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Heritage Language Learners' Lexical Performance across Pair Types and (Non-)Digital Collaborative Writing Task Environments

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Abstract: A need exists to address how the availability of digital platforms plays a role in collaborative writing. Further, interest has emerged to understand heritage language (HL) learners' writing as a result of task-based peer interactions with either second language (L2) or HL learners across face-to-face (FTF) and synchronous computer-mediated communication (SCMC) modes. However, it remains unknown how pair type and interaction mode can influence advanced learners' lexical performance on written texts through measures of lexical richness. Therefore, this study tested 13 HL–L2 and 16 HL–HL dyads enrolled in advanced Spanish content courses who completed two writing tasks across FTF and SCMC modes. The writing tasks consisted of the hiring (Task A) and laying off (Task B) of an individual for known Spanish companies. The written texts were analyzed for lexical richness through lexical density, lexical sophistication, and lexical diversity indices. The main results revealed that the HL–L2 pairs significantly produced a higher ratio of lexical density in their written texts. No significant results were found for lexical diversity or lexical sophistication across pair types and interaction mode. These results imply that HL–L2 pairs distinguished the register of the writing task more so than HL–HL pairs.

Keywords: heritage language learners; task-based language teaching; synchronous computer mediated communication; writing tasks; lexical richness

1. Introduction

The rise of digital technologies across educational settings has certainly transformed pedagogical practices, which also includes the teaching of foreign/second/heritage languages (Blake and Guillén 2020; Thorne and Reinhardt 2008). Regarding the domain of writing in a second language (L2), Elola and Oskoz (2017) called for a better understanding of the affordances of digital platforms and tools in fostering the processes and products that result from collaborative writing in virtual spaces. This call has become even more critical given the recent COVID-19 pandemic that has forced language teachers and instructors to deliver instruction via digital platforms. As such, an urgent need has emerged to design collaborative tasks for remote teaching that would be effective in promoting L2 development in a digital environment (González-Lloret 2020). However, in addition to the important pedagogical implications that such inquiry entails, research on the effects of digital technologies on collaborative writing has theoretical implications for language development and performance within pedagogical models such as task-based language teaching (TBLT). TBLT is an educational framework for the teaching of L2 based on empirical evidence that examines tasks as the central unit for the design of classroom activities and assessment (Van den Branden et al. 2009). Further, technology-mediated TBLT addresses the synergy between tasks and the use of technology. Within technology-mediated TBLT, tasks are characterized as language activities that imitate the real world with a primary focus on meaning, during which L2 learners primarily utilize their own linguistic resources to meet a communicative purpose. Tasks should also give L2 learners an opportunity to reflect on

their learning (see González-Lloret and Ortega 2014). A recent qualitative synthesis of 16 studies revealed that technology-mediated tasks facilitated L2 learners' collaborations and interactions as well as their development of positive attitudes towards language learning (Chong and Reinders 2020). Regarding writing tasks, though, Manchón (2014) has highlighted that task environments or conditions and learner factors together can conspire in determining writing outcomes. This is particularly in line with recent theoretical claims that learners' completion of tasks under different conditions such as face-to-face (FTF) and synchronous computer-mediated communication (SCMC) can play a bigger role than the task features themselves, such as the number of items in a task (Skehan 2016).

However, in testing the theoretical claims of the interplay between task environment and learner factors in the TBLT literature, an important population of learners that has received less attention are heritage language (HL) learners, who are increasingly more present in language courses, especially for languages such as Spanish and Korean in the United States (US) context (Hur et al. 2021). Unlike L2 learners, HL learners are typically early bilinguals who acquired their heritage or family language, which is a minority language in the society at large, at home to engage mostly in speaking and listening modes of communication. In other words, their acquisition of the HL is primarily in a naturalistic environment through oral modalities. Therefore, in the US context, adult HL learners are native bilingual students who enter the classroom setting with some functional knowledge of the family language along with English, the majority language of the society (Valdés 2001). Given this reality, the field of instructed HL acquisition has developed within HL studies (Montrul and Bowles 2017; Bowles 2018) to address the effects of pedagogical interventions in HL learners' development of the HL. Along these lines, an exploratory meta-analysis revealed that instruction has a moderate positive effect on HL learning (Bowles and Torres 2021). Yet, we need a better understanding of what instructional features and conditions are most beneficial for HL learners, given their prior language experience with the HL (Bowles 2018; Sanz and Torres 2018), especially to provide evidence-based pedagogical recommendations.

Within instructed HL acquisition, a few studies have adopted a TBLT framework to examine how HL learners engage with communicative tasks, which can be in conjunction with corrective feedback, explicit grammar instruction and/or peer interactions (Blake and Zyzik 2003; Kang 2010; Bowles 2011; Bowles et al. 2014; Henshaw 2015; Kim et al. 2018; Torres 2018, 2020; Torres and Cung 2019). These studies have begun to shed light onto how HL learners respond to task features and conditions, including the use of writing tasks as part of the study design (Bowles 2011; Henshaw 2015). Further, Torres and Cung (2019) and Torres (2020) investigated a group of Spanish HL learners' interactional moves and language performance resulting from the completion of writing tasks across different pair types and FTF and text SCMC modes. Among these TBLT studies with HL learners, however, we still know very little about the lexical richness of the texts they produce as a result of engaging with written tasks, especially in a digital environment. Therefore, the goal of this study is to investigate whether advanced HL learners' collaborative writing efforts across HL–L2 and HL–HL pair types as well as FTF and SCMC task environments have an effect on lexical richness, as measured by lexical density, lexical diversity and lexical sophistication indices.

1.1. Lexical Development in HL Speakers

As with other linguistic domains such as morphosyntax and phonology, several factors can determine HL learners' lexical knowledge. Such factors can include the context in which HL learners mostly use the HL, proficiency level, the frequency of use, timing of acquisition and word type, among others (Montrul 2016b; Fairclough and Garza 2018; Zyzik n.d.). Given the early bilingual experience of HL learners, it is no surprise that their lexical knowledge is significantly shaped by their context using the HL in the home and/or community to engage in communication. Based on a few empirical studies, adult HL speakers seem to arrive to the instructed setting with relatively easy access to lexical

items that are acquired early, are frequent and belong to concrete semantic fields (Polinksy 2006; Montrul and Foote 2014).

Further, HL speakers' lexical abilities are seemingly contingent on whether HL speakers are required to demonstrate receptive or productive lexical knowledge during an experimental task. Evidence exists that receptive HL bilinguals of Spanish, with little production abilities in the HL, can demonstrate a knowledge of 3000 Spanish words, which is consistent with the proposed minimal number of words that are shared by a speech community (Fairclough 2013). Productive lexical abilities will vary according to word type and proficiency levels. A few studies with Spanish HL speakers have documented that lexical knowledge in the production of written texts is determined by level of Spanish proficiency and years of studying Spanish in an instructed setting (see Fairclough and Garza 2018 for a review). Both proficiency and formal study are particularly critical for the learning of more specialized and abstract vocabulary used in academic settings, which is a domain that HL speakers need to develop (Valdés and Geoffrion-Vinci 1998; Swender et al. 2014). Zyzik (n.d.) also argued that lower frequency words, especially those that only appear in certain registers, can be challenging for HL speakers.

In sum, the acquisition of lexical knowledge among HL speakers is a complex process that is dictated by a number of variables. According to HL scholars, to date, we still have little research that has investigated lexical development and performance issues among HL speakers, even within Spanish studies (Montrul 2016b; Fairclough and Garza 2018; Zyzik n.d.). Nevertheless, studies point out that the experience of the HL speaker is critical in determining the size and depth (productive abilities) of their vocabulary knowledge. As part of this experience, it seems that HL speakers' formal classroom exposure to the HL is a key determinant of their lexical development, especially with regard to productive abilities. Within instructed contexts, then, a need exists to further understand how HL learners deploy their lexical knowledge to complete classroom tasks and activities. More specifically, in line with the goal of this study, one way to analyze HL learners' lexical performance in their execution of written tasks is through measures that estimate lexical richness. Measures of lexical richness aim to quantify how learners use the breadth and variety of their lexical knowledge to produce written texts (Laufer and Nation 1995; Kyle 2019).

1.2. Lexical Richness and HL Learners

L2 vocabulary acquisition studies have typically employed three different lexical constructs—lexical density, lexical diversity, and lexical sophistication—to capture the lexical richness of written language production. The first construct is lexical density, which refers to the ratio of lexical words to the total number of words in a written text (Engber 1995). Lexical or content words are those that belong to open-class categories of nouns, adjectives, a majority of verbs and some adverbs that convey the primary information of a text, whereas function words belong to closed-class grammatical word categories such as discourse markers and prepositions (Laufer and Nation 1995; Kyle 2019). Therefore, a text is considered lexically dense when it contains a high number of lexical words and fewer function words in relation to the total number of words. In his recent review, Kyle (2019) argued that lexical density appears to be a more useful construct to distinguish modes or registers of language rather than lexical proficiency, as studies have not really found significant strong relationships between lexical density and writing proficiency. The second construct is lexical diversity and has been broadly defined as capturing the range or variety of vocabulary produced (Durán et al. 2004; Yu 2009; Jarvis 2013). Jarvis (2013) also operationalized lexical diversity as "the proportion of words in a language sample that are not repetitions of words already encountered" (p. 88). The basic measurement has been a type to token ratio, in which different words are divided by the total number of words in a text. According to Tracy-Ventura (2017), the third construct, lexical sophistication, represents a learner's ability to use advanced vocabulary. Advanced vocabulary is determined by an index of low frequency words in a given language. Low frequency words are

considered any word that falls below the 2000 most frequent words in the Spanish language (Davies 2006). In Spanish L2 lexical studies, for instance, scholars rely on corpora, such as the one from Davies (2006), to determine the frequency of Spanish words. The current study, therefore, adapts lexical richness as a superordinate construct that is captured by lexical density, lexical diversity, and lexical sophistication indices (Jarvis 2013) to examine HL learners' lexical performance in producing written texts.

While these lexical measures have been widely used in L2 acquisition studies, HL scholars have also adapted them to examine written texts, particularly those produced by HL learners of Spanish. It is important to note that the following published studies reported on different measures of writing, but we will only focus on lexical measures. In a pilot study, Fairclough and Belpoliti (2016) reported on the lexical richness of essays written by receptive Spanish HL learners, as part of a placement test, and who enrolled in a first-year college Spanish course. For lexical density, the findings indicated a rather balanced distribution between content and function words (46%), which, according to the authors, is indicative of oral production markers in their writing. With regard to lexical sophistication, the participants produced 92.90% of lexical items classified in Davies' (2006) list of 1000 most frequently used words in Spanish. Finally, the findings also revealed a low ratio index for lexical diversity, which indicates repetition of words with little variation. Jegerski and Ponti (2014) examined the role of peer and instructor feedback on writing drafts of Spanish HL learners enrolled in an advanced Spanish composition course. The authors found that feedback led to a significantly higher word count in later writing drafts, but it had no impact on lexical density. More recently, Bowles and Bello-Uriarte (2019) investigated the impact of one semester of Spanish instruction on HL learners' writing development, and this included lexical richness measures. Bowles and Bello-Uriarte found that instruction had a moderate impact (d = 0.433) on the development of lexical sophistication in their writing. According to the researchers, these results imply that instructed HL speakers' vocabulary became more sophisticated, as they used a greater ratio of low frequency words. No significant gains were found for lexical density or lexical diversity.

These studies indicate that the use of lexical measures can provide insight into how instruction can play a role in HL writing. While Fairclough and Belpoliti (2016) did not report on the effects of instruction per se, the measures were useful to understand the lexical abilities that HL learners can gain in their homes/communities, and thereby, bring with them into a classroom setting. Importantly, having more than one lexical measure as part of the data analysis can offer a more nuanced breakdown of the aspects of lexical performance and development that can be facilitated or impervious to instruction. This will lead to future research synthesis that would allow researchers to make more precise evidence-based recommendations for vocabulary instruction with HL learners. However, based on these studies, it is very premature to draw any conclusions on the role of instruction, especially regarding measures of lexical richness. It is no surprise that the field lacks instructed studies that have investigated HL learners' lexical performance, given the overall lacuna of vocabulary studies in the field (Montrul 2016b). Therefore, the main goal of this study is to contribute to the growing body of instructed HL studies, particularly on examining a task-based approach to compare HL learners' lexical performance on their writing in (non)digital environments as well as in pairs with HL or L2 peers.

1.3. Task-Based Collaborative Writing Studies with HL Learners

TBLT is a pedagogical model that is compatible with recommended macrobased teaching approaches to HL learners (Carreira 2016). According to Carreira (2016), a macrobased approach prioritizes grammar and vocabulary instruction in the context of examining "big ideas in a text" (Carreira 2016, p. 125). In other words, instructors tackle lexical and grammatical forms with students, as these forms emerge from learners' engagement with the meaning and ideas of the text. With a task-based approach, however, learners are not necessarily analyzing texts, but rather, are engaging in communication that is relevant to how language is used in the real world to meet a communicative goal or solve a problem

(Long 2015; Ellis 2018). Task-based approaches have been instrumental for the design of languages for professions courses such as Business Spanish (Serafini and Torres 2015; Torres and Serafini 2016). This is also applicable in the field of HL studies given the attention to Spanish for professions courses for HL learners (Abbott and Martínez 2018). Of relevance also, among the different pedagogical models for HL instruction such as project-based learning, learning by design, translanguaging and others (Carreira and Chik 2018; Zapata and Lacorte 2017; Pascual y Cabo and Torres n.d.), most of the current empirical evidence in the field has derived from task-based studies with HL learners. Yet, it is important to note that more studies are needed across different pedagogical models to provide evidence-based recommendations to HL practitioners (see Torres n.d.).

Within these task-based studies, a few have examined how the specific design of collaborative writing tasks leads to learning opportunities that emerge from interactional moves such as language-related episodes and corrective feedback. According to accounts of the interactionist approach (Long 1996; Mackey et al. 2012; Gass and Mackey 2015; Loewen and Sato 2018), these learning opportunities partly emerge through interactional moves that draw learners' attentional resources to language forms in the input, while they engage in a meaning-oriented task. In task-based collaborative writing studies with HL–L2 pairs, for instance, Bowles (2011) found that HL and L2 learners generated language-related episodes (i.e., dialogue about language issues while completing meaning-oriented tasks), but they differed according to the type of language-related episode each pair type generated. That is, HL learners had more questions about spelling and accent placement, whereas L2 learners needed assistance with vocabulary and a few grammatical issues. Henshaw (2015) also examined HL–L2 pairs completing a writing task, and her findings revealed that L2 learners significantly triggered conversations about language forms such as lexical, orthographic, and grammatical items more often, and these were mostly resolved by HL learners during the collaborative writing process. Results from an immediate posttest showed that L2 learners significantly utilized the target forms they learned during their peer interactions more often than the HL learners. These studies reveal the ways in which HL and L2 learners utilize their linguistic resources to collaborate in meeting writing task goals. It is important to note that these HL–L2 collaborative writing interactions in both Bowles (2011) and Henshaw (2015) occurred in the FTF mode.

More recently, though, in response to the affordances of technology that have enabled the creation of digital platforms for collaborative writing (Thorne and Reinhardt 2008; Elola and Oskoz 2017; Zheng et al. 2018), a couple of studies have begun to document how HL learners tackle writing tasks in a digital environment when collaborating with another HL or L2 learner. Torres and Cung (2019) investigated the interactional moves such as language-related episodes that emerged from the writing collaborations between HL–HL and HL–L2 advanced learners of Spanish across FTF and text SCMC environments. The findings revealed that both HL–HL and HL–L2 pairs significantly produced more language-related episodes in FTF but self-repaired their non-target-like utterances more often in SCMC mode. In fact, HL–HL pairs only demonstrated self-repair utterances in the SCMC mode, which indicates that the SCMC condition was more effective in drawing HL learners' attention to language forms. In another study with the same participants, Torres (2020) examined morphosyntactic (e.g., noun–adjective gender agreement, subject–verb agreement) and spelling accuracy as well as syntactic complexity (e.g., dependent clauses, coordinate phrases) of the written texts each pair produced across FTF and SCMC interaction modes. The main results demonstrated that SCMC mode had an overall effect on the level of syntactic complexity each pair type produced, especially the HL–L2 pairs. Specifically, the SCMC mode led to a greater ratio of coordination in the written texts. That is, the dyads produced more coordinate phrases per T-unit in SCMC, which is often associated with lower levels of proficiency (Bardovi-Harlig 1992). According to data from debriefing questionnaires, these results may be due to the fact that HL learners reported that it was more challenging to complete the writing task in the SCMC mode (e.g., "I learned that it doesn't come as easy to communicate when it comes to accomplishing

the task over chat"). Therefore, this may have compromised their cognitive resources to produce more instances of subordination in their written texts, which requires more cognitive effort.

The results in both Torres and Cung (2019) and Torres (2020) imply that engaging in task-based collaborative writing in a digital environment (text SCMC mode in this case) can have an impact on how HL–HL and HL–L2 pairs monitor their language production as well as the syntactic complexity of their written texts. Torres (2020) supports theoretical claims in TBLT that the interplay between task environments (FTF, SCMC) and learner factors (HL–HL, HL–L2 pairs) can determine writing outcomes (Manchón 2014). Moreover, Skehan (2016) has argued that the task environment or condition, and not task features that can make a task more or less complex, can play a larger role in how learners respond to task-based instruction. However, more research is needed to further document how a digital environment can affect writing outcomes with HL learners. Of relevance also, it appears that not all linguistic domains may be equally affected by task-based collaborative writing in a digital environment. For instance, in Torres (2020), syntactic complexity was compromised in the text SCMC environment, yet both HL–HL and HL–L2 learners demonstrated comparable morphosyntactic and spelling accuracy in the written texts completed across FTF and SCMC modes. However, to the best of our knowledge, to date, no study has examined whether HL learners' involvement in collaborative writing texts in a digital environment has an effect on the lexical richness of the written texts. Therefore, this study examines the written texts produced by the same HL–HL and HL–L2 pairs in Torres (2020) across FTF and text SCMC modes for lexical richness measures—lexical density, lexical diversity, and lexical sophistication.

1.4. Research Questions

The previous literature points out that the field of instructed HL acquisition needs studies examining the lexical performance of HL learners when they engage in collaborative writing tasks in a digital environment. Adopting a technology-mediated TBLT framework, the current study investigates the lexical richness in written texts produced by HL learners when they interact with a HL or L2 learner and across FTF and text SCMC interactional modes. Therefore, the following research questions were considered:

1. To what extent does lexical richness differ between mode of interaction (FTF, SCMC) dyads, as measured by lexical density, lexical diversity, and lexical sophistication indices?
2. To what extent does lexical richness differ between HL–L2 and HL–HL dyads, as measured by lexical density, lexical diversity, and lexical sophistication indices?

2. Materials and Methods

2.1. Participants

A total of 58 participants, of which 49 identified as female and 13 were L2 learners, who were enrolled and recruited from advanced Spanish content classes in a mid-size public university in Southern California, participated in the current study. The average age of the HL participants was 20.89 (*SD* = 1.72), and 21 (*SD* = 1.11) for the L2 participants. All participants completed an electronic language background questionnaire via Survey Monkey (Torres 2013) to determine their language history and Spanish–English bilingual experience. Based on the language background experience, the HL participants reported learning Spanish and English during early childhood, whereas L2 participants began learning Spanish in their young adulthood years while in secondary schools. HL and L2 participants also reported on the frequency of their Spanish and English use across a number of settings such as home, work and school. For language use, then, participants answered a few questions on a five-point Likert scale, which ranged from always to never, about their Spanish and English use (e.g., "I speak Spanish with my friends in my neighborhood"). We calculated a composite score for each participant by adding their ratings for the questions on language use in English and Spanish. Both HL (*M* = 75.20,

SD = 8.24) and L2 (*M* = 77.40, *SD* = 8.90) groups used English with comparable frequency, but HL participants used Spanish more frequently (*M* = 57.50, *SD* = 10.78) than their L2 peers (*M* = 42.40, *SD* = 10.99).

To estimate the participants' proficiency levels in Spanish, we administered a modified version of the DELE (Diploma of Spanish as a Foreign Language) test, which consisted of a fill-in-the-blank vocabulary section and a cloze passage. This modified version of the DELE has been validated and used in studies with HL speakers in the United States (see Montrul 2016a). Participants could receive up to a total of 50 possible points by adding up the correct answers of the DELE test. We analyzed the DELE results for each group, and a significant difference (*t*(20.7) = 5.3, *p* < 0.01) emerged between the HL and L2 groups in which the HL participants had, on average, a higher DELE score (*M* = 40.30, *SD* = 5.51, *Max.* = 48, *Min.* = 23) than the L2 participants (*M* = 30.80, *SD* = 6.07, *Max.* = 41, *Min.* = 16).

At the time of the study, all participants were enrolled in advanced Spanish linguistics and/or literature content courses from where they were recruited. Participants must demonstrate knowledge equivalent to three years of college-level Spanish through a placement exam or coursework to take advanced content courses. With regard to participants' years of Spanish study, L2 participants (*M* = 6.18, *SD* = 1.47) significantly studied Spanish for longer than HL participants (*M* = 4.48, *SD* = 2.47), as revealed by an independent samples *t*-test (*t*(44) = −2.14, *p* = 0.03).

Overall, our HL participants were early bilinguals who used English more frequently in their daily lives and were more proficient in Spanish than L2 participants. The L2 participants, on the other hand, were late bilinguals, used English more often and were less proficient in Spanish. The HL participants used Spanish more frequently in their lives than their L2 peers, but L2 participants significantly had more classroom experience with Spanish. Based on the DELE test, participants were paired to match their proficiency levels as closely as possible. The HL–L2 pairs were matched first and then, the remaining HL participants into HL–HL pairs, which gave a total of 13 HL–L2 and 16 HL–HL dyads.

2.2. Decision-Making/Writing Tasks

For the study, two decision-making/writing tasks were designed, in which participants had to play the role of business consultants (see Torres and Cung 2019). One task version required participants to recommend the hiring of an individual, whereas, for the other task version, participants needed to recommend the laying off of an employee. For both tasks, first, the dyads had to collaborate to select an individual from a list of six profiles to recommend for hiring or laying off. Then, participants were instructed to handwrite a letter to the CEO of the company justifying their reasons for selecting that individual. To promote mutual collaboration and to avoid scribe effects (e.g., Henshaw 2015), the participants each wrote their own draft, but they needed to make sure they produced the exact wording on their individual drafts. It is important to note that each dyad completed both task versions, one in FTF mode, and the other through text SCMC via Skype. For the text SCMC mode, participants interacted using only the written chat box function in Skype due to its free availability. To establish that participants' task performance was not compromised by their motivation to complete each task version, participants completed a brief questionnaire to measure their level of motivation following each task version, which has been used in previous studies (Torres and Serafini 2016). No significant differences emerged between learners' motivation in completing each task version, *t*(115) = 0.93, *p* = 0.354, which indicates that any observations on their lexical performance were not due to participants' task-specific motivation.

2.3. Procedure

Once participants consented to participate in the study, for which they would receive extra credit, during the first session, participants completed the DELE test and the language background questionnaire. As previously stated, participants were put into dyads based on the DELE scores. For the second session, each dyad completed the two decision-

making/writing tasks, the task-specific motivation survey and debriefing questionnaire (e.g., Did your partner help you with Spanish? If yes, how so?; What was the most difficult part about the task?) about their perceptions on the writing collaboration. Each dyad was randomly assigned to one of four conditions that were counterbalanced by task version and interaction mode. Participants' interactions in FTF mode were recorded with Audacity 2.0, a free and open-source digital editor and recorder software, and a digital recorder for later transcription and coding. The written text from the Skype chat box was copied and pasted to a Word document for coding. All the participants completed both sessions of the study.

2.4. Coding Procedure

2.4.1. Lexical Density

According to Laufer and Nation (1995), a text is considered dense when the number of lexical words (e.g., nouns, adjectives, verbs), which are words that primarily convey meaning, is relatively higher than the number of functional words (e.g., prepositions). In Figure 1 below, words such as *despedir* (to fire) and *gastos* (expenses) are examples of lexical items, while words such as *para* (for) and *ella* (she) are functional words. To measure lexical density, we first identified the part of speech of every word. Then, nouns (except for proper nouns), adjectives, verbs, and adverbs were classified as lexical items. It is important to note that all words regardless of spelling were included in the analysis because the aim was to assess lexical density, and not spelling errors. Lastly, lexical density was calculated by dividing the total number of lexical items per the total number of words in the text. This indicated the ratio of lexical/content words in comparison to functional words, as illustrated by the following formula:

$$\text{Number of lexical items} * 100 / \text{Total number of words}$$

2.4.2. Lexical Diversity

We calculated the type to token ratio to measure the lexical diversity of each text. One limitation of the type to token ratio is its sensibility to text length (Owen and Leonard 2002). Thus, we first analyzed whether there were significant differences in text length (measured by total word count) across pairs (HL–HL, HL–L2) and modality (FTF, SCMC). Text length did not vary across pairs, $t(56) = 0.801$, $p = 1.426$, nor across modalities, $t(56) = 1.431$, $p = 0.158$. Given the fact that text length did not significantly differ, we continued with type to token ratio as a measure of lexical diversity (Bérubé et al. 2018).

Malvern et al. (2004) explain that "[a]ll the words in a language sample are tokens, but each individual word is a type" (p. 19). Therefore, one word *type* may be repeated several times in a text, resulting in multiple *tokens*. In Figure 1, while the verb *es* (inflected form of 'to be') occurs several times in the text, it is only counted once as a word type. We used AntConc (Anthony 2014), an online corpus analysis toolkit, to extract and count word types in each text. Finally, as illustrated in the formula below, the lexical diversity of each text was calculated by the proportion of word types to the total amount of tokens.
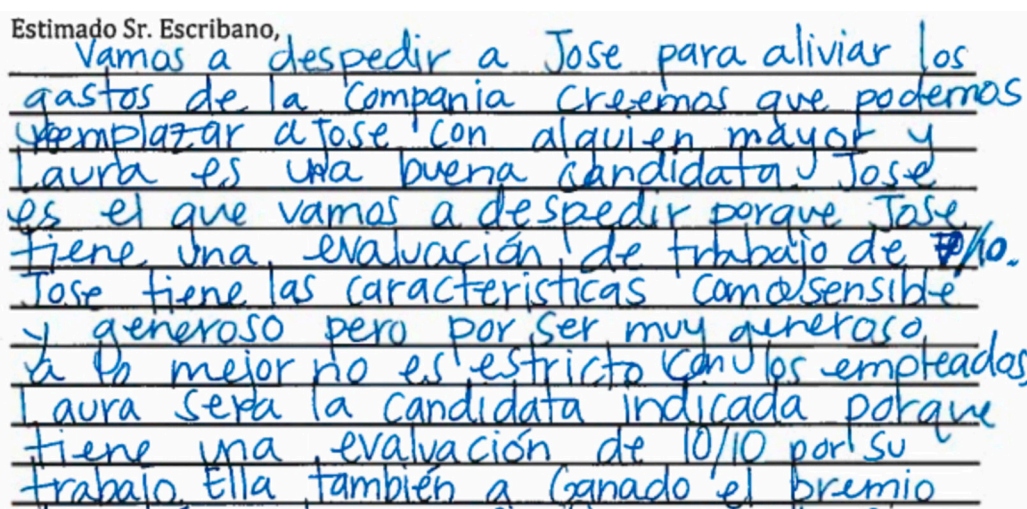
$$\text{Number of word types} * 100 / \text{Total number of words}$$

2.4.3. Lexical Sophistication

The use of low frequency words in a text is a sign of lexical sophistication (Kyle 2019). We coded the ranking of every lexical item based on a frequency index (Davies 2006). The higher the ranking, the more advanced and sophisticated the word. Following the methodology of other studies (e.g., Bowles and Bello-Uriarte 2019), any word beyond the first 2000 most frequent words in Davies' (2006) frequency dictionary was considered a sophisticated word. For example, in Figure 1, the word *vamos* (inflected form of 'to go') has a ranking of 30, while *generoso* (generous) has a ranking of 2398. The former is an example of a frequent non-sophisticated word, while the latter is an infrequent sophisticated word.

The ranking of verbs was extracted by looking at their infinitive form, while nouns and adjectives were coded using their masculine singular form. Words that were not found in the frequency dictionary (7.6% of lexical items) were eliminated from the data analysis. These eliminated words included *la evaluación* ('the evaluation') and English borrowings such as *marketing.* Furthermore, since functional words are typically highly frequent words (Schmauder et al. 2000), we did not code their ranking. In the end, the lexical sophistication of a text was calculated by dividing the total number of sophisticated words by the total word count, as it is illustrated by the following formula:

Number of sophisticated lexical items (2000 + ranking) * 100/Total number of words

Figure 1. Sample letter (HL–HL pair, SCMC mode). "Dear Mr. Escribano, we are going to lay off Jose to alleviate the expenses of the company. We believe that we can replace Jose with someone older and Laura is a good candidate. Jose is the one that we will lay off because Jose has a work evaluation of 7/10. Jose has the characteristics of being sensitive and generous but for being so generous, maybe he is not strict with the employees. Laura will be the suitable candidate because she has an evaluation of 10/10 for her work. She has also won the prize".

3. Results

With regard to our statistical reasoning to address the two research questions in the current study, we used a multivariate analysis of variance (MANOVA) due to the number of dependent variables. Based on Larson-Hall's (2010) recommendations, we checked that our data met the assumptions to run the MANOVA and any relevant subsequent ANOVA analyses. In screening our data, we found a violation of multivariate normality based on a Shapiro–Wilk test ($p < 0.001$). This violation was due to a positively skewed distribution for the lexical sophistication results. As such, we log-transformed our lexical sophistication data in R, which addressed the multivariate normality issue. At this point, we were able to conduct our MANOVA analysis.

In the current study, the first research question addressed to what extent does lexical richness, as measured by lexical density, lexical diversity, and lexical sophistication indices, differ according to FTF and SCMC interaction mode. Table 1 displays the descriptive statistics (mean, standard deviations, minimum score, maximum score) for each lexical richness measure across FTF and SCMC modes. For lexical density, the average score was 53.77 ($SD = 3.15$, *Min.* = 48.66, *Max.* = 63.16) for FTF and 53.06 ($SD = 3.37$, *Min.* = 46.40, *Max.* = 62.50) for SCMC mode. An average score of 67.01 ($SD = 8.51$, *Min.* = 51.22, *Max.* = 79.63) was found for lexical diversity in the FTF mode and 64.92 ($SD = 9.86$, *Min.* = 48.45, *Max.* = 97.06) in the SCMC mode. The mean score for lexical sophistication for the FTF mode was 5.15 ($SD = 3.86$, *Min.* = 0.00, *Max.* = 7.98) and 5.75 ($SD = 2.51$, *Min.* = 0.00, *Max.* = 11.94) for the SCMC mode. These scores were entered into the MANOVA analysis. The MANOVA

analysis revealed a non-significant finding, Pillai's Trace = 0.02, $F(3, 54) = 0.524$, $p = 0.66$. Therefore, overall, lexical richness did not differ according to FTF and SCMC mode.

Table 1. Descriptive statistics for lexical density, lexical diversity, and lexical sophistication across FTF and SCMC interaction modes.

Interaction Mode	Lexical Density	Lexical Diversity	Lexical Sophistication
FTF [a] (*n* = 29)	53.77 [c] (3.15) [d]	67.01 (8.51)	5.15 (3.86)
	[48.68 [e], 63.16 [f]]	[51.22, 79.63]	[0.00, 7.98]
SCMC [b] (*n* = 29)	53.06 (3.37)	64.92 (9.86)	5.75 (2.51)
	[46.40, 62.50]	[48.45, 97.06]	[0.00, 11.94]

Note: [a] = face-to-face; [b] = synchronous computer-mediated communication [c] = mean; [d] = standard deviation; [e] = minimum; [f] = maximum.

The second research question was concerned with the extent to which lexical richness, as measured by lexical density, lexical diversity, and lexical sophistication indices, differed according to HL–HL and HL–L2 pair types. Table 2 demonstrates the descriptive statistics (mean, standard deviations, minimum score, maximum score) for each lexical richness measure for HL–HL and HL–L2 pair types. The findings showed that HL–HL pairs' mean score for lexical density was 52.27 (*SD* = 2.64, *Min.* = 46.40, *Max.* = 56.38), and 54.83 (*SD* = 3.42, *Min.* = 48.69, 63.16) for the HL–L2 group. The HL–L2 pairs had an average score of 66.20 (*SD* = 10.69, *Min.* = 48.45, *Max.* = 97.06) for lexical diversity, while the HL–HL pairs had a mean score of 65.76 (*SD* = 7.94, *Min.* = 48.69, *Max.* = 79.63). For lexical sophistication, HL–L2 pairs' mean score was 5.00 (*SD* = 2.59, *Min.* = 0.00, *Max.* = 7.98). HL–HL pairs' average score for lexical sophistication was 5.82 (*SD* = 3.69, *Min.* = 1.14, *Max.* = 18.52) and 5.00 (*SD* = 2.59, *Min.* = 0.00, *Max.* = 7.98) for HL–L2 peers. The scores were also entered in a MANOVA analysis. A statistically significant MANOVA effect was found, Pillai's Trace = 0.17, $F(3, 54) = 3.56$, $p = 0.02$. This finding indicates that lexical richness did differ according to HL–HL and HL–L2 pair type. To determine the dependent variable(s) for the significant finding, subsequent univariate one-way ANOVAs were run. One significant univariate one-way ANOVA was found for lexical density, $F(3, 54) = 10.39$, $p = 0.002$, *partial* $n^2 = 0.156$. The effect size was estimated at 0.156, which indicates that about 16% of the variance in lexical density scores was due to HL–HL and HL–L2 pair type.

Table 2. Descriptive statistics for lexical density, lexical diversity and lexical sophistication across HL–HL [a] and HL–L2 [b] pair types.

Pair Type	Lexical Density	Lexical Diversity	Lexical Sophistication
HL–HL pairs (*n* = 32)	52.27 [c] (2.64) [d]	65.76 (7.94)	5.82 (3.69)
	[46.40 [e], 56.38 [f]]	[48.69, 79.63]	[1.14, 18.52]
HL–L2 pairs (*n* = 26)	54.83 (3.42)	66.20 (10.69)	5.00 (2.59)
	[48.98, 63.16]	[48.45, 97.06]	[0.00, 7.98]

Note: [a] = heritage language; [b] = second language; [c] = mean; [d] = standard deviation; [e] = minimum; [f] = maximum.

4. Discussion

The current study sought to investigate HL learners' lexical performance on written texts composed across FTF and text SCMC interaction modes with a HL or L2 peer. The study is grounded on the interactionist approach (Gass and Mackey 2015) and TBLT theoretical claims that the interaction between task environment and learner factors can have an effect on writing outcomes (Manchón 2014). Furthermore, in line with calls to examine how digital platforms can potentially transform collaborative writing practices in educational settings (Elola and Oskoz 2017), more research is needed to understand its effects on learners' linguistic performance. This study also builds on previous work that

gauged the accuracy and syntactic complexity of written texts produced by the same HL–HL and HL–L2 pairs from the current study across FTF and SCMC modes (Torres 2020). As such, considering how pedagogical interventions can have differential effects depending on the linguistic domain, we extended the analysis to include lexical richness, as captured by lexical density, lexical diversity, and lexical sophistication measures.

The first research question was concerned with the contrastive role of FTF and SCMC modes on the lexical richness of collaborative written texts produced by both HL–HL and HL–L2 pair types. Overall, the results revealed no significant differences with regard to the lexical richness of the written texts between both interaction modes. Put differently, whether the HL–HL and HL–L2 pairs were interacting in FTF or SCMC modes, the interaction mode did not alter their lexical performance. It is important to recall that, in the current study, each HL–HL and HL–L2 pair completed two writing tasks across both modes. As such, this minimized any potential confluence of individual differences that can emerge when employing a between-subjects design, in which each pair would only contribute one data point. The results of the study align with Torres (2020) in the areas of morphosyntactic and accent placement accuracy. That is, in addition to accuracy, a digital collaborative writing environment appears to not have an impact on advanced HL–HL and HL–L2 learners' ability to produce a lexically rich written text. These findings are in contrast, however, to the SCMC mode having an impact on the syntactic complexity of written texts produced by the same participants in Torres (2020). The overall trend was that both HL–HL and HL–L2 pairs produced a greater ratio of subordination (i.e., number of dependent clauses per T-unit), which is considered a high level of syntactic complexification, in collaborative written texts that were generated in FTF mode.

These combined findings point out that the effects of a digital collaborative writing environment that involves advanced HL–HL and HL–L2 pairs is contingent on the linguistic domain in question. Unlike for syntactic complexity, for instance, it seems that advanced HL–HL and HL–L2 learners can retrieve the same range of Spanish vocabulary items from their mental lexicon independent of a (non)digital environment when executing a writing task. Arguably, this could be attributed to the lower cognitive demands necessary to recall lexical items. In the case of syntactic complexity, however, it requires more cognitive effort to linguistically encode idea units to convey clear and elaborate written content. This observation in conjunction with the effects that written modality has on HL learners' approach to instruction (Torres n.d.b) can determine their ability to produce a higher level of syntactic complexification such as subordinate clauses in their written texts. This preliminary observation needs to be replicated with HL–HL and HL–L2 pairs at different proficiency levels and with less formal classroom Spanish experience, as these factors can potentially contribute to the effects of (non)digital collaborative writing environments on learners' linguistic performance. This is in light of some evidence that intermediate to advanced HL learners show significant improvements in their individual writing skills, especially in the areas of fluency, complexity, and lexical sophistication as a result of instruction (Bowles and Bello-Uriarte 2019).

The second research question addressed to what extent does lexical richness differ according to HL–HL and HL–L2 pair types. No significant differences were found for lexical diversity or lexical sophistication. However, the results revealed that about 16% of the variance in scores for lexical density were accounted for by pair type, with HL–L2 pairs producing a greater ratio of lexical density in their written texts. This indicates that HL–L2 pairs produced more dense texts than the HL–HL pairs, which is due to a higher number of content words (nouns, verbs, adjectives) vis-à-vis function words such as prepositions and pronouns in relation to the total word count of the written texts. According to Laufer and Nation (1995), an increase in syntactic complexity (subordination) can also mean an increase in lexical density, as the number of functional words decreases in dependent clauses. However, this was not the case with this learner population given that Torres (2020) found that the same HL–HL pairs from the current study significantly produced a higher ratio of subordination in comparison to their HL–L2 peers. As such, it is reasonable

to expect that the HL–HL pairs should have demonstrated a greater ratio of lexical density in their written texts. Further, Bowles and Bello-Uriarte (2019) found that while individual HL learners' written texts significantly increased in complexity, this was not the same case for lexical density. Therefore, both of these writing studies with HL learners do not support the claim made by Laufer and Nation (1995) regarding the relationship between lexical density and syntactic complexity.

Therefore, these findings must be examined with an understanding of the prior language experience of HL learners. That is, how does their early bilingual experience, which largely takes place in a naturalistic environment using the HL at home to engage in oral communication, explain this finding. First, it is important to recall that researchers consider lexical density as a useful measure to distinguish different registers (Kyle 2019). In their analysis of essays from an online placement test for HL learners with mostly receptive skills in the HL, Fairclough and Belpoliti (2016) reported that students produced a large number of functional words, which, according to the authors, is associated with an oral register and lower level of writing proficiency. This finding supports early claims in the field that HL learners make use of their oral register to compose written texts (Colombi 1997). As a result, while it also depends on the literacy skills they gain at home and in their local bilingual communities, many HL speakers, who enter a HL education program, will produce written texts with a low lexical density ratio because they are mostly relying on their oral communication skills. It is no surprise, therefore, that one of the main goals of HL programs is to help students develop written and formal registers in the HL (Beaudrie et al. 2014).

In the current study, for the writing task, our advanced HL–HL and HL–L2 pairs were required to use a written register to communicate in a business context. The average lexical density ratios of our HL–HL and HL–L2 pairs (see Table 2) were higher than the 46.4% reported in Fairclough and Belpoliti (2016), but comparable to the lexical density ratio of 54.68 in the argumentative essays produced after a semester of instruction by individual HL participants in Bowles and Bello-Uriarte (2019). These findings imply that HL learners with higher levels of written proficiency, which may be a result of formal Spanish study, produce more dense written texts. The novel finding of the current study that needs explanation, however, is why HL–L2 pairs produced more dense written texts than HL–HL pairs. The obvious difference between the two pair types is the L2 learner in the HL–L2 pair composition.

According to the debriefing questionnaire, the majority of HL learners in the HL–L2 pairs (58%) reported that their L2 partner assisted more with language issues during the execution of the writing task—e.g., "They helped correct me with words I thought were okay to use" and "I have trouble coming up with words quickly, so she was able to help a lot with that". In contrast, HL learners in the HL–HL pairs (52%) reported that they received more help from their partners with the brainstorming and organization of ideas for the business letters (e.g., "My partner gave ideas as to what we should write"). The two sample comments from the HL learners in the HL–L2 pairs indicate that L2 learners helped with the selection of lexical items for the business letters. Unlike HL learners, the prior language experience of L2 learners consists of more exposure to the L2 through written input. In fact, Hulstijn (2015) claims that L2 learners can reach higher language cognition knowledge, which can include a greater ratio of lexical density, especially in written discourse. Further, the L2 learners in the current study had significantly more classroom experience with Spanish than the HL learners. Arguably, then, L2 learners have more experience being exposed to more formal written registers of Spanish that were needed to produce more lexically dense business letters. On the other hand, the HL–HL pairs, while enrolled in advanced Spanish content courses, seemingly produce functional words to a greater extent, most likely due to their reliance on their oral register in the HL vis-à-vis their HL–L2 peers. This observation is also supported by their lesser experience with formal Spanish study and that they were perhaps more focused on addressing the content of the writing task rather than language issues.

Overall, these results suggest that instruction on written registers ought to continue for HL learners in advanced content courses of literature, linguistics, and Spanish for professions, among others. The writing task of this study is appropriate for a Business Spanish course. As such, given the interest in Spanish for the professional curricula for many HL learners who wish to use their HL in professional settings such as healthcare (Abbott and Martínez 2018), instructors need to address the use of different written registers that would allow for effective communication. For courses following a task-based framework for Spanish for professions, the analysis of register should be included in the pre-task (i.e., before students complete the task) and post-task (i.e., after students completed the task) phases of a lesson to make sure HL students are aware of their written production in different professional settings. One specific recommendation is to provide HL learners with writing models during the pre-task phase so that they can analyze and imitate the use of a particular register during the task execution phase.

5. Conclusions

The current study is not without its limitations. First, to further understand HL and L2 learners' specific contributions to the execution of collaborative writing tasks across FTF and SCMC environments, future writing studies should collect and analyze individual writing samples from all participants. Having these data would help researchers make more compelling claims about how each learner's writing proficiency made an impact on collaborative writing efforts. Second, this study could have included L2–L2 pairs to provide more robust observations about the role L2 learners played in producing more lexically dense texts. However, as the case is with many Spanish departments in the United States, especially in places such as Southern California, many Spanish majors and minors are HL speakers. In these cases, therefore, to echo Torres (2020), researchers may want to engage in multisite collaborations to include different pair types in the research design.

The goal of this study was to examine the roles of FTF and text SCMC interaction modes as well as advanced HL–HL and HL–L2 pair types in producing lexically rich written texts, as measured by lexical density, lexical diversity, and lexical sophistication indices. FTF and SCMC modes did not have an impact on each pair type's lexical performance, which indicates that interaction mode does not alter advanced learners' abilities to retrieve lexical items during collaborative writing tasks. With regard to the role of pair type, HL–L2 pairs significantly demonstrated a higher lexical density ratio in their written texts, which is a characteristic associated with a more advanced written register. These results were attributed to the contribution of the L2 learner in the writing collaboration, especially given their significantly longer study of Spanish in the classroom and their experience with the L2 through mostly written input.

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