Interlinear Translations Reduce Cognitive Load on efl Vocabulary Acquisition

Traducciones interlineales reducen la carga cognitiva en la adquisición de vocabulario en inglés como lengua extranjera

Traductions interlinéaires réduissent la charge cognitive sur l'acquisition du vocabulaire de l'anglais langue étrangère

Traduções interlineares reduzem a carga cognitiva na aquisição de vocabulário no inglês como língua estrangeira

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Abstract

The use of translation in language teaching has been a source of controversial debate. Nevertheless, glossing—specifically, interlinear translations—remains an understudied learning strategy, despite having been used by learners and teachers of foreign languages since at least 1000 C. E. In the absence of a review tracing the history of interlinear translations, as well as the lack of empirical studies addressing their effect on second language reading, the present article aims to explore the role of first-language interlinear glossing by describing the results of an intervention using different reading formats in a first-semester university English reading program. In the experiment, a group of EFL beginner participants (n = 48) were assigned to one of three experimental conditions, namely, reading a text in academic English (L2) with a Spanish (L1) translation using either interlinear, construed, or marginal glossing. A translation task of the same text into their first language followed immediately and was repeated past eight days. Independent ANOVA measurements reveal an increase of translated words for the interlinear over the other two conditions, which is consistent with the hypothesis that interlinear translations allow explicit focus on word recall by reducing cognitive load in working memory, and the split-attention effect between the L2 text and its corresponding translation on a separate page. This study aims to enrich our current understanding of the impact of glossing layouts on cognitive processing.

***Keywords*:** interlinear translations, glossing, cognitive load, L2 reading, working memory, English for academic purposes

Resumen

El uso de la traducción en la enseñanza de lenguas ha sido fuente de polémicos debates. Sin embargo, la glosa —específicamente, las traducciones interlineales— sigue siendo una estrategia de aprendizaje poco estudiada, a pesar de haber sido utilizada por estudiantes y profesores de lenguas extranjeras desde el año 1000

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d.C. por lo menos. En ausencia de una revisión que rastree la historia de las traducciones interlineales, así como la escasez de estudios empíricos suficientes que aborden su efecto en la comprensión lectora en segundas lenguas, el presente artículo pretende explorar el papel de la glosa interlineal en la primera lengua describiendo los resultados de una intervención en la que se utilizaron diferentes formatos de lectura en un programa de lectura de inglés universitario de primer semestre. En el experimento, se sometió a un grupo de estudiantes principiantes de inglés como lengua extranjera (n = 48) a una de las tres condiciones experimentales, en concreto, la lectura de un texto en inglés académico con una traducción al español utilizando glosas interlineales, intercaladas o marginales. Inmediatamente después se realizó una tarea de traducción del mismo texto a su lengua materna, el cual se repitió ocho días después. Mediciones independientes ANOVA revelan un aumento de palabras traducidas para la condición interlineal sobre los otros dos formatos, lo que es consistente con la hipótesis de que las traducciones interlineales permiten centrarse explícitamente en la recuperación de palabras, y reduce la carga cognitiva en la memoria de trabajo y el efecto de la atención dividida entre el texto en segunda lengua y su correspondiente traducción en una página aparte. Este estudio pretende enriquecer nuestra comprensión actual del impacto de la disposición de las glosas en el procesamiento cognitivo.

Palabras clave: traducciones interlineales, glosa, carga cognitiva, lectura L2, memoria de trabajo, inglés con fines académicos

Résumé

Le recours à la traduction dans l'enseignement des langues a fait l'objet de débats controversés. Néanmoins, la glose – et plus particulièrement les traductions interlinéaires – reste une stratégie d'apprentissage peu étudiée, bien qu'elle ait été utilisée par les apprenants et les enseignants de langues étrangères depuis au moins l'an 1000 de l'ère commune. En l'absence d'une revue retraçant l'histoire des traductions interlinéaires, ainsi que d'un nombre suffisant d'études empiriques traitant de leur effet sur la lecture en langue seconde, le présent article vise à explorer le rôle de la glose interlinéaire en langue maternelle en décrivant les résultats d'une intervention utilisant différents formats de lecture dans le cadre d'un programme de lecture de l'anglais dans la première année d'université. Dans l'expérience, un groupe de débutants en anglais langue étrangère (n = 48) ont été assignés à l'une des trois conditions expérimentales, à savoir la lecture d'un texte en anglais académique (L2) avec une traduction vers l'espagnol (L1) utilisant soit la glose interlinéaire, soit la glose intercalée, soit la glose marginale. Une tâche de traduction du même texte dans leur première langue a suivi immédiatement et s'est répétée huit jours plus tard. Les mesures ANOVA indépendantes révèlent une augmentation du nombre de mots traduits dans le cas de la traduction interlinéaire par rapport aux deux autres conditions, ce qui est conforme à l'hypothèse selon laquelle les traductions interlinéaires permettent de se concentrer explicitement sur le rappel des mots en réduisant la charge cognitive associée à la mémoire de travail, et à l'effet de l'attention partagée entre le texte L2 et sa traduction correspondante sur une page séparée. Cette étude vise à enrichir notre compréhension actuelle de l'impact de la mise en page des gloses sur le processus cognitif.

Mots-clés : traductions interlinéaires, gloses, charge cognitive, lecture en L2, mémoire de travail, anglais à des fins académiques

Resumo

O uso da tradução no ensino de línguas tem sido uma fonte de debate polêmico. No entanto, a glosa – especificamente, as traduções interlineares – continua sendo uma estratégia de aprendizagem pouco estudada, apesar de ter sido usada por alunos e professores de idiomas estrangeiros desde pelo menos o ano 1000 aec. Na ausência de uma revisão que trace a história das traduções interlineares, bem como a escassez de estudos empíricos suficientes que abordem seu efeito na leitura de uma segunda língua, o presente artigo tem como objetivo explorar o papel da glosa interlinear no primeiro idioma, descrevendo os resultados de uma intervenção que usa diferentes formatos de leitura em um programa de leitura de inglês universitário do primeiro semestre. No experimento, um grupo de alunos principiantes de inglês como língua estrangeira (n = 48) foi designado para uma das três condições experimentais, ou seja, ler um texto em inglês acadêmico com uma tradução para o espanhol usando glosa interlinear, intercalada ou marginal. Em seguida, uma tarefa de tradução do mesmo texto para seu primeiro idioma foi realizada imediatamente e repetida oito dias depois. As medições anova independentes revelam um aumento de palavras traduzidas para a condição interlinear em relação aos outros dois formatos, o que é consistente com a hipótese de que as traduções interlineares permitem o foco explícito na recordação de palavras, reduzindo a carga cognitiva na memória de trabalho, e o efeito de atenção dividida entre o texto L2 e sua tradução correspondente em uma página separada. Este estudo tem como objetivo enriquecer nossa compreensão atual do impacto dos layouts de glosa no processamento cognitivo.

Palavras-chave: traduções interlineares, glosa, carga cognitiva, leitura em L2, memória de trabalho, inglês para fins acadêmicos

Introduction

This exploratory study investigates the effects of interlinear translations (ITs) to learn English vocabulary in a text. The study addresses how, by using glosses in a first language (L1), a text written in a foreign language (L2) can reduce the cognitive load (CL) associated to word recall, where recall is defined as the rate of L1 word meanings participants recall immediately after reading the L2 text and one week later. In this sense, the study focuses on the use of L1 glosses to develop L2 word recall. To achieve this, the study compares three different experimental conditions: (a) interlinear translation, (b) marginal translation, and (c) construed translation.

To measure the effect of each reading format, an analysis of the correlation between word recall and cognitive effort was performed in order to establish a potential link between the degree of effort that these three types of reading aids require. In what follows, I will describe these conditions and will discuss relevant literature on glosses and the cognitive factors affecting word recall. Then, the research questions and hypotheses will be presented, followed by the results, discussion, and conclusions.

Theoretical Framework

A long-held view in language teaching criticises the usage of translation (Husain, 1994; Kern, 1994; Malmkjær, 1998; Tsagari & Floros, 2013). This position can be traced back to the period around the end of World War II when multiple socioeconomic changes fostered a communicative shift in language teaching: from an instruction focused on reading to one focused on developing oral skills and listening (Bonilla Carvajal, 2013; Larsen-Freeman, 2008). This shift started in the 19th century with the opposition to the use of ITs, especially for learning Latin and Classical Greek (Blum, 2008). As a result, L2-language methodologists have embraced the idea that the L1—and translation, in particular—should be downturned rather emphazing in more oral-based activities in the L2 (Hummel, 2010). This position, however, and the rejection to using ITs[1], find no scientific support. As of today, the topic remains underdiscussed in applied linguistics and vocabulary studies (Elekaei et al., 2015; Zarei & Hasani, 2011). This evident gap in the literature had been noticed several decades ago (Spann, 1938, p. iv).

Conversely, cognitive load theory (CLT) supports translation for language learning. This theory argues that, carrying out a complex task—such as reading in a foreign language (FL)—imposes a certain load on cognitive resources which affect performance (F. G. W. C. Paas & Van Merriënboer, 1994, p. 122). Given the limited capacity of human working memory (WM), instructional design should avoid overloading a learner's attention with a poorly designed task, since such overload decreases performance. Take, for example, when an independent language learner first attempts to read an L2 text using a bilingual dictionary. His attention will naturally be split between multiple sources of information only to figure out the overall sense in a sentence: unknown word meanings, looking up words, deciding the appropriate context-relevant definition, going back to the text to resume reading the sentence or concatenating the new word meaning to the sentence and paragraph ideas, among others.

Thus, a desideratum for instructional design would be avoiding materials that require splitting one's attention into multiple sources of information. This is possible when all sources of attention are merged into one, optimising the process and cutting off the redundancy of several steps to achieve a single goal (Chandler & Sweller, 1992).

Types of Glossing Translations

Reading the abundant literature about glossing leads the reader to wonder why only a handful of

1 The opposition to using ITs arose in the 19th century out of a rejection to the claims of their most enthusiastic supporter: James Hamilton. Readers interested in the exchange of arguments against Hamilton's interlinears may refer to Donato (1827) and Hartnoll (1823).

Figure 1 Example of an Interlinear Translation

"Horae	quidem	cedunt	et	dies	et	menses	et	anni,	nec
"Hours	*indeed*	*go-away*	*and*	*days*	*and*	*months*	*and*	*years,*	*neither*
praeteritum	tempus	umquam	revertitur	nec	quid	sequatur		sciri	
the-preterite	*time*	*ever*	*returns*	*nor*	*what*	*follows*		*be-known*	
potest.	Quod	cuique	temporis	ad	vivendum	datur,	eo	debet	
can.	*What*	*to-everyone*	*of-time*	*to*	*live*	*is-given,*	*with-it*	*must*	
esse	contentus."								
be	*happy."*								

Source: Cicero (1923)

studies has addressed the value of ITs[2], considering that they are a method that integrates multiple sources of attention into a unique display.

An IT is a glossing method that presents a word-by-word translation of a text where the L1 words are located underneath the L2 line to be translated, interlineally. Apart from reading in an L2, its main use "...is either to understand the mechanics of the source language or to construe a difficult text as a pre-translation process." (Newmark, 1988, pp. 45–46). Figure 1 presents an example from Cicero's *De Senectute* (Cic. Sen. 69).

ITs rearrange the L2 word order, since it is seldom the case that two languages will have an identical syntax. The IT tries to slightly accommodate the L2 word order so that the L1 line underneath can be read smoothly. Another central aspect of ITs is the mode of reading. In the 19th century, the method was based on reading out loud for students, regardless of class size, and clearly uttering each sentence, one word at a time: the word in the L2 line, then in the L1 gloss. A student repeated the verse in the same mode of reading, and then another student followed the same procedure. As homework, students would make sure they were able to read the Latin text directly, unassisted by the L1 gloss (Smith, 1860, p. 235).

Another form to gloss a text is marginal gloss (for examples, see Loggon, 1830, pp. 51–120; Salazar i Morales, 1857). In this method, the L2 text is on the left-hand panel and its corresponding word-by-word L1 glossing on the opposite right side (see Figure 2).

If the purpose is to present vocabulary for later word recall, how much information should be included in a gloss to ensure word recall? Should the gloss be presented as individual words (marginal) or should it preserve the L2 sentence without interrupting the pace of reading? An intermediate between the interlinear and marginal is the "construed" gloss (see Figure 3). The term comes from the 1700-1800's practice of assessing students' understanding by asking them to "construe" a text, that is, to read an L2 text out loud providing the L1 definition of each word. To prepare pupils for this, books were printed where the presentation follows the L2 and L1 words in the same line, differentiated by the use of italics (De Lasteyrie, 1826, pp. 15–24; Drift, 1729; Hampton, 1693).

These different glossing formats have different effects on the cognitive processing of textual information and the ensuing understanding of ideas. If the reader's attention is split by the multiple interruptions needed to shift their attention to the gloss on an opposite panel, the individual

2 To the best of my knowledge, only Carter (2019), Elekaei et al. (2015), Hamilton (1831, cited by Smith, 1860, pp. 21–24), Stevens (1828), Thompson (1829), and Zarei & Hasani (2011), incorporate ITs in their research. Regrettably, they do not illustrate how those texts were 'interlinearised'.

Figure 2 Example of a Marginal Gloss

Text	Columnar gloss
Horae quidem cedunt et dies et menses et anni, nec praeteritum tempus umquam revertitur nec quid sequatur sciri potest. Quod cuique temporis ad vivendum datur, eo debet esse contentus.	***Horae**:* An hour (one twelfth of the day between sunrise and sunset). Time, time of year, season. The hours, daughters of Jupiter and Themis, goddesses that presided over the changes of the seasons and kept watch at the gates of heaven ***Quidem***: Assuredly, certainly, in fact, indeed ***Cedunt***: To go from, give place, remove, withdraw, go away, depart ***Et***: And indeed, both, also, likewise, and moreover, and that too ***Dies***: A set day, appointed time, term, days ***Et***: And indeed, both, also, likewise, and moreover, and that too ***Menses***: The months, the fixed time, the period ***Et***: And indeed, both, also, likewise, and moreover, and that too ***Anni***: Years ago, last year name of a Roman a part of a year, a season of the year the age to which one must attain in order to be in an office

Figure 3 Example of a Construed Translation

Construed translation
Hours Horae *indeed* quidem *go away* cedunt *and* et *days* dies *and* et *months* menses *and* et *years* anni, *neither* nec *the preterite* praeteritum *time* tempus *ever* umquam *returns* revertitur *nor* nec *what* quid *follows* sequatur *can* potest *be known* sciri. *What* Quod *is given* datur *of time* temporis *to everyone* cuique *to live* ad vivendum, *each* eo *must* debet *be content* esse contentus (*with it*).

word or the L1 line underneath, then, the overall understanding of the text can be jeopardised at the expense of vocabulary processing. This paper therefore reports the results of an experiment requiring participants to recall the L1 (Spanish) meaning of an L2 (English) text, after having read the text with the aid of one of the above-mentioned types of glossing: interlinear, marginal and construed. Finally, every participant completed a self-rating item on mental load and invested mental effort (as used by Sweller et al., 2019) in order to gauge the perceived cognitive load required by every approach.

Glosses in Language Learning: Findings and Inconclusive Results

Research on glosses began in the early 70's (Holley & King, 1971) and has since yielded mostly positive results for vocabulary gain, but with certain conflicting findings. For example, extensive research on glosses has shown that dictionary-entry type glosses (e.g., marginal) enhance vocabulary retention, while learners tend to favor hypertext glosses over traditional end-of-text lists (Almutairi, 2018; Gettys et al., 2001). Electronic glossing, especially when combined with multimedia, leads to the highest vocabulary gains and improved reading rate (H. Lee et al., 2016; Türk & Erçetin, 2014).

It is worth noting that beginner L2 learners generally prefer L1 definitions in glosses (Arpaci, 2016) which have also enhanced target word learning with experimental groups (Barabadi et al., 2018). L1 definitions result in higher vocabulary gains compared to learners inferring L2 meanings (H. Lee et al., 2017). Overall, L1 glosses aid vocabulary recall and facilitate incidental word learning

(Çakmak & Erçetin, 2018). Other studies highlight the positive impact of L1 glosses on L2 vocabulary learning during reading (J.-Y. Lee & Jeon, 2017), although some experimental research reveals differing results, suggesting potential counterproductive effects as will be shown below.

For example, studies report that glosses only have an effect on incidental learning, whereas their relationship to understanding a text is not as significant a predictor as that of WM (Varol & Erçetin, 2016). The potential benefit of combining both verbal and visual annotations in a gloss has also been shown to be hindered by the limitations of WM (Acha, 2009). This has been corroborated in studies comparing the effectiveness of different glosses on incidental vocabulary learning, where the significant relationship between WM and reading proficiency is maintained regardless of the method used (Ertürk, 2016).

Zarei & Hasani (2011) conducted a study comparing interlinear and post-text translations to determine their impact on vocabulary recall. ITs yielded the best performance, followed by pre-text, marginal and post-text translations. However, the study lacks important details regarding gloss layout, font size, word arrangement, and participant perception, affecting its validity and replicability.

Elekaei et al. (2015) found that ITs allowed learners to outperform those reading with footnote, marginal, or glossary glosses in vocabulary retention. ITs users comprehended the text better and had significantly higher vocabulary recall. The immediate presentation of new words and glosses with ITs allowed for uninterrupted focused understanding. However, the study also lacks clear illustrations of the interlinear typographic layout, an essential aspect given the different visual organisation of gloss types.

More recently—and inspired by the ideas suggested by Blum (2008)—, Carter (2019) decided to prove the concept of ITs for a reading–intensive Latin course with high school students in the UK. He compared parallel-facing translations of bilingual readings with ITs. Although this paper is not a rigorous scientific article, but rather a report on a pedagogical experience, its findings confirm the preference that teachers and students have for ITs compared with bilingual opposite page translations.

Finally, Zhao (2023) created an app with marginal and interlinear translations and found that marginal glosses improved vocabulary. Preferences depended on L2 proficiency, as beginners favored ITs because it reduced word look-ups, while maintaining reading flow and streamlining comprehension.

Promising as all that sounds, ITs have not been properly tested with contemporary, rigorous, empirical methodologies. The paucity of studies is a testimony to the amount of work that remains to be done. This was also the conclusion of Azari et al's. (2012) review of the effects of glossing. It is especially important to find out which type of glossing works best (in L1 or in L2), as well as the level of students that best benefit from them: elementary, intermediate or advanced.

Cognitive Load Theory: Cognitive Factors Affecting Performance

Cognitive load theory (CLT) is a theory based on the human limited WM capacity (Miller, 1956) and schema construction (Chase & Simon, 1973) to explain how task complexity affects students' ability to process information (Sweller et al., 2019). CLT predicts that, as the number of concurrent cognitive processes increases, performance decreases. CLT plays a central role in language teaching. The link between WM and learning has been long established to be central, and one of the best predictors of success is, indeed, WM capacity (Gathercole & Baddeley, 2014). In short, automating processes reduces CL, like a juggler mastering each movement. Thus, CL is like a computer's RAM, and WM is akin to its primary storage.

In foreign language teaching, CLT supports instructional design in a way that places the optimisation of activities according to the natural constraints of human cognition. The central tenet in CLT is that humans have not evolved to acquire domain-specific skills (i.e. learning grammar rules or L2 vocabulary), but only generic-cognitive knowledge that does not require explicit instruction, which is referred to as biologically-secondary, domain-specific knowledge in the CLT literature. Therefore, CLT places WM at its core to craft instructional designs aimed at reducing unnecessary WM load for learners who are taught domain-specific contents (Sweller et al., 2019). In practice, an effective instructional design minimises extraneous load, enhancing learning. The goal is to maintain a manageable level of CL within WM capacity (F. Paas, Renkl, et al., 2003).

Research Questions

This study investigates the effects of different types of glossing on word recall during a task of reading texts of academic English. This work aims to enrich our current understanding of the impact of interlinear, marginal or construed glossing on word recall by means of conducting correlation analyses between learning and cognitive effort separately for all glossing types, as well as the following questions:

1. What type of L1 glossing (i.e. interlinear, marginal or construed) will induce higher L2 word recall rate (as measured by an L2-L1 translation task immediately, and eight days after) for EFL beginner learners reading a text in academic English?

2. Which of these glossing types will induce higher CL, as measured by the score of the perception questionnaire NASA-Task Load Index, and by the number of word meanings recalled in the translation task?

Attending the questions above, it is important to note, however, that the current study considers all the words in the texts that participants read, instead of targeting a set of predetermined words that might be unknown to them. This caution is important to be considered as readers can contrast findings and decide to establish a comparison to other glossing research on vocabulary.

Methods

In this section, I provide a description of the participants, materials, procedure and data collection tools that were used for this study.

Participants

First-semester students from different undergraduate majors at a Colombian university were invited to participate. A total of 54 students joined (34 women, 20 men), some of them were recruited by instructors leading their English-as-a-foreign-language class. From this initial pool, 52 participants began the test while only 48 completed all phases. Students majoring in English were not invited to participate because they were already receiving additional instruction in the L2, which would give them an additional head start.

Mean age was 19 years while elementary and high school education combined yielded a mean average of 10 years. 81% of participants reported that they did not speak a language other than Spanish. The remaining 19% did claim to speak English or at least count their years of schooling as evidence of proficiency. Participants who indicated to have speech, hearing, or vision disorders were not part of the study. All subjects were first-semester college students with normal or corrected-to-normal vision.

Employing a questionnaire that assesses the linguistic background, age of arrival, degree of exposure and cultural affinity of a speaker towards an L2 (see section *LEAP-Q Description*), participants reported to have had an exposure to an English-intensive or bilingual education (see Table 1). This was a similar result to their self-perceived rate of English proficiency in the same scale 1-10: (4.0).

Table 1 Reported Previous L2 Exposure

Questions inquiring previous L2 Exposure	Yes (Percentage responses)	No (Percentage responses)
Exposure to an English-intensive or bilingual education in primary or secondary school	8	92
Having taken English classes at a private institution or academy	37	63
Having traveled to an English-speaking country	4	96
Having an employment that requires English speaking skills	0	100

Materials

Data were gathered through the following documents: (a) a questionnaire of self-perceived language experience and proficiency (Marian et al., 2007), (b) a text in English (*Regular Exercise Can Improve Your Memory*, n. d.) presented in one of three glossing arrangements: marginal (Figure 5), interlinear (Figure 4), or construed (Figure 6); (c) the NASA TLX questionnaire of self-perceived cognitive difficulty (Hart & Staveland, 1988); (d) an online form to complete the L2-L1 translation task (see Figure 7).

In the next sections, I will provide a description of each material and the way they were used.

LEAP-Q Description

LEAP-Q (Marian et al., 2007) is a questionnaire that assesses the linguistic background, age of arrival, degree of exposure, and cultural affinity of a speaker in relation to an L2, with questions designed as a Likert scale allowing the test taker to determine their agreement with a given statement.

Glossed Versions of a Text

During the study, participants were randomly assigned to one of three reading formats. They all read the same text with different types of glossing. Figure 4 presents a fragment of the reading text as presented in the interlinear condition.

As shown in Figure 4, the Interlinear glossed text contains the same original English text, with some minor syntactic modifications (e. g. in the first sentence, the original reads: "American neurologists", Interlinear: "neurologists American"). Underneath each word, there is a Spanish literal translation. In each condition, learners were instructed to read silently one word from the L2 followed by the one in the L1 gloss, *i. e.* So *Entonces* what *qué* does *sí* correlate *(se) correlaciona* with *con* success *el*-éxito. They were also instructed to make sure that they read once again the L2 sentence in full to confirm whether the meaning of all words was clear. If they were unsure, they could re-read the L1 line underneath. This reading process emulates the one suggested by James Hamilton himself in his textbooks (De Lasteyrie,

Figure 4 Fragment of an Interlinear English-Spanish Glossed Text

According to	a	new	publication	by	neurologists	American,	exercise
Según	una	nueva	publicación	de	los-neurólogos	americanos,	el-ejercicio

regular	can	improve	your	memory	and	skills	thinking.	We
regular	puede	mejorar	su	memoria	y	las-destrezas	(de) pensamiento.	Nosotros

know	that	exercise	has	proven	to be	good	for	your	heart	and
sabemos	que	el-ejercicio	ha	demostrado	ser	bueno	para	su	salud	y

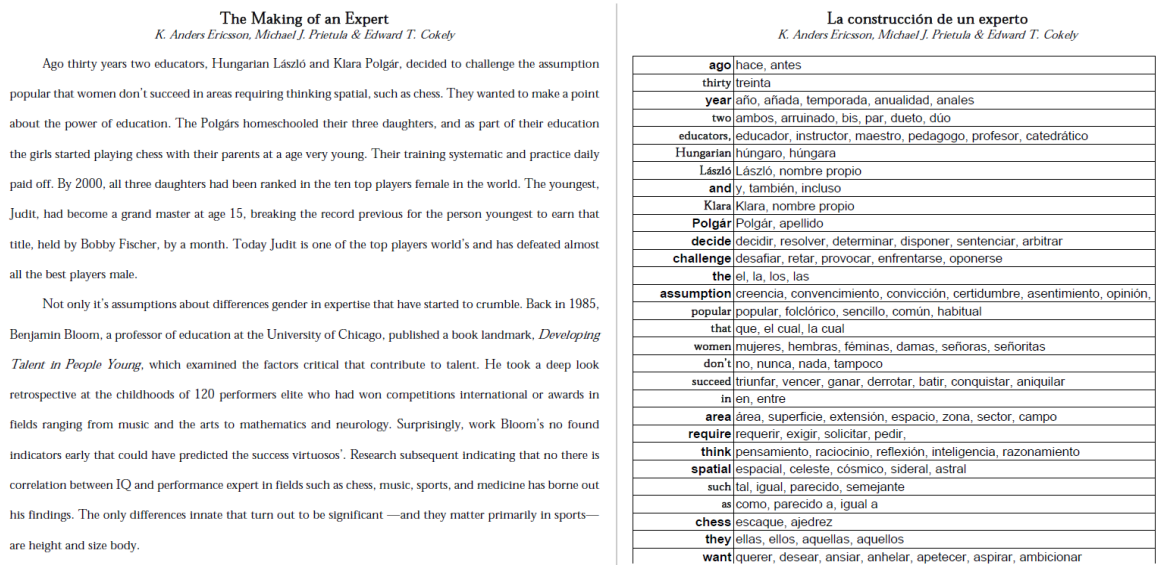
fitness	overall,	but	now	doctors	say	that	it	can	actually	help
aptitud-física	general,	pero	ahora	los-doctores	dicen	que	ello	puede	de-hecho	ayudar

you	remember	things.
te	a-recordar	cosas.

1826; Hamilton, 1824, p. ix, Saint-Réal, 1827; Smith, 1860, p. 235). Hiding the L1 gloss in an IT to self-assess one's knowledge of the L2 text has been also the standard practice to avoid relying only on the L1 line for understanding (Spann, 1937, p. v).

The construed and marginal versions of the text had the same number of words, minor syntactic

Figure 5 Fragment of a Marginal English-Spanish Glossed Text



The Making of an Expert

K. Anders Ericsson, Michael J. Prietula & Edward T. Cokely

Ago thirty years two educators, Hungarian László and Klara Polgár, decided to challenge the assumption popular that women don't succeed in areas requiring thinking spatial, such as chess. They wanted to make a point about the power of education. The Polgárs homeschooled their three daughters, and as part of their education the girls started playing chess with their parents at a age very young. Their training systematic and practice daily paid off. By 2000, all three daughters had been ranked in the ten top players female in the world. The youngest, Judit, had become a grand master at age 15, breaking the record previous for the person youngest to earn that title, held by Bobby Fischer, by a month. Today Judit is one of the top players world's and has defeated almost all the best players male.

Not only it's assumptions about differences gender in expertise that have started to crumble. Back in 1985, Benjamin Bloom, a professor of education at the University of Chicago, published a book landmark, *Developing Talent in People Young*, which examined the factors critical that contribute to talent. He took a deep look retrospective at the childhoods of 120 performers elite who had won competitions international or awards in fields ranging from music and the arts to mathematics and neurology. Surprisingly, work Bloom's no found indicators early that could have predicted the success virtuosos'. Research subsequent indicating that no there is correlation between IQ and performance expert in fields such as chess, music, sports, and medicine has borne out his findings. The only differences innate that turn out to be significant —and they matter primarily in sports— are height and size body.

La construcción de un experto

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ago	hace, antes
thirty	treinta
year	año, añada, temporada, anualidad, anales
two	ambos, arruinado, bis, par, dueto, dúo
educators,	educador, instructor, maestro, pedagogo, profesor, catedrático
Hungarian	húngaro, húngara
László	László, nombre propio
and	y, también, incluso
Klara	Klara, nombre propio
Polgár	Polgár, apellido
decide	decidir, resolver, determinar, disponer, sentenciar, arbitrar
challenge	desafiar, retar, provocar, enfrentarse, oponerse
the	el, la, los, las
assumption	creencia, convencimiento, convicción, certidumbre, asentimiento, opinión,
popular	popular, folclórico, sencillo, común, habitual
that	que, el cual, la cual
women	mujeres, hembras, féminas, damas, señoras, señoritas
don't	no, nunca, nada, tampoco
succeed	triunfar, vencer, ganar, derrotar, batir, conquistar, aniquilar
in	en, entre
area	área, superficie, extensión, espacio, zona, sector, campo
require	requerir, exigir, solicitar, pedir,
think	pensamiento, raciocinio, reflexión, inteligencia, razonamiento
spatial	espacial, celeste, cósmico, sideral, astral
such	tal, igual, parecido, semejante
as	como, parecido a, igual a
chess	escaque, ajedrez
they	ellas, ellos, aquellas, aquellos
want	querer, desear, ansiar, anhelar, apetecer, aspirar, ambicionar

Figure 6 Fragment of a Construed English-Spanish Glossed Text

The Making *La construcción* of *de* an *un* Expert *experto*

K. Anders Ericsson, Michael J. Prietula & Edward T. Cokely

Ago *Hace* thirty *treinta* years *años* two *dos* educators, *educadores,* Hungarian *los-húngaros* László *László* and *y* Klara Polgár, *Klara Polgár,* decided *decidieron* to challenge *desafiar* the assumption *la creencia* popular *popular* that *(de) que* women *las-mujeres* don't *no* succeed *triunfan* in areas *en áreas* requiring *(que) requieren* thinking *pensamiento* spatial, *espacial,* such as *tales como* chess. *el-ajedrez.* They *Ellos* wanted *querían* to make *probar* a point *una idea* about *acerca-de* the power *el poder* of *de* education. *la-educación.*

The Polgárs *Los Polgárs* homeschooled *educaron-en-casa* their *(a) sus* three daughters, *tres hijas,* and *y* as part of *como parte de* their *su* education *educación* the *las* girls *niñas* started *empezaron* playing *a-jugar* chess *ajedrez* with *con* their *sus* parents *padres* at *a* a *una* age *edad* very *muy* young *joven.* Their *Su* training *entrenamiento* systematic *sistemático* and *y* practice *práctica* daily *diaria* paid off. *dio-frutos.* By *Hacia* 2000, *(el año) 2000,* all *todas* three *las-tres* daughters *hijas* had been *habían estado* ranked *clasificadas* in *entre* the *las* ten *diez* top *mejores* players *jugadoras* female *femeninas* in the *en el* world *mundo.*

modifications and equal typography as seen in Figures 5 and 6.

Comprehension Questions

Before reading, participants were announced that they would be asked a series of reading comprehension questions at the end. This ensured that they would focus their attention not only on the words, but also on the overall meaning of sentences. Participants were asked to fill out a form in their L1, containing the following questions:

1- What is the central idea of the text?

2- Does the text make any recommendations that could be useful to university students?

3- If you had to provide an alternative title to the text, how would you rename it?

Their answers were collected simply to determine whether they had actually paid attention to the meaning of the text. Their responses were not coded or counted towards determining which of the reading formats was the most optimal for vocabulary acquisition. This is because their answers varied in the number of words, and in the conceptual understanding that they had of the text. What that means is that being able to provide a detailed answer to these three questions is not something that entirely depends on the type of glossing. It depends on other factors that go well beyond the independent variable. Their goal was to make sure that they could recognise the English words, even without having access to the gloss later.

Cognitive Load Questionnaire

As is standard procedure in CL studies to measure cognitive effort during the completion of a task, a questionnaire was used to ask participants about their self-perceived mental effort while performing the L2-L1 translation. The questionnaire was a digital version of the cognitive effort questionnaire NASA Task Load Index (NASA-TLX; Hart & Staveland, 1988). This questionnaire seeks to find out information of the perceived effort in carrying out a task. It is divided into 6 domains: mental demand, physical demand, temporal demand, performance, effort, and frustration, to be answered on a nine-point Likert-scale ranging from very low to very high effort.

Using this NASA-TLX survey, participants were asked to rank their perception of the level of difficulty in completing the task of reading and translating an English text under each reading format, and how much mental effort they invested in its completion. F. Paas, Renkl, et al. suggest that the combination of subjective CL tests together with performance-based measures constitute a reliable estimate of the optimisation of instructional methods (2003, p. 64). This is why a considerable portion of CLT research still relies on subjective ratings (De Jong, 2010).

The choice of the NASA-TLX is based on the need to cross-examine the quantitative results, since they only tell us whether participants performed well but, even those who did, might have still considered reading with a certain type of gloss cognitively taxing.

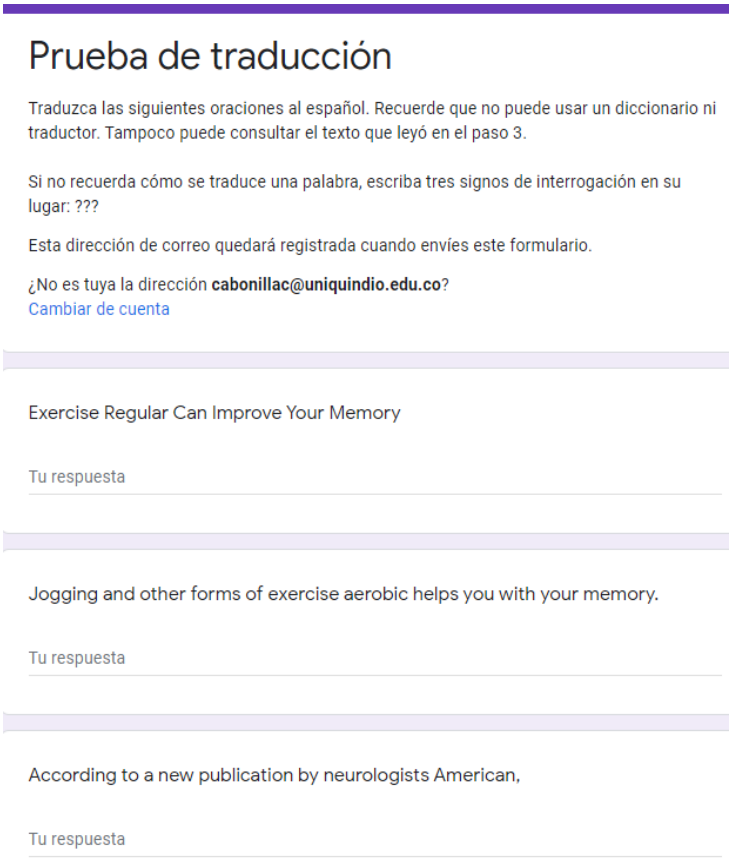
Translation Task

Participants were asked to translate the L2 text without glosses using an online form that collected their input, importing them into a spreadsheet for a quantitative analysis. The text was presented one sentence at a time and required participants to type L1 translations of each L2 word presented in the text (see Figure 7). Participants typed their answers in the space marked as *Tu respuesta*, Spanish for "Your answer."

Procedure

Participants received an email with specific instructions on how to enroll in a learning management system (Google Classroom™). The information collected was stored locally in the servers of the university where the study took place. After participants logged in and enrolled in

Figure 7 Translation Test Conducted by the Participants



the module, they proceeded to fill out the consent form and the LEAP-Q questionnaire.

The participants in the sample were assigned to one of the groups using a non-probability sampling method of convenience: Participants that took classes on a certain day were all assigned to one of the conditions, such that three different groups were recruited from students taking English classes on different days of the week. A total of 16 participants were applied the construed reading format, 14, the interlineal and 18, the marginal. In the first session a consent form was signed, the LEAP-Q questionnaire was filled out; the English text was read in one of the three conditions, and a series of reading comprehension questions about the contents of the text were answered. Finally, the self-perceived effort questionnaire NASA-TLX was completed. This first session took approximately one hour.

All the participants followed the same procedure under the three conditions, namely, they were instructed to read silently one word from the L2 and its accompanying L1 equivalent in the gloss. They were also instructed to make sure they read once again the L2 sentence to confirm whether the meaning of all words was clear. If doubts persisted, they were to re-read the L1 gloss to ensure comprehension, following the original procedure used in schools that taught using ITs or construed glosses.

The experimenter informed all participants that they would meet again eight days later for the next session. In the second session, participants were given 40 minutes to read the L2 text without the gloss, just from the online form and to input their translation in L1 of the L2 text (Figure 4). This online form was used to record the English-to-Spanish translations produced by the participants. The data were imported into a spreadsheet to

identify the accuracy and rate of word recall using different types of glossing.

Results

The research design operated with a dependent variable of total gain score (number of translated words in the first and second translation tasks out of a total of 300 running words), and the total numbers for the self-scores in the LEAP-Q and NASA TLX questionnaires (see Table 2).

After downloading the data spreadsheets from Google Classroom™ as comma-separated-value files, the statistical analysis was conducted using the 2023 Microsoft Excel 365 version. In order to identify a possible confounding factor that might skew results, single-factor variance analyses were applied to answers to questions 7 to 9. This allows for the identification of a possible group that had had more participants reporting exposure to English or a higher reading level in English than the other group. Table 2 shows the results of each question under interlinear, construed, or marginal glossing conditions. For the first question, about the participants' identification with English-speaking countries' culture, the total average was 3.9 (SD 1.5), which is not statistically significant, as confirmed with a single factor ANOVA: $F(2,45) = 0.011$, p. 0.98.

For the second question, about exposure to the English language, the total average was 3.0 (SD 1.6)—again not significant, since a single factor ANOVA presents: $F(2,45) = 0.102$, p. 0.90.

Finally, average results for the third question, inquiring about their perceived reading level in English yielded a total average of 2.5 (SD 1.4), which showed no significant differences among groups, since the single-factor ANOVA output was $F(2,45) = 0.202$, p. 0.81.

Figure 8 shows the average score of participants' self-perception of the mental effort demanded by the reading task (vertical Y axis). Interestingly, there is a minimal difference between the interlinear and marginal conditions, with marginal glossing ranked as less demanding.

Another factor that weighs on the result of performance is the degree of prior exposure to English,

Table 2 Single-factor Variance Analyses from LEAP-Q and NASA TLX Questionnaires

Questions	Interlinear Glossing Results	Construed Glossing Results	Marginal Glossing Results	Total Average	Standard Deviation (SD)
On a scale of zero to ten, please rate the extent to which you identify with the culture of English-speaking countries, 0 means little or no identification and 10 a maximum identification and cultural affinity	3.86	3.94	3.89	3.9	1.5
On a scale of 0 to 10, how much exposure do you have to English? This can be through movies, music, and reading on the Internet	3.07	2.88	3.11	3.0	1.6
How would you rate your reading level in English? 0 means you can't read anything in English, and 10 means you can read a full text like a novel or newspaper without using a dictionary	2.57	2.31	2.61	2.5	1.4

Figure 8 Average Mental Effort in Each Reading Condition

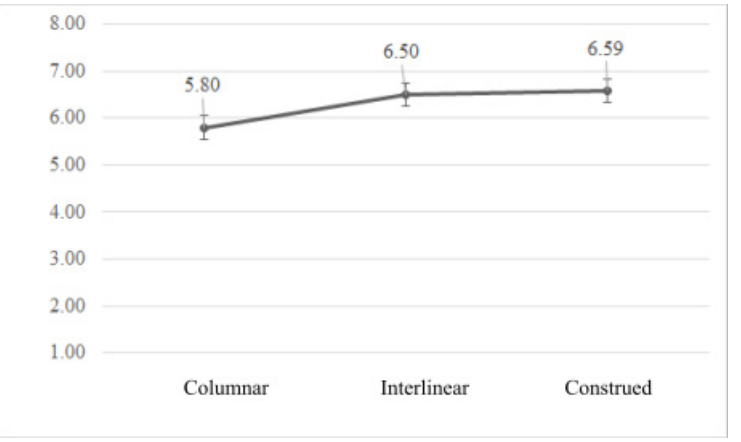
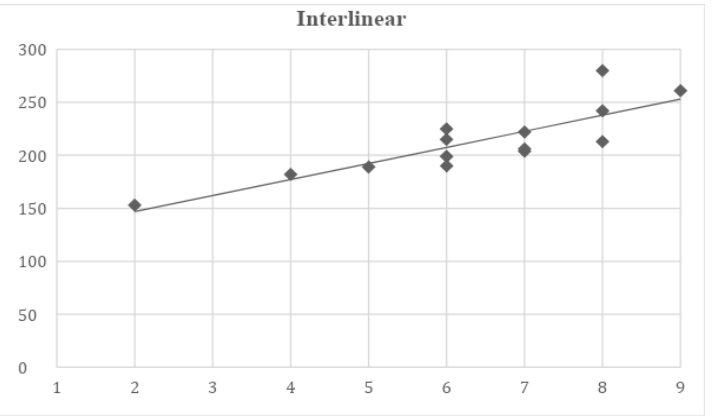


Figure 9 Self-Rated Perception of Participants About Their Own Proficiency Reading in English Compared with Their Performance in Translating Words: Interlinear



as participants reported it in the LEAP-Q test. Figure 9 illustrates that the greater the exposure (horizontal axis), the higher the performance in the number of translated words (vertical axis) across all conditions (see Figure 9). The horizontal X axis represents the self-rated exposure to English (how much each participant perceived to be exposed to English in a scale from 1 to 9) and the vertical Y axis the number of translated words in the translation task.

Figures 10 and 11 illustrate the participants' self-rated proficiency when reading in English prior to the task. Results for all conditions suggest that participants who self-rated themselves on the lower end of the scale (horizontal X axis), showed smaller quantities of words translated (vertical Y axis). According to the results, those who perceived their capacity to be higher, also achieved a higher performance.

Results of the Translation Task

Clear patterns emerge when counting the number of words translated into L1 and cross-examining the data across conditions. Figure 12, for example, displays the number of words translated on the vertical axis and each of the reading conditions on the horizontal axis. The trendline in the distribution shows a difference between the interlineal and marginal text conditions, with a much smaller change between interlinear and construed. The values above the columns represent the average for each group. The vertical Y axis reflects the number

Figure 10 Self-Rated Perception of Participants About Their Own Proficiency Reading in English Compared with Their Performance in Translating Words: Construed

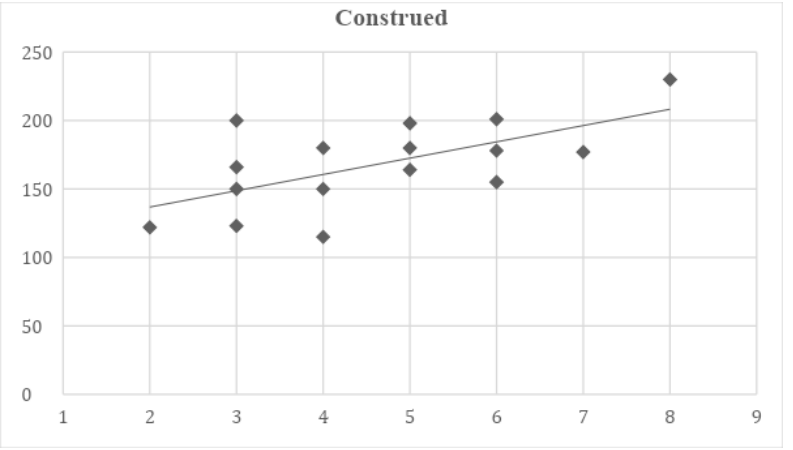


Figure 11 Self-Rated Perception of Participants About Their Own Proficiency Reading in English Compared with Their Performance in Translating Words: Marginal

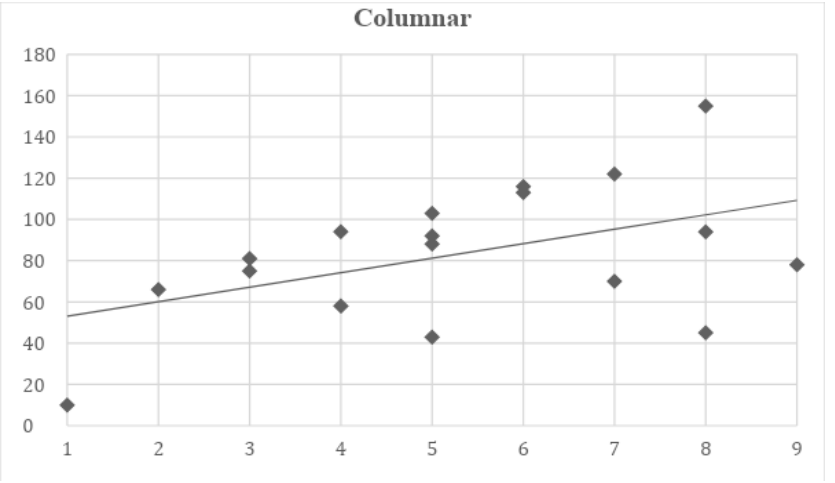


Figure 12 Results of the Translation Task Performed during Session 1

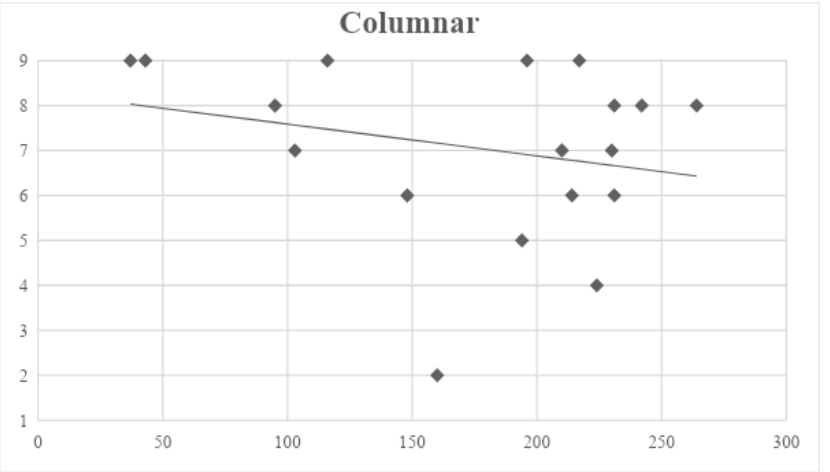
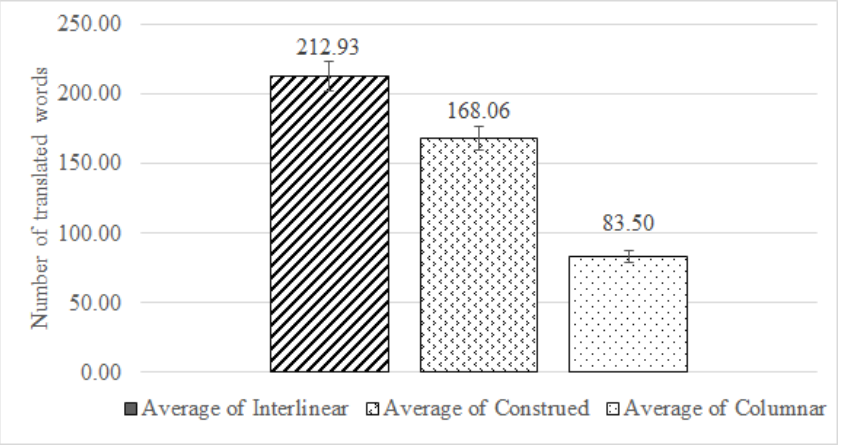


Figure 13 Average of the Translation Task Performed During Session 2



of words that participants translated. Figure 12 shows the showed an average number of 274.93 words translated (SD: 15.93), while for construed, the average value was 251.88 (SD: 19,40), and in the marginal condition it was 175,28 (SD: 69,41) in the first session.

Those results were considerably reduced for the second session, which took place eight days later. This time, the interlinear condition had a mean average of: 212.93 (SD: 32.65); construed, 168.06 (SD: 31.74), and especially, marginal yielded 83.50 (SD: 33.42).

These results for both sessions were first analyzed using a t-test (Figure 13). The decision was to use a Welch's t-test, considering that this is an unbalanced research design, because not all the participants that were recruited for every reading condition completed every part of the study. Thus, the *n* values were: for interlinear: 14, for construed: 16; for marginal: 18.

Unequal sample sizes are not apt for a standard students' t-test, because one of the assumptions for such tests is the approximate equal sample size (e.g. a sample size ratio of 1.5) and equal variance within results: the assumption of homogeneity of variances. The more the ratio differs from 1.1 in a sample, the t-test becomes increasingly sensitive to heteroscedasticity.

So, using the results of a Welch's t-test for independent samples hypothesizing a mean difference of 0, a comparison of interlinear vs. construed using a two-tailed test, without predicting a direction for the results, yielded: $P(T<=t)$: 0.001, which was significantly inferior to the threshold alpha of 0.05, and lead us to determine that there is indeed a significant difference between the two conditions. A similar result is obtained when comparing construed and marginal conditions, namely: $P(T<=t)$: 0.000.

A one-way analysis of variance (ANOVA) was also conducted, with one factor with at least two independent levels. The alpha threshold was 0.05. The choice for a single factor ANOVA is because we have word counts as the only factor across three conditions, with all other variables remaining constant.

As seen in Table 3, for a design with 2 degrees of freedom (DF) 2 and 45, if the Freedom value is greater than the critical F of 3.20, we can reject the null hypothesis. For a comparison of the three conditions, the value in $F = 22.24$. and thereby the three conditions differed significantly on word recall, $F(2 \text{ and } 45) = 22.24$, $p < 0.05$.

Although these results tell us that the three conditions have a significant difference, there is still need to run a post-hoc test. The Bonferroni Correction test is used when analyzing multiple comparisons,

Table 3 Means and *p*-Values of One-Way Analysis of Variance

Summary				
Groups	**Count**	**Sum**	**Average**	**Variance**
Interlinear	14	3849	274.9286	253.6099
Construed	16	4030	251.875	376.3833
Columnar	18	3155	185.2778	4817.977

ANOVA						
Source of variation	**SS**	**df**	**MS**	**F**	**p-value**	**F crit**
Between groups	89816.96	2	44908.48	22.24	0.0000002	3.20
Within groups	90848.29	45	2018.851			
Total	180665.25	47				

Note: *ss*: sum of squares; *df*: degrees of freedom; *ms*: mean square; *F*: *F* statistic ; *p*-value: probability value; *F crit*: critical F value

where the likelihood of making a Type I error increases. In that case, we are expected to divide the alpha 0.05 by the number of comparisons: 3 / 0.05 = 0.0167. The results of the P(T< = t) two-tail above were 0.001 for the t-test comparing interlinear and construed glossing, and 0.000 for construed and marginal glossing. Since 0.0167 is higher than those two results, there was a 95% chance that the observed differences between the three conditions were statistically significant.

It is important to mention that this analysis did not consider years of exposure to L2, education, sex, or starting age of English learning, since participants with considerable proficiency in English were filtered out of the sample. In the word count, running words comprised the total number of tokens against which the rate of L1 meanings was compared. For the words in L1 that participants translated, those that had even some minor mistakes were counted in both groups, i.e. translating a plural in L2 as a singular in L1 i.e. *women* = *mujer*. They were counted as long as they preserved the intended original meaning.

In order to determine whether the translation task scores can be predicted by the cognitive effort, scatterplots are presented next. Results of the first reading task display a trendline comparing the number of translated words (in the horizontal X axis) with the cognitive effort score given to the reading task (in the vertical y axis) for each of the three conditions.

The descending numbers towards the right in each figure mean that, as participants translated a higher number of words, they also rated the task as an easier activity. The NASA-TLX test ranks the self-perceived cognitive effort of a task in a Likert scale, where 9 is the most effortful and 1 is the least. Figures 14, 15, and 16 reflect that, although there is not a strong and significant pattern to associate one specific reading condition as less difficult, it seems as if ITs had the clearest observable pattern of participants rating the task as easy, together with them achieving the highest results.

Construed and cognitive effort provided a negative correlation of r = -0.18, which is a very weak

Figure 14 Comparison of NASA-TLX Cognitive Effort with Translated Words: Construed

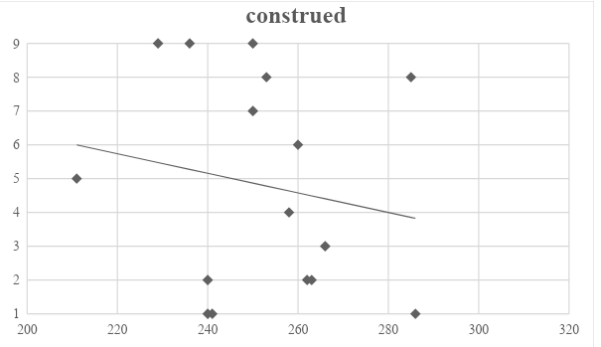


Figure 15 Comparison of NASA-TLX Cognitive Effort with Translated Words: Marginal

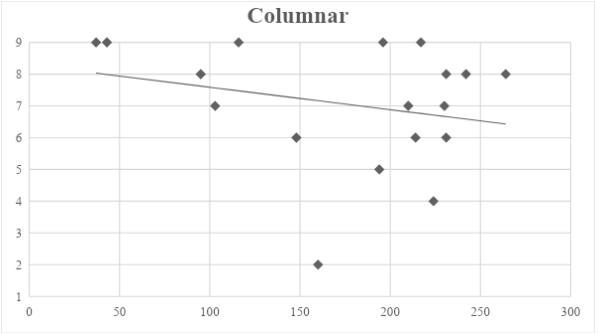
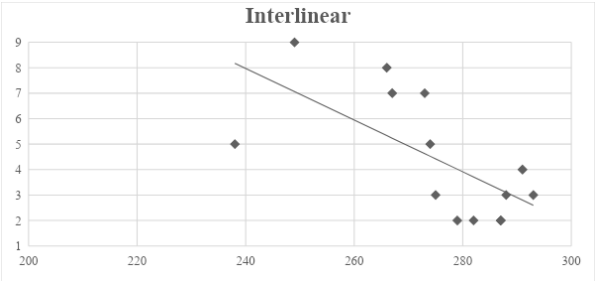


Figure 16 Comparison of NASA-TLX Cognitive Effort with Translated Words: Interlinear



association (see Figure 14). Marginal and cognitive effort provided a negative correlation of r = -0.25, which is a weak association (see Figure 15). Interlinear and cognitive effort provided a negative correlation of r = -0.66, which is a moderate association (see Figure 16).

Discussion

ANOVA results suggest that participants assigned to the interlinear glossing condition obtained higher scores than the other two groups. This suggests a connection between the exposure to a simultaneous word-by-word version of an L2 text, and its exact word-by-word translation in an ensuing word recall and written translation task.

We can also observe on Figure 13 that the Pearson product moment coefficient of correlation shows the steepest slopes in the interlinear layout. This, in conjunction with the results of the translation task in both the first and second sessions, suggest that the interlinear condition had the strongest correlation with a higher proficiency: N (13), r = -0.66, p < 0.05. This implies that the participants that experienced an increased rate of cognitive effort, as measured by the NASA-TLX test, tended to recall less L2 meanings in L1 in all other conditions. Furthermore, the fact that the results of cognitive effort did not perfectly line in a correlation with our measures of word recall might be an indicator that other task-specific factors are influential to predict the outcome of a task requiring L2 reading and word recall.

In the same line, the lack of a significant correlation between the construed and marginal conditions with the NASA-TLX test suggest a trade-off effect among different glossing types and the facilitative effect of the layout of L2 and L1 words in a page, as proposed by Elekaei et al. (2015) and Zarei & Hasani (2011).

It is noteworthy that the correlation trendlines among the translation task and prior exposure to English were consistent between self-perceived proficiency and glossing type. This shows that participants who self-ranked as more proficient were naturally more apt to translate more words, removing the potential confounding factor of English proficiency as a better predictor of results in translation. The overall averages of the translation tasks in each condition show a tendency for interlinear participants to outperform those of construed and marginal.

CLT may help understand this difference among groups. The attention shift required when fixating a reader's sight onto the L2 words and then changing to the L1 words is greater in the construed and marginal conditions than in interlinear arrangements. Therefore, the proximity of L2 and L1 words might lower the time required for WM to retain the morphosemantics of an L2 lexeme with its L1 meaning, and with the overall meaning of the sentence. Thus, we can infer that a

benefit of rearranging the typographical distribution of words in a text can assist readers in word recall when L2 and L1 words are grouped more closely. The longer the time to shift the readers' attention from the L2 word to its L1 equivalent can considerably decrease their chances of appropriately learning new words or understanding the text. Consequently, the results seem to corroborate prior studies in the literature regarding how access to glosses facilitates vocabulary recall (Çakmak & Erçetin, 2018), and incidental learning of new words from context (Huang & Lin, 2014).

The study also points out the differential importance of gloss type and meaning recall, in the sense that very concrete trade-offs exist in learners' performance on vocabulary learning and gloss types (Sadeghi et al., 2017). However, although it is an important first step, this study alone cannot fully address the issue of whether the distance between L2 and L1 words in a gloss carries a task-specific effect on cognitive effort and, likewise, word recall, as measured by the NASA-TLX and translation tasks, respectively. This might be due to the type of tests used, the limited number of participants, or another undetermined factor which produced little variance in the data between the interlinear and construed conditions in sessions 1 and 2.

Previous reports stated that ITs can be linked to reading capacity (Thompson, 1829). Also, L1 glossing can be associated to a significant quantitative advantage over a no-gloss condition (Al-Jabri, 2009), and to enhancement of word knowledge in an immediate retention task (Xu, 2010). Exposure to L1 and L2 sentence equivalents contribute to vocabulary retention (Hummel, 2010) and, more specifically, to a significant association in reading comprehension across two languages (Yau, 2011). Arguably, ITs aid during the task, which has been strongly linked to better performance compared to pre or post assistance when reading in a foreign language (Alessi & Dwyer, 2008). "Of this [interlinear] translation the obvious advantages are to save the trouble of looking for the words in a dictionary, and the difficulty of making a proper choice between various acceptations of the same words." (Carré, 1822, p. xxv).

These results also align with prior research that has found how glosses that result in higher scores of multiple-choice reading comprehension tests are effective due to the physical closeness between the glosses and the glossed words. Proximity reduces the attention split between the glosses and the text, decreasing memory load (Chen, 2016).

In sum, this study supports the claims by Zarei & Hasani (2011) on the improved performance of readers with interlinear glosses versus post-text glosses for vocabulary recall. It provides additional data to help answer current questions in applied linguistics, such as those by Azari et al. (2012) in their review of learning vocabulary with glosses, or Yanagisawa et al.'s (2020) meta-analysis on the effect sizes of glossing different conditions on readings. In the same vein, these data help guide the questions presented by Holley & King's (1971, p. 218) pioneer question of whether students trained to use glosses for learning would achieve higher scores if compared to a dictionary-only control condition. Equally important, our results confirm that, when comparing glossing conditions to an IT, performance is reduced in a translation task (Azari et al., 2012), which further validates the effect of variance on the type of gloss (L1 or L2) and its effects in a task of word recall (S. Choi, 2016). As a result, it would be in the best interest of researchers to replicate this methodology to find out whether durability in the memory span is achieved by ITs beyond one week, or if there is transferability of knowledge into other L2 contexts other than the text they read in this task, as suggested by Prince (1996).

It has been my intention with this work, not only to provide answers to questions that directly pertain to applied linguistics, but also to bring to the fore the importance of looking back into the past to see whether something was discarded based on scientific grounds or not. Thus, I could echo Spann's

words in 1937: "If this text succeeds in calling attention to the problem of learning with the aid of interlinear or bilingual texts, and in getting either a positive or a negative solution of it, the purpose in publishing it will have been accomplished." (p. v).

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