez
Departamento de Psicología de Educación
Avenida Blasco Ibañez 21 46010 Dispatcho F119
Valencia, España
Juliana do Amaral
Departamento de Psicología de Educación
Avenida Blasco Ibañez 21 46010 Dispatcho M212
Valencia, España

p) El proyecto se realizará siguiendo los criterios éticos internacionales recogidos en la Declaración de Helsinki.

Garantimos que este proyecto se realizará siguiendo los criterios éticos internacionales recogidos en la Declaración de Helsinki.

2.- COMPROMISO DE CONFIDENCIALIDAD.

a) *Medidas para asegurar el respeto a la vida privada y a la confidencialidad de los datos personales*

Se han adoptado las medidas oportunas para garantizar la completa confidencialidad de los datos personales de los sujetos de experimentación que participen en este estudio, de acuerdo con la Ley De Protección de Datos de Carácter Personal (LOPD) 3/2018, de 5 de diciembre. Es decir, sus informaciones se mantendrán en sigilo al largo de todo el proceso de coleta de datos, análisis y publicación.

b) *Medidas para acceder a la información relevante para usted que surjan de la investigación o de los resultados totales*

Sepa que tiene derecho a acceder a cualquier momento a la información generada sobre usted en el estudio. Usted podrá solicitar estes dados en presencial por agendamiento de cita o virtualmente por email.

c) *Medidas tomadas por tratarse de un estudio anonimizado*:

Se ha establecido un sistema de anonimización efectivo que no permite la identificación posterior del sujeto. En ningún caso se juntarán los consentimientos otorgados, donde sí se identifica al sujeto, con los cuestionarios utilizados en el estudio. En el uso que se realice de los resultados del estudio, con fines de docencia, investigación y/o publicación, se respetará siempre la debida anonimización de los

datos de carácter personal, de modo que los sujetos de la investigación no resultarán identificados o identificables.

3. CONSENTIMIENTO

Don/Doña _____,
mayor de edad, titular del DNI : _____, por el presente documento manifiesto que he sido informado/a de las características del Proyecto de Investigación titulado: **"The attentive online reading: does metacognitive instruction affect navigation and learning from L2 hypertext?"**
He leído tanto el apartado 1 del presente documento titulado "Información al sujeto de experimentación", como el apartado 2 titulado "Compromiso de confidencialidad", y he podido formular las dudas que me han surgido al respecto. Considero que he entendido dicha información.
Estoy informado/a de la posibilidad de retirarme en cualquier momento del estudio.

En virtud de tales condiciones, consiento participar en este estudio. En prueba de conformidad, firmo el presente documento en el lugar y fecha que se indican a continuación.

Valencia, _____ de _____ de 20___.

Nombre y apellidos del / de la participante:	*Nombre y apellidos del padre, madre o tutor (en el caso de menores o incapaces)*:	*Nombre y apellidos del investigador principal*:
Firma:	Firma:	Firma:

Si el sujeto del estudio es un adolescente capaz intelectual y emocionalmente de entre 12 y 16 años debe de ser oída su opinión y autorizar su participación en el estudio firmando también este consentimiento. Cuando se trate de menores no incapaces ni incapacitados, pero emancipados o con 16 años cumplidos, no cabe prestar el consentimiento por representación y será el propio sujeto del estudio quien firmará el consentimiento (Ley 41/2002).

REVOCACIÓN DEL CONSENTIMIENTO
Revoco el consentimiento prestado en fecha _____ para participar en el proyecto titulado "_____" y, para que así conste, firmo la presente revocación.

En Valencia, a _____ de _____ de 20___.

Nombre y apellidos del / de la participante:	*Nombre y apellidos del padre, madre o tutor (en el caso de menores o incapaces)*:	*Nombre y apellidos del investigador principal*:
Firma:	Firma:	Firma:

APPENDIX C – Demographics survey

Study EMMEs L2

Survey

*

Please enter a date:

1/3 Identificación

nformaciones del participante

Participante número: *

Please write your answer here:

*

Please choose **only one** of the following:

- ◯ Female
- ◯ Male

Edad: *

Please write your answer here:

Curso de grado: *

Please write your answer here:

¿Cuánto tiempo usted ha estudiado Inglés? *

Choose one of the following answers
Please choose **only one** of the following:

- ◯ 1-3 años
- ◯ 3-5 años
- ◯ 5-7 años
- ◯ más de 7 años

¿Ya hizo un exámen de nivel de Inglés? En caso positivo, escriba su puntuacón bajo: *

Please write your answer here:

APPENDIX D – Second Language Online Reading Strategy Inventory (SLORSI)

Second Language Online Reading Strategy Inventory (SLORSI)

The purpose of this questionnaire is to understand how adults or tertiary-level second language learners utilize online reading strategies while reading academic or study-related materials in English in an online digital environment. The term online texts in the following questionnaire items include not only word texts but also multimedia materials such as video, audio and animations. Each strategy item is followed by five numbers (1, 2, 3, 4, 5) and we would like you to tick the number that best indicates your opinion.

1 means "I strongly disagree with this statement."

2 means "I disagree with this statement."

3 means "I neither agree nor disagree with this statement."

4 means "I agree with this statement."

5 means "I strongly agree with this statement."

There are no right or wrong answers to the items. The data collected will be highly confidential and will be used for research purpose only. Your decision to participate in this survey and your survey results will NOT have any influence on the evaluation and grading of the course you are enrolled in.

Thank you very much for your cooperation.

Strategy items	Scale				
1. I check if my guesses about the online text are right or wrong.	1	2	3	4	5
2. While reading on line, I read the first sentence of each paragraph for a quick overview.	1	2	3	4	5
3. I collaborate with others on line to gain a deeper understanding of a text.	1	2	3	4	5
4. I contrast information from various pages to sort out those that mostly serve my reading purposes.	1	2	3	4	5
5. I save the link when I feel an online text is important.	1	2	3	4	5
6. When I read on line, I try to guess what the content is going to be next.	1	2	3	4	5

7. I translate difficult sentences into my native language to deal with comprehension failures.	1	2	3	4	5
8. When reading on line, I look for sites that cover both sides of an issue.	1	2	3	4	5
9. I click on a hyperlink when it is important for my understanding of the current online text.	1	2	3	4	5
10. I use my background knowledge about the topic to locate target information.	1	2	3	4	5
11. When I read on line, I guess the meaning of unknown words or phrases.	1	2	3	4	5
12. I look for multiple online texts on the same topic.	1	2	3	4	5
13. I check to see whether new information fits my reading purpose.	1	2	3	4	5
14. I look for the native language equivalents of terms in an online specialized dictionary.	1	2	3	4	5
15. When I feel an online text is important, I save it together with my notes.	1	2	3	4	5
16. I use my knowledge of informational website structures to locate target information.	1	2	3	4	5
17. I communicate with other readers by leaving comments in message areas.	1	2	3	4	5
18. I take an overall view of an online text to see what it is about at the beginning stage.	1	2	3	4	5
19. I consciously control my reading path by clicking on suitable links.	1	2	3	4	5
20. I discuss my comprehension problems in online social media (e.g., Facebook, WhatsApp, Wechat, etc.).	1	2	3	4	5
21. Before I start reading a new website, I glance over the website's main menu.	1	2	3	4	5
22. When I feel an online text is important, I save it with highlighted information in it.	1	2	3	4	5
23. I remind myself of my reading purposes before clicking on a link.	1	2	3	4	5
24. I scroll up and down in an online text to find relationships among ideas in it.	1	2	3	4	5
25. I use prior knowledge of printed informational text structures to locate target information.	1	2	3	4	5
26. I look for the native language equivalents of key words on line by using search engines.	1	2	3	4	5

27. I save pages bearing similar information in an internet bookmark folder for future reviewing.	1	2	3	4	5
28. I check whether information on a new webpage fits my understanding of the text.	1	2	3	4	5
29. I critically analyze and evaluate the information presented in an online text.	1	2	3	4	5

(Source: Li, 2020. Items 1, 6, 8, 11, 18, 24, 28, 29 were adapted from Anderson (2003); items 2, 21, 27 were adapted from Chen (2009); items 10, 16, 25 were adapted from the findings of Coiro and Dobler (2007).

APPENDIX E – Misconceptions about Learning Styles Questionnaire

3/3 Learning Styles questionnaire

Adapted from Eitel et al, 2021 (four first items of the Misconceptions about Multimedia Learning Questionnaire - MMLQ)

LS1: Performance is decreased when visual learners study with text or when verbal learners study with animations ordiagrams. *

Choose one of the following answers
Please choose **only one** of the following:

- ◯ I agree
- ◯ I do not agree

How certain are you? *

Choose one of the following answers
Please choose **only one** of the following:

- ◯ Very certain
- ◯ Certain
- ◯ Somewhat certain
- ◯ Uncertain
- ◯ Very uncertain

LS2: Performance is better when students work with materials that are constructed to match their learning style. *

Choose one of the following answers
Please choose **only one** of the following:

- ◯ I agree
- ◯ I do not agree

How certain are you? *

Choose one of the following answers
Please choose **only one** of the following:

- ◯ Very certain
- ◯ Certain
- ◯ Somewhat certain
- ◯ Uncertain
- ◯ Very uncertain

LS3: A necessary condition for good teaching is to know the students' learning style (visual, verbal, kinesiological). *

Choose one of the following answers
Please choose **only one** of the following:

- ◯ I agree
- ◯ I do not agree

How certain are you? *

Choose one of the following answers
Please choose **only one** of the following:

- ◯ Very certain
- ◯ Certain
- ◯ Somewhat certain
- ◯ Uncertain
- ◯ Very uncertain

LS4: Whether students learn better with visual or verbal materials depends on their learning style. *

Choose one of the following answers
Please choose **only one** of the following:

- ◯ I agree
- ◯ I do not agree

How certain are you? *

Choose one of the following answers
Please choose **only one** of the following:

- ◯ Very certain
- ◯ Certain
- ◯ Somewhat certain
- ◯ Uncertain
- ◯ Very uncertain

APPENDIX F – Experimental condition – EMMEs worksheet

While you watch the eye movements, take notes:

PART 1 – STUDENTS WHO PERFORM WELL

STUDENT 1

What does this student do?

_____

_____

_____

_____

On a 5-point scale, how do you rate this students' reading and analysis of the material? Justify your answer.

Very poor	Poor	Average	Good	Very good
1	2	3	4	5

_____

_____

_____

_____

STUDENT 2

What does this student do?

_____

_____

_____

_____

On a 5-point scale, how do you rate this students' reading and analysis of the material? Justify your answer.

Very poor	Poor	Average	Good	Very good
1	2	3	4	5

_____

_____

_____

STUDENT 3

What does this student do?

_____

_____

_____

_____

On a 5-point scale, how do you rate this students' reading and analysis of the material? Justify your answer.

Very poor	Poor	Average	Good	Very good
1	2	3	4	5

_____

_____

_____

_____

STUDENT 4

What does this student do?

_____

_____

_____

_____

On a 5-point scale, how do you rate this students' reading and analysis of the material? Justify your answer.

Very poor	Poor	Average	Good	Very good
1	2	3	4	5

_____

_____

_____

STUDENT 5

What does this student do?

_____

_____

_____

_____

On a 5-point scale, how do you rate this students' reading and analysis of the material? Justify your answer.

Very poor	Poor	Average	Good	Very good
1	2	3	4	5

_____

_____

_____

_____

PART 2 – STUDENTS WHO DO NOT PERFORM SO WELL

STUDENT 1

What does this student do?

_____

_____

_____

_____

On a 5-point scale, how do you rate this students' reading and analysis of the material? Justify your answer.

Very poor	Poor	Average	Good	Very good
1	2	3	4	5

_____

_____

_____

STUDENT 2

What does this student do?

_____

_____

_____

_____

On a 5-point scale, how do you rate this students' reading and analysis of the material? Justify your answer.

Very poor	Poor	Average	Good	Very good
1	2	3	4	5

_____

_____

_____

_____

STUDENT 3

What does this student do?

_____

_____

_____

_____

On a 5-point scale, how do you rate this students' reading and analysis of the material? Justify your answer.

Very poor	Poor	Average	Good	Very good
1	2	3	4	5

_____

_____

_____

_____

APPENDIX G – Control condition – Video task worksheet

Participant nº:

Online reading strategies

https://www.youtube.com/watch?v=Gvdxke1s0-I

You are going to watch a video about *Online reading strategies*. While you watch the video, answer the questions below. You can pause the video at any time you want within the time set.

1) What are the differences between evaluating the reliability of a source in print and online?

_____

_____

_____

_____

2) How do the multimodal features of online texts affect reading? Is this influence positive or negative?

_____

_____

_____

_____

3) Why is online reading described as non-linear? What are the consequences of this non-linearity?

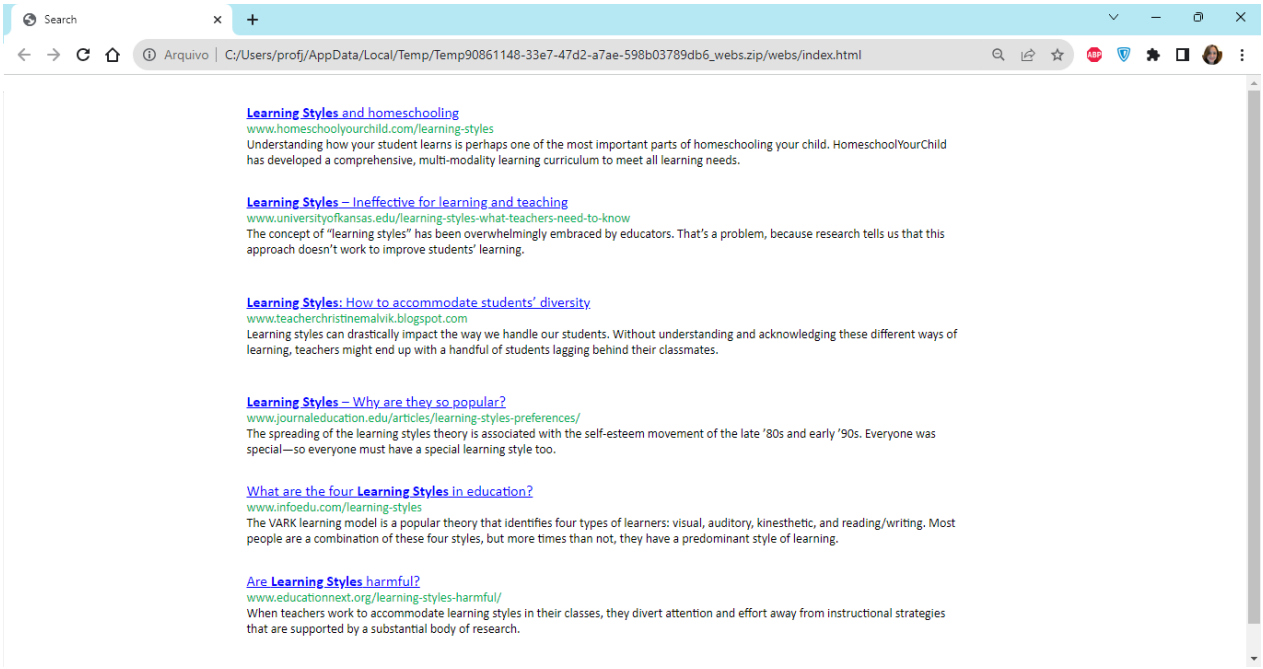
_____

_____

_____

_____

APPENDIX H – Search engine results page and texts used as stimuli in the eye tracking experiment



Homeschool your child

Learning Styles and homeschooling

Charles Williams, Sales Manager

The idea of different learning styles started to gain popularity in the mid-70's and since then, the notion has influenced the way education and learning is perceived. Just like there are different teaching methods, many individuals also believe there are different ways to learn and understand new information. Many parents of struggling students who are looking into homeschooling as an educational alternative for the first time, usually start out by learning more about the types of learning styles and how children learn best.

Understanding how your student learns is perhaps one of the most important parts of homeschooling your child. Learning styles allow your child to get the most from their homeschool experience, and helps parents choose the best curriculum for their children.

How HomeschoolYourChild works for different types of learners

Catering to individual learning needs can have a dramatic effect on how your child understands the different topics being taught. HomeschoolYourChild has developed a comprehensive, multi-modality learning curriculum that allows all students to reach successful levels of understanding no matter what their learning style is. Our lessons are scientifically designed to meet a vast array of learning needs, which reduces learning anxiety and improves performance.

Different types of learners will benefit from our award-winning online curriculum because:

- Our visually appealing, animated and interactive lessons keep students engaged.
- Lessons can be redone for those who benefit from repetition to fully grasp concepts.
- Our curriculum offers a wide selection of written and spoken materials for those who learn best by listening, speaking, reading and writing.
- There are tons of printables to work with for those who love learning with their hands.
- Our online curriculum provides the perfect environment for those who learn best independently.
- There are plenty of lessons with verbal instruction to help those who learn best by listening.
- Our interactive activities help auditory and verbal learners understand concepts and ideas.
- Our wide selection of printable worksheets and ideas for science projects helps physical learners get hands-on.
- Our comprehensive math and language arts curriculum allows verbal and logical learners to excel with access to multiple levels.
- The student-paced approach and individual log-ins allow solitary learners to work when and where is most convenient for them.

HomeschoolYourChild tracks student progress and helps children advance through individualized learning paths. This ensures complete coverage of the needed skills and concepts to ensure success. Get started today! HOMESCHOOL YOUR CHILD offers the perfect course to attend all your child's needs and learning styles. Risk-free and 14-day money-back guarantee.

University of Kansas - School of Education

Learning Styles – Ineffective for learning and teaching

Michelle Johnson, Professor at the Department of Education

The concept of "learning styles" has been overwhelmingly embraced by educators in the U.S. and worldwide. Studies show that an estimated 89% of teachers believe in matching instruction to a student's preferred learning style (Newton & Salvi, 2020). That's a problem—because research tells us that this approach doesn't work to improve learning.

What do they mean by "Learning Styles"?

It's true that people have fairly stable strengths and weaknesses in their cognitive abilities, such as processing language or visual-spatial stimuli. People can also have preferences in the way they receive information—Joan may prefer to read an article while Jay may rather listen to a lecture. The "learning styles" theory makes a big leap, suggesting that students will learn better if they are taught in a manner that conforms to their preferences. More than 70 different systems have been developed that use student questionnaires/self-reports to categorize their supposed learning preferences.

If only it were that simple. While this brief survey may provide some insights for teachers, we must be wary of overestimating the value of the results. By placing students in categories that reflect "preferred learning styles," we run the risk of oversimplifying the complex nature of teaching and learning to the detriment of our students. Study after study has shown that matching instructional mode to a student's supposedly identified "learning style" does not produce better learning outcomes. In fact, a student's "learning style" may not even predict the way they prefer to be taught or the way they actually choose to study on their own (Newton & Salvi, 2020).

Simply put, students' learning preferences as identified via questionnaires do not predict the singular, best way to teach them. A single student may learn best with one approach in one subject and a different one in another. The best approach for them may even vary day-to-day. Most likely, students are best served when a variety of strategies are employed in a lesson. As appealing as a framework like VARK is—relatively easy to conceptualize and quick to assess — everyone engages in different modes of learning in various ways. The brain processes information in very complex and nuanced ways that can't be so simply generalized.

References

Newton, P. M. & Salvi, A. (2020). How common is belief in the learning styles neuromyth, and does it matter? A pragmatic systematic review. Frontiers in Education, 5(602451), 1-14. doi.org/10.3389/feduc.2020.602451

Teacher Christine's Blog

Learning Styles: How to accommodate students' diversity

Christine Malvik, primary school teacher at Collegis School

We all experience the world in unique ways, and with that comes variation in the ways we learn best. Understanding these different types of learning styles can drastically impact the way we handle our students, set up group projects and adapt individual learning. Without understanding and acknowledging these different ways of learning, teachers might end up with a handful of students lagging behind their classmates—in part because their unique learning style hasn't been activated.

Part of our responsibility as an educator is to adjust your lessons to the unique group of students you are working with at any given time. The best teachers can cater to each student's strengths, ensuring they are truly grasping the information.

So how do you meet the needs of different types of learners in your class? Join me as I outline the four types of learning styles and how we can practically apply this information in our classrooms.

How to cater to visual learners: The whiteboard or smartboard is your best friend when teaching these types of learners. Give students opportunities to draw pictures and diagrams on the board, or ask students to doodle examples based on the topic they're learning. Teachers catering to visual learners should regularly make handouts and use presentations. Visual learners may also need more time to process material, as they observe the visual cues before them.

How to cater to auditory learners: Since these students generally find it hard to stay quiet for long periods of time, get your auditory learners involved in the lecture by asking them to repeat new concepts back to you. Ask questions and let them answer. Invoke group discussions. Watching videos and using music or audiotapes are also helpful ways of learning for this group.

How to cater to kinesthetic learners: The best way teachers can help these students is by getting them moving. Instruct students to act out a certain scene from a book or a lesson. Encourage them by incorporating movement into lessons: pacing to help memorize, learning games or having students write on the whiteboard as part of an activity.

How to cater to reading/writing learners: This is probably the easiest type to cater to since much of the traditional educational system tends to center on writing essays, doing research and reading books. Allow plenty of time for these students to read and write.

Journal of Education

Learning Styles – Why are they so popular?

Mary-Ann Adane, PhD candidate in Education (Vandervilt University)

Researchers are not sure how the concept of learning styles has spread, but it is probably associated with the self-esteem movement of the late '80s and early '90s. Everyone was special—so everyone must have a special learning style too. Teachers told students about it in grade school. "Teachers like to think that they can reach every student, even struggling students, just by tailoring their instruction to match each student's preferred learning format," says Abby Knoll, a Ph.D. student at Central Michigan University who has studied learning styles. Students, meanwhile, like to blame their scholastic failures on their teacher's failure to align their teaching style with the student's learning style. Pashler and his colleagues (2008) point to two reasons to explain why learning styles have gained—and kept—such traction, aside from the enormous industry that supports the concept: the need for social labels and the erroneous understanding of metacognition.

Social labels. People like to identify themselves and others by "type." Such categories help order the social environment and offer quick ways of understanding each other. Also, this approach appeals to the idea that learners should be recognized as unique individuals—or, more precisely, that differences among students should be acknowledged—rather than treated as a number in a crowd or a faceless class of students. Carried further, teaching to different learning styles suggests that "all people have the potential to learn effectively and easily if only instruction is tailored to their individual learning styles" (Pashler et al, 2008, p. 107).

Metacognition misinterpreted. There may be another reason why this approach to learning styles is so widely accepted. They very loosely resemble the concept of metacognition, or the process of thinking about one's thinking. For instance, having your students describe which study strategies and conditions for their last exam worked for them and which didn't is likely to improve their studying on the next exam. Integrating such metacognitive activities into the classroom—unlike learning styles—is supported by a wealth of research (for a review see Askell Williams, Lawson, & Murray-Harvey, 2007). Importantly, metacognition is focused on planning, monitoring, and evaluating any kind of thinking about thinking and does nothing to connect one's identity or abilities to any singular approach to knowledge.

References

Askell-Williams, H., Lawson, M. & Murray, Harvey, R. (2007). 'What happens in my university classes that helps me to learn?': Teacher education students' instructional metacognitive knowledge. *International Journal of the Scholarship of Teaching and Learning, 1,* 1-21.

Pashler, Harold, McDaniel, M., Rohrer, D., & Bjork, R. (2008). Learning styles: Concepts and evidence. *Psychological Science in the Public Interest, 9,* 103-119.

infoEdu : education and learning

What are the four Learning Styles in education?

Alex Garcia, Staff writer at infoEdu

One of the popular theories in Educational psychology to this day is the VARK model. This model identifies four types of learners: visual, auditory, kinesthetic, and reading/writing. Most people are a combination of these four styles, but more times than not, they have a predominant style of learning. Each of these styles has a complementary way of teaching.

Visual learning style. Visual learners are individuals who prefer to take in their information visually—be that with maps, graphs, diagrams, charts, and others. However, they don't necessarily respond well to photos or videos, rather needing their information using different visual aids such as patterns and shapes. The best way to present to visual learners is by showing them the relationship between different ideas visually. For instance, when explaining a scientific process, it can be done by using a flow chart.

Auditory learning style. Auditory learners are individuals who learn better when they take in information in auditory form when it is heard or spoken. They are prone to sorting their ideas after speaking, rather than thinking ideas through before. Since, to them, saying things out loud helps them understand the concept. Auditory learners learn best when information is presented to them via strategies that involve talking, such as lectures and group discussions. They can benefit from repeating back the lessons, having recordings of the lectures, group activities which require classmates explaining ideas, etc.

Kinesthetic learning style. Kinesthetic learners are individuals who prefer to learn by doing. They enjoy a hands-on experience. They are usually more in touch with reality and more connected to it, which is why they require using tactile experience to understand something better. The best way to present new information to a kinesthetic learner is through personal experience, practice, examples, or simulations. For instance, they can remember an experiment by recreating it themselves.

Reading/Writing. Reading/writing learners consume information best when it's in words, whether that's by writing it down or reading it. To them, text is more powerful than any kind of visual or auditory representation of an idea. These individuals usually perform very well on written assignments. There are different ways to get a reading/writing learner to engage and understand a certain lesson. For instance, it would be best to have them describe charts and diagrams by written statements, take written quizzes, or written assignments.

Education Next Magazine

Are Learning Styles harmful?

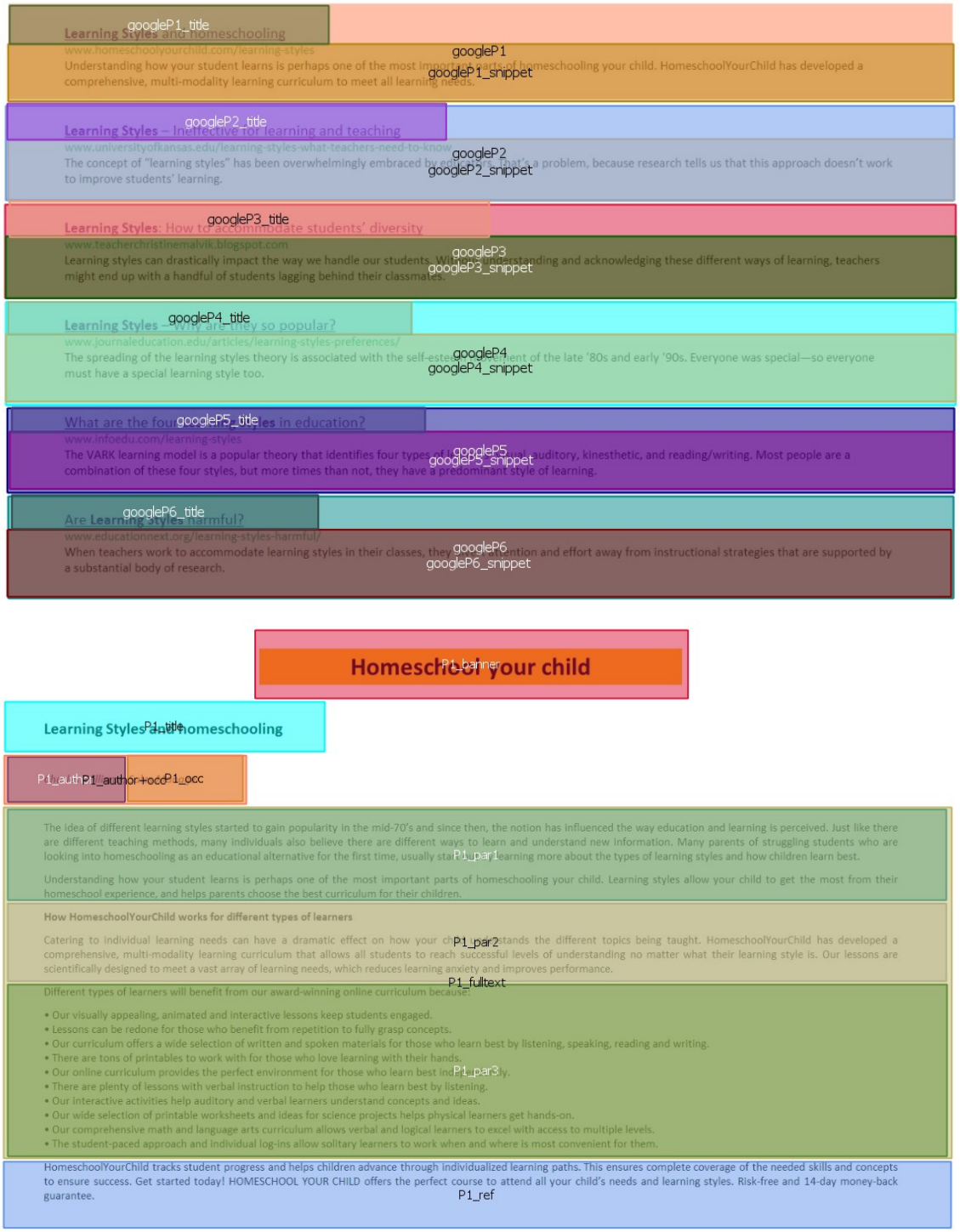
William Furey, Science Journalist

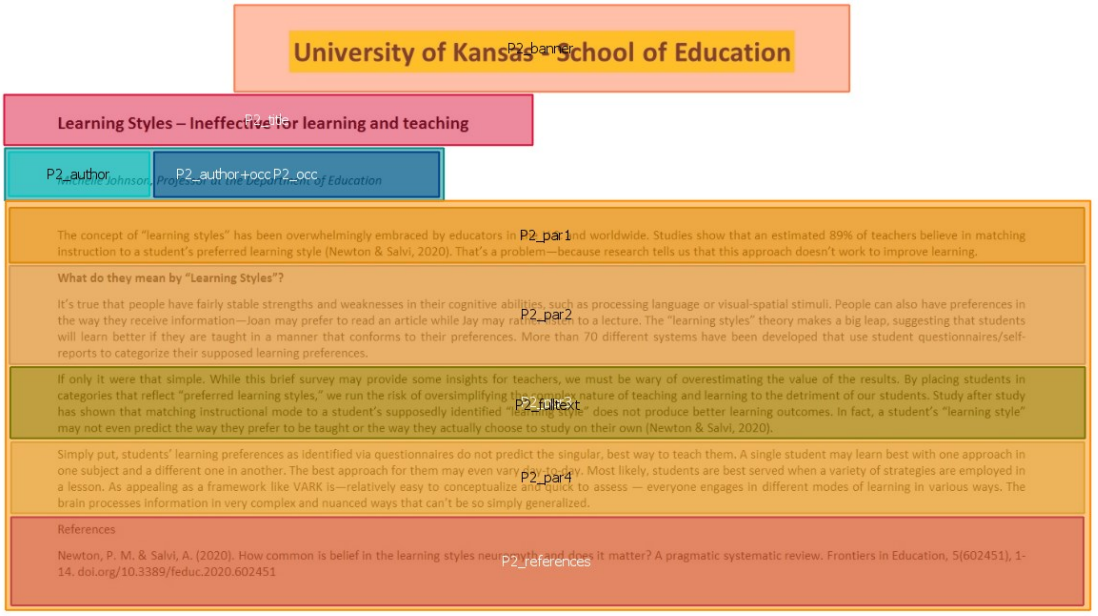
It is reasonable to ask how learning styles theory could harm students. Would-be teachers need to recognize and respect individual differences and understand the importance of differentiated instruction, right? Doesn't incorporating learning-styles theory into instruction align with these core principles?

It seems harmless enough, but when teachers work to accommodate learning styles, they divert attention and effort away from instructional strategies that are supported by a substantial body of research. There are principles of instruction and strategies for effective learning that are supported by converging empirical evidence from multiple fields—practical knowledge teachers ought to have upon entering their first classroom. When training programs spend time discussing learning styles, that's time not spent discussing proven practices to enhance student learning. For example, the National Council on Teacher Quality's textbook study found 59 percent of textbooks did not even mention the six highest-impact teaching methods identified by the Institute for Education Statistics more than a decade ago, and just 15 percent spent a full page on those practices. Even then, it was only two books, and they discussed just two of the six strategies. Meanwhile, more than half of textbooks included details about learning styles. Rather than learning to assess, group, and plan instruction for visual, auditory, and kinesthetic learners, teachers can learn to assess and differentiate instruction based on individuals' level of mastery with prerequisite skills and knowledge—important factors that do influence student learning.

In addition to the misallocation of teachers' time and effort, there are other potentially detrimental effects of learning-styles-based instruction, detailed memorably by Daniel Willingham. Students may act on their label. If a student believes she or he has a particular dominant learning style, the student may avoid effective learning strategies or even entire subjects they believe are a better fit for a learning style they don't think suits them. Moreover, since individuals are able to control the type of mental processing they use, students who are taught they have a dominant learning style may attempt to process information in their preferred style, even when the method does not fit the task. And teachers who attempt to accommodate multiple learning styles in a lesson, rather than focusing on the most effective methods to present the specific material, can negatively influence student learning by causing cognitive overload.

APPENDIX I – Areas of interest (AOIs)




University of Kansas School of Education
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Learning Styles – Ineffective for learning and teaching
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P2_par1
What do they mean by "Learning Styles"?
It's true that people have fairly stable strengths and weaknesses in their cognitive abilities, such as processing language or visual-spatial stimuli. People can also have preferences in the way they receive information—Joan may prefer to read an article while Jay may rather listen to a lecture. The "learning styles" theory makes a big leap, suggesting that students will learn better if they are taught in a manner that conforms to their preferences. More than 70 different systems have been developed that use student questionnaires/self-reports to categorize their supposed learning preferences.
P2_par2
If only it were that simple. While this brief survey may provide some insights for teachers, we must be wary of overestimating the value of the results. By placing students in categories that reflect "preferred learning styles," we run the risk of oversimplifying the complex nature of teaching and learning to the detriment of our students. Study after study has shown that matching instructional mode to a student's supposedly identified "learning style" does not produce better learning outcomes. In fact, a student's "learning style" may not even predict the way they prefer to be taught or the way they actually choose to study on their own (Newton & Salvi, 2020).
P2_fulltext
Simply put, students' learning preferences as identified via questionnaires do not predict the singular, best way to teach them. A single student may learn best with one approach in one subject and a different one in another. The best approach for them may even vary day to day. Most likely, students are best served when a variety of strategies are employed in a lesson. As appealing as a framework like VARK is—relatively easy to conceptualize and quick to assess — everyone engages in different modes of learning in various ways. The brain processes information in very complex and nuanced ways that can't be so simply generalized.
P2_par4
References
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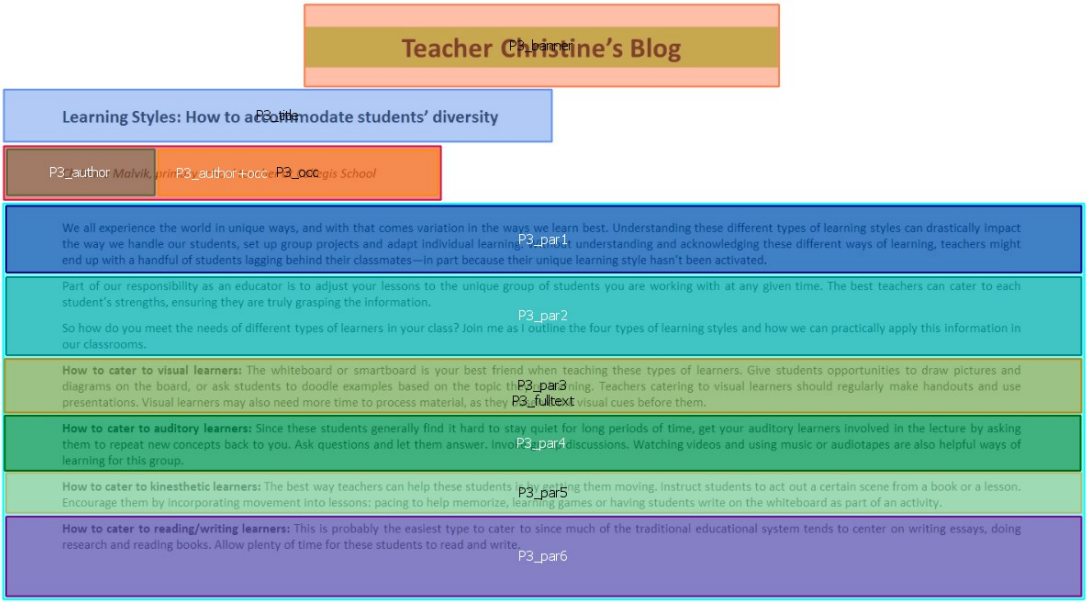
Teacher Christine's Blog
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Learning Styles: How to accommodate students' diversity
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So how do you meet the needs of different types of learners in your class? Join me as I outline the four types of learning styles and how we can practically apply this information in our classrooms.
P3_par2
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P3_par3
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P3_par5
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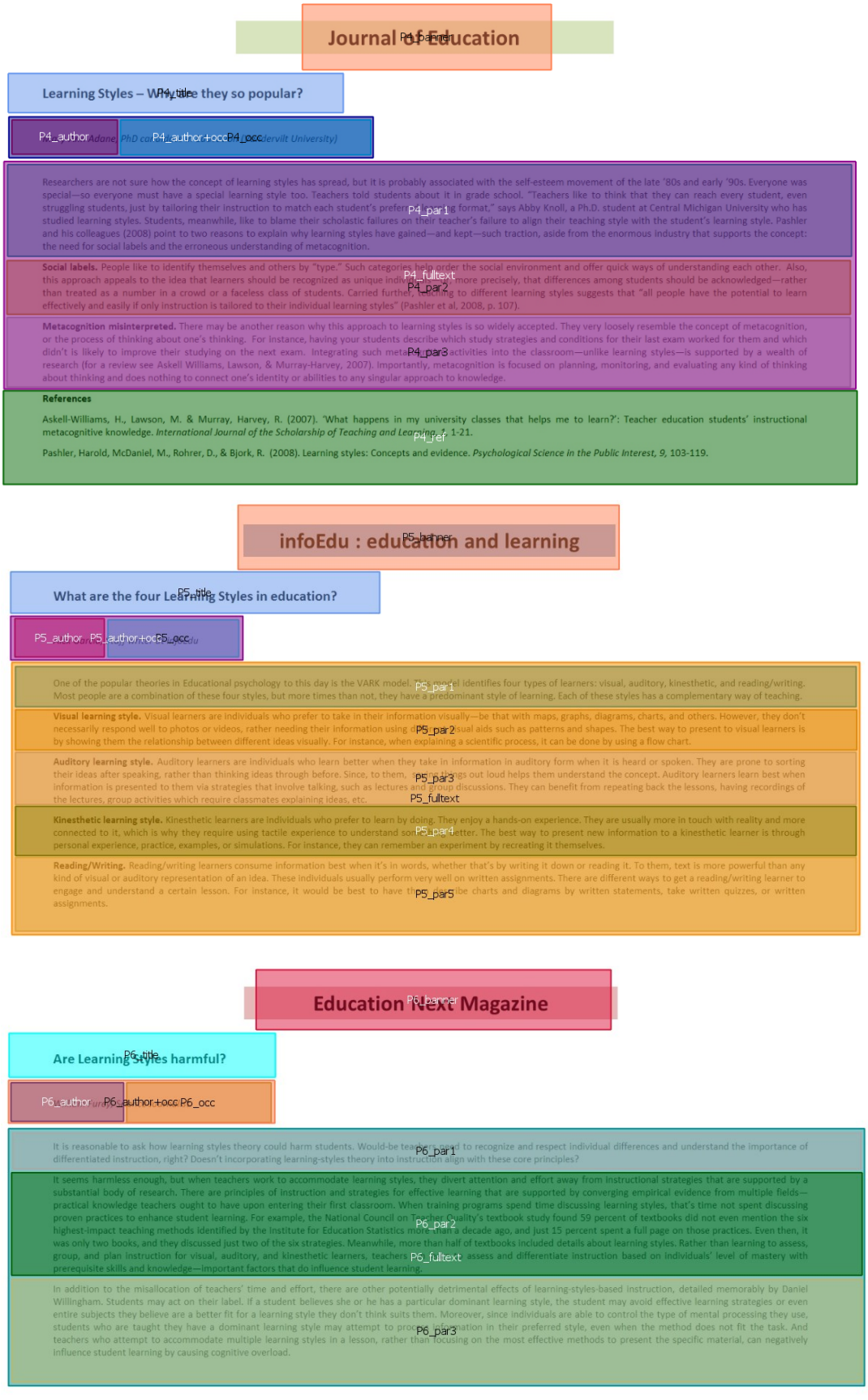
Journal of Education
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P4_par2
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P4_par3
References
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infoEdu : education and learning
P5_banner
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Education Next Magazine
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Are Learning Styles harmful?
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P6_author
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P6_occ
It is reasonable to ask how learning styles theory could harm students. Would-be teachers need to recognize and respect individual differences and understand the importance of differentiated instruction, right? Doesn't incorporating learning-styles theory into instruction align with these core principles?
P6_par1
It seems harmless enough, but when teachers work to accommodate learning styles, they divert attention and effort away from instructional strategies that are supported by a substantial body of research. There are principles of instruction and strategies for effective learning that are supported by converging empirical evidence from multiple fields—practical knowledge teachers ought to have upon entering their first classroom. When training programs spend time discussing learning styles, that's time not spent discussing proven practices to enhance student learning. For example, the National Council on Teacher Quality's textbook study found 59 percent of textbooks did not even mention the six highest-impact teaching methods identified by the Institute for Education Statistics more than a decade ago, and just 15 percent spent a full page on those practices. Even then, it was only two books, and they discussed just two of the six strategies. Meanwhile, more than half of textbooks included details about learning styles. Rather than learning to assess, group, and plan instruction for visual, auditory, and kinesthetic learners, teachers need to assess and differentiate instruction based on individuals' level of mastery with prerequisite skills and knowledge—important factors that do influence student learning.
P6_par2
P6_fulltext
In addition to the misallocation of teachers' time and effort, there are other potentially detrimental effects of learning-styles-based instruction, detailed memorably by Daniel Willingham. Students may act on their label. If a student believes she or he has a particular dominant learning style, the student may avoid effective learning strategies or even entire subjects they believe are a better fit for a learning style they don't think suits them. Moreover, since individuals are able to control the type of mental processing they use, students who are taught they have a dominant learning style may attempt to process information in their preferred style, even when the method does not fit the task. And teachers who attempt to accommodate multiple learning styles in a lesson, rather than focusing on the most effective methods to present the specific material, can negatively influence student learning by causing cognitive overload.
P6_par3

APPENDIX J – Essay task worksheet

Participant nº:

Date:

Multiple-source integration task

The texts you have just read presented different perspectives about learning styles. Now, please write a short essay stating your informed opinion on the topic you just read about by describing and evaluating these different perspectives, supporting your arguments based on the web pages you have just visited.

Write your answer in a concise and elaborate manner, using approximately half a page. Give your text a title.

APPENDIX K – Source memory task worksheet

Participant nº: Date:

Source-memory task

(Salmerón. Gil & Braten, 2018)

Please write down all information you remember about each page you just read. For each text, include information about the **type of document (article, magazine...), information source (type of the webpage, institution...), name and occupation of the author or any other information you think is relevant.**

Estimated time: 4'

Page 1: Learning styles and homeschooling Type of document: Information source: Name of the author: Occupation of the author: Other:
Page 2: Learning styles – Ineffective for learning and teaching Type of document: Information source: Name of the author: Occupation of the author: Other:
Page 3: Learning styles – How to accommodate students' diversity Type of document: Information source: Name of the author: Occupation of the author: Other:
Page 4: Learning styles – Why are they so popular? Type of document: Information source: Name of the author: Occupation of the author: Other:
Page 5: What are the four Learning styles in education? Type of document: Information source: Name of the author: Occupation of the author: Other:
Page 6: Are Learning styles harmful? Type of document: Information source: Name of the author: Occupation of the author: Other:

APPENDIX L – Protocol for data collection

PROCEDIMIENTO ESTUDIO EMMES Y EVALUACIÓN DE DOCUMENTOS MULTIPLES EN L2 (2021/2022)

El navegador del ordenador debe estar abierto con 2 pestanas: LimeSurvey y LexTALE

https://emmes-study-doamaral.limesurvey.net/461154?lang=en

http://www.lextale.com/takethetest.html

0. CONSENTIMIENTO INFORMADO – tiempo estimado: 5´

Parte 0/5 del LimeSurvey

El objetivo de este estudio es investigar como diferentes tipos de intervención afectan la lectura de textos digitales en Inglés como segunda lengua entre estudiantes universitarios que hablen inglés como L2. La duración aproximada está estimada en 1h15.

Usted va a hacer: unos testes previos, asistirás un video y contestarás preguntas, después una tarea de navegación, una tarea sobre fuentes y al final, vas a escribir un pequeño ensayo. Durante todo el proceso te daré las instrucciones parae cada tarea. Yo estaré en esta misma sala por si surja algún problema.

1. PORTATIL (avisar de no cerrar) – tiempo estimado: 15´

Parte 1/5 hasta 5/5 del LimeSurvey

En primer lugar, vas a responder:

1) un cuestionario demográfico

2) una encuesta sobre atención y motivación

3) una encuesta sobre estrategias de búsqueda

4) una encuesta sobre lectura digital en L2

5) un cuestionario para avaliar sus conocimientos en el tema Estilos de aprendizaje

6) un test de nivel de Inglés - *LexTALE* http://www.lextale.com/takethetest.html

Intenta responder lo más rápido posible.

2. INSTRUCCIONES EMMEs EXPERIMENTAL (darle la hoja de trabajo) – tiempo estimado: 12´

Ahora vas a mirar un video donde estudiantes leen informaciones en internet. El punto colorido que se mueve en la pantalla representa donde sus ojos se están fijando y el rombo rojo representa el lugar en que el estudiante ha hecho un click. Primero verás un ejemplo de una página de Wikipedia para que te familiarices con los vídeos que verás después. Enseguida vas a ver distintos momentos de estudiantes que están buscando en internet información sobre qué agua es mejor para beber, la del grifo o la mineral embotellada. Después verás a estudiantes que no hacen la tarea tan bien como los anteriores. Al final de cada estudiante, verás un mensaje que te pide: "pausa el vídeo y haz la tarea". La tarea son estas dos preguntas: A) What does this student do? (Qué hace este estudiante); B) On a 5-point scale, how do you rate this students' reading and analysis of the material? Justify your answer (en una escala de 5 puntos, como clasificas tu la lectura y anàlisis que este estudiante ha hecho del material?) Mira atentamente los vídeos fíjate en lo que hace cada estudiante, donde fija sus ojos, en que informaciones se detiene por más tiempo y cuales ignora – y se estas informaciones que mira son importantes o no.

2. INSTRUCCIONES EMMEs CONTROL (darle la hoja de trabajo) – tiempo: 12′

https://www.youtube.com/watch?v=Gvdxke1s0-I7

Ahora vas a mirar un video sobre estrategias de lectura en línea. Mientras lo asiste, vas a contestar estas tres preguntas:

1) What are the differences between evaluating the reliability of a source in print and online? (¿Cuáles son las diferencias entre evaluar la fiabilidad de una fuente en papel y online?)

2) How do the multimodal features of online texts affect reading? Is this influence positive or negative? (¿Cómo las características multimodales afectan la lectura? Esa influencia es positiva o negativa?)

3) Why is online reading described as non-linear? What are the consequences of this non-linearity? (Por qué la lectura online es descrita como no lineal?)

Puedes hacer cuantas pausas quieras en el video dentro del tiempo establecido.

3. INSTRUCCIONES TAREA DE NAVEGACIÓN CON EYE TRACKING (sacar el portátil) – tiempo estimado: 15′

Ahora vas a leer unas páginas web en el eye-tracker. Todos los textos son sobre estilos de aprendizaje.

Los estilos de aprendizaje son un tema bastante controvertido dentro del campo de la Psicología de la educación. Mientras unos defienden que cada estudiante tiene una manera más eficiente de aprender, otros argumentan que esto es un mito. Para aclarar esta cuestión, usted va a leer los resultados de una búsqueda en Google sobre el tema. Evalúa atentamente las páginas para que te sientas preparado/a para responder a una tarea sobre las fuentes que has consultado y escribir un texto sobre esto. Puedes volver a las páginas y releer si quieras, pero acuérdate que no podrás volver a los textos después, mientras haces las tareas. Por favor, procura mantener la cabeza en la misma posición, sin hacer movimientos para bajo ni para los lados. Cuando acabas de leer, avísame.

Procedimientos Eye-tracking

En el EyeView X:

- verificar se los ojos del participante están a 60 cm del eye tracker
- verificar altura y distancia entre participante e eye tracker
- calibración (el participante debe mirar los puntos. Repetir máx. 4 veces)

En el Experimenter 3.6:

- verificar se está conectado al ET (portátil – 1 / eye-tracker – 2)
- Carpeta para guardar: L2EMME
- Código del participante: **PPE01/PPC02** (número del participante + condición Experimental/Controle)
- Comprueba si está guardado
- Anotar cualquier anormalidad en la hoja con fecha y número del participante.

4. SOURCE MEMORY TASK Y MULTIPLE SOURCE INTEGRATION TASK (en el portátil) – tiempo estimado: 18´

Ahora vas a escribir todas las informaciones que te acuerdas sobre cada página que has visitado. Para cada texto, por favor intenta incluir informaciones sobre el tipo de documento (artículo, revista...), informaciones sobre fuente (tipo de página, instituición...), el nombre y posición del autor etc.

Por último, vas a escribir un ensayo corto exponiendo tu opinión informada sobre el tema que has leído describiendo y evaluando as diferentes perspectivas, basando tus argumentos en las páginas que has visitado. Escribe de manera concisa y elaborada, usando aproximadamente mitad de la página. Da un título para tu texto.