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## Article

# Effects of Transcription Mode on Word-Level Features of Compositional Quality among French Immersion Elementary Students

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**Abstract:** Transcription is an important component of the writing process that affects the quality of children's compositions. However, little is known about how transcription mode influences productivity or spelling accuracy, two word-level markers of compositional quality, among children learning to write in an additional language. To address this issue, we compared the effects of handwriting and keyboarding on text length and spelling in the compositions of L2 French learners. Grade 2 to 4 students ( $n = 48$ ) in French Immersion were given two writing prompts and asked to produce one text on paper and one using a keyboard. The prompts were counterbalanced across the two writing conditions. The total number of words, total number of words spelled correctly, and proportion of correctly spelled words were calculated. A series of repeated measures ANOVAs revealed an advantage in both the average number of correctly spelled words and the proportion of correctly spelled words in the students' compositions favouring the keyboarding condition. Conversely, the total number of words across conditions was not significantly different. Our findings suggest that keyboarding may offer an advantage over handwriting with respect to spelling accuracy in the context of L2 composition in the elementary years.

**Keywords:** transcription modality; composition; text length; spelling accuracy; L2 French; French Immersion



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## 1. Introduction

Writing is a complex task that involves the integration of multiple skills to produce a text that reflects the writer's communicative intention (Cartwright 2015; Graham and Harris 2000). Transcription is among the foundational skills implicated in the writing process (Berninger and Winn 2006). Handwriting is the primary transcription mode in elementary classrooms, but keyboarding is becoming more prevalent in the classroom as early as Grade 1. One of the consequences of the COVID-19 pandemic was the interruption of in-person schooling and adoption of online learning that required children to compose text online (Barbour et al. 2020). Yet few studies have examined the effects of transcription mode on composition, particularly among children required to write in an additional language (L2) (Criado et al. 2022). Our study aimed to address this gap in the literature. Specifically, our objective was to examine how transcription mode influences two markers of quality (i.e., productivity and spelling accuracy) in the context of composition among elementary school L2 learners of French.

We pursued our research objective within the context of an early French Immersion (FI) program in an English-dominant city in Canada. FI offers integrated language and content instruction in French to non-francophone children, beginning in kindergarten or Grade 1.

In the program from which our sample was drawn, students receive instruction in all core subjects in French between kindergarten and Grade 3; specialty subjects, such as art, music, and gym, are taught in English. English language arts are introduced in Grade 4. At the same time, FI children are exposed to English in the home and the community (Au-Yeung et al. 2015). Children in FI are among the growing number of children worldwide who develop literacy skills in school in a language other than the home language (Paradis et al. 2011). To optimize writing outcomes among these children, it is important to identify the tools that best support their learning.

We situate our study within The Not-So-Simple View of Writing (Berninger 2002), which conceptualizes compositional writing as the product of two necessary skills: transcription skills (handwriting/keyboarding and spelling) and word-, sentence-, and text-level generation skills (Arfé et al. 2016). Transcription integrates the retrieval of orthographic symbols and the motor output requirements for producing them for the purpose of translating internal language into the external symbols that express the writer's thoughts (Abbott and Berninger 1993; Berninger et al. 2009). In the early stages of learning to write, transcription draws heavily on the limited cognitive resources available in working memory (Drijbooms et al. 2015). As transcription skills are automatized, cognitive resources in working memory may be reallocated to such higher-level compositional skills as ideation, planning, and revision (Berninger and Winn 2006; Limpo et al. 2017). Automaticity of foundational transcription skills is thus key to achieving proficiency in composition.

The two transcription modes through which children generate text are handwriting and keyboarding. The two modalities share underlying cognitive processing demands but differ in terms of transcription processes, including, most notably, in the processes that support letter selection and the motor gestures required for letter formation (Spilling et al. 2022). When handwriting, letter selection is dependent on recall followed by retrieval from long-term memory of a corresponding grapheme that specifies letter shape (van Galen 1991). This information is held in working memory as a motor plan is initiated specifying the hand gestures needed to produce the letter on the page, requiring skill in spatial organization (Graham et al. 2000; Perminger et al. 2004). Conversely, when keyboarding, the writer is afforded an external representation of letters to cue retrieval. Recognizing letters presented in a visual display may be less cognitively demanding than having to recall them and may support word output in novice writers (Perminger et al. 2004; Sormunen 1993). Furthermore, the motor movements involved in keyboarding are largely similar across letters, especially among inexperienced keyboarders, further alleviating processing load (Spilling et al. 2022). Additionally, keyboarding features an automatic spell check that may allow cognitive resources to be reallocated to the higher-order demands of composition that would otherwise be allocated to spelling (Graham et al. 2011; McCutchen 1996).

Text composition, whether by handwriting or keyboarding, is a standard classroom practice; as such, it has high ecological validity as a subject of empirical study. In our study, we examined the effects of modality on two word-level measures of compositional quality: productivity and spelling accuracy. Productivity is typically assessed in terms of the total number of words or utterances generated by the writer (Dosi and Douka 2021). Previous studies have considered the influence of modality on productivity in the context of composition among typically developing elementary-school-aged children. These studies have yielded mixed results, with some favouring handwriting (Alves et al. 2016; Berninger et al. 2009; Read 2004) others keyboarding (Barrera et al. 2001; Yamaç et al. 2020), and others reporting no difference in productivity as a function of modality (Spilling et al. 2022). For example, Berninger et al. (2009) had second-, fourth-, and sixth-grade English-speaking children write an essay on a specified topic, first by hand, then by keyboard, in the ten minutes allotted for each. The authors found that in each grade, children's compositions were longer when written by hand than by keyboard. Conversely, Yamaç et al. (2020) conducted a study in which fourth-grade Turkish students were assigned to one of two interventions, one focused on digital writing instruction with tablets, the second on paper-and-pencil instruction. The authors found no difference in pretest–post-test productivity

scores in either group. However, significant differences in text length favouring the digital group were found when comparing texts produced by the children at two timepoints mid-intervention. Notably, keyboarding instruction was a feature of the majority of studies that reported superior productivity in the keyboarding condition; thus, instructional factors may very well explain the disparity in results among previous studies.

To our knowledge, only one study has examined modality effects on productivity within the context of composition among bilingual children. Dahlström and Boström (2017) had six L1 and ten L2 Swedish-speaking Grade 4 children write narrative texts using pen and paper and a digital tablet. All children had previous experience composing text using both digital tools and pen and paper. The authors found that when using the tablet, the L2 children produced significantly longer texts than they did when using pen and paper. The L1 children, on the other hand, produced significantly longer texts in the handwriting condition. The authors concluded that digital tools act as scaffolds that support L2 students in the composition process, although they offer little explanation of the ways in which digital tools might differentially support L1 and L2 text composition.

Our study also considered modality effects on spelling accuracy. Spelling requires the writer to link the orthographic representation of a word with its phonological counterpart. Accurate spelling positively impacts written expression by rendering it more readable (Berninger 2002). In our study, we considered spelling accuracy within the context of French L2 text generation, a naturalistic means of assessing spelling ability (Joye et al. 2020). French is represented by a phono-morphemic writing system, that is, one that represents both sound and meaning in units of spelling (Casalis et al. 2015). Moreover, French orthography is opaque, meaning that it is characterized by inconsistencies in speech-to-print correspondence (Schmalz et al. 2015). These inconsistencies are due, in large part, to its homophonic and morphographic features. For instance, verb conjugation requires the writer to distinguish the many inflectional suffixes that are homophonic yet vary in their spellings (e.g., the infinitive *-er*, the past participle *-é*, the second person plural of the present indicative *-ez*) (Brissaud et al. 2006; Brissaud and Chevrot 2011).

Moreover, nearly 30% of French words end with a silent letter or a combination of letters that is not conveyed phonologically. Morphological information, for example, is often conveyed by way of silent-letter endings in French (e.g., the first and second person singular *-ais*, third person singular *-ait* and plural *-aient* of the imperfect), rendering the verb in *je jouais* 'I played' phonetically but not orthographically indistinguishable from *il/elle jouait* 's/he played' and *ils/elles jouaient* 'they<sub>masc/fem</sub> played' (Mussar et al. 2020). In addition, many phonologically identical word endings have multiple spellings in French due to the presence of silent consonants (e.g., /aR/ as in *canard* 'duck' and *quart* 'quarter') or a silent final 'e' (e.g., /aR/ as in *gare* 'station'). This feature of French orthography may impact children's spelling, as research indicates that unarticulated features of a word are harder to spell than articulated ones (Cormier and Kelson 2000). French orthography, therefore, presents a number of challenges for L2 learners.

Previous studies have largely considered modality effects on spelling accuracy among monolingual English-speaking children within the context of copying tasks (Cunningham and Stanovich 1990; Perminger et al. 2004; Vaughn et al. 1992, 1993) and spelling of words or sentences to dictation (Berninger et al. 1998; Masterson and Apel 2006), yielding mixed results. The disparity in findings is not surprising given the differences in methodology in previous studies. For example, Cunningham and Stanovich (1990) presented a series of words in print to first-grade children who reproduced them by hand and using a keyboard. The authors found that spelling accuracy was superior in the handwriting condition relative to the keyboarding condition. Conversely, in a study conducted by Masterson and Apel (2006), students in Grades 2 through 6 with English as an L1 were assessed for accuracy in spelling a list of 40 dictated words varying in orthographic complexity in both handwriting and keyboarding mode. The authors reported comparable results regarding spelling accuracy across modalities with no effect on complexity after controlling for keyboarding proficiency.

In educational systems worldwide, children are instructed to write in a language that is not their mother tongue. This scenario accentuates the necessity for research that examines the processes by which these learners acquire writing skills in a second language (L2), as advocated by [Miller and McCardle \(2010\)](#). To our knowledge, only one study has compared modality effects on spelling within the context of composition among young children. [Spilling et al. \(2022\)](#) had monolingual Norwegian-speaking first-grade children write narratives using both a digital tablet and pencil-and-paper. Instruction using digital tablets had begun in parallel with handwriting instruction at school entry. A range of surface (e.g., text length, spelling accuracy) and substantive (e.g., vocabulary, story grammar) features of written narratives were assessed. The data provided moderate to strong evidence in favour of no effect of modality on either spelling accuracy or text length. Moreover, based on their overall findings, the authors concluded that in the early stages of development, skill in composition is independent of modality.

## 2. Materials and Methods

Transcription is a component of the writing process that is expected to influence the quality of children's texts ([Berninger 2002](#)). Yet little is known about the influence of transcription mode on word-level markers of compositional quality among L2 learners. Therefore, the present study contributes to the limited literature by investigating (1) if transcription mode influences productivity (i.e., text length measured in number of words) in the context of French (L2) text composition among FI students, and (2) if transcription mode influences spelling accuracy (i.e., the number and the proportion of correctly spelled words) in the context of French (L2) composition among FI students.

### 2.1. Participants

The participants in our study consisted of a total of 47 FI students (27 girls;  $M_{\text{age}} = 103.40$  months,  $SD = 9.97$ ) in Grade 2 ( $n = 14$ ;  $M_{\text{age}} = 86.29$  months,  $SD = 3.37$ ), Grade 3 ( $n = 26$ ;  $M_{\text{age}} = 98.49$  months,  $SD = 5.56$ ), and Grade 4 ( $n = 7$ ;  $M_{\text{age}} = 113.24$  months,  $SD = 4.41$ ) from a large metropolitan centre where the societal language is English. All students entered publicly funded, full-day FI programs in kindergarten (i.e., at approximately 5 years of age). Integrated language and content instruction was delivered in French from the time of school entry in accordance with provincially mandated curricular expectations. Thirty-seven children spoke English as their L1, six spoke English as their L1 but also spoke another language at home, and four spoke English as their L2. No child spoke French at home. The mean parental education level was an undergraduate degree.

Our study was conducted online during the second of two extended school closures due to COVID-19; at this point, keyboarding had been widely adopted as a feature of teaching and learning. However, in the province in which our study was conducted, the school curriculum offers no guidelines for stand-alone instruction in the mechanics of handwriting or keyboarding in the elementary grades (although, beginning in Grade 2, curriculum documents state that students are expected to use legible printing in their written work ([Ontario Ministry of Education 2006](#), SE 2.7). However, in the local school board from which our study sample was drawn, Information and Communication Technology (ICT) standards are in place that are intended as a framework for using technology as a cross-curricular teaching and learning tool. The framework specifies learning expectations for each of the elementary grades. Expectations in Grade 2 make no reference to keyboarding skill. In Grades 3 and 4, students are expected to “demonstrate proper technique and posture when keyboarding” ([Toronto District School Board n.d.](#), p. 19). The ICT standards state that students' skill in using word-processing software may be evaluated, but evaluation is not mandatory. No mention is made in ministry or board documents, however, of the means by which students are to learn keyboarding or handwriting techniques or the amount of time in the school day teachers are to allocate to such instruction. Finally, we noted anecdotally that student access to digital devices varied considerably across the schools that participated in our study, and that computer use was intended largely to support inquiry-based projects

rather than composition. That said, we note that all children succeeded in producing both a handwritten and keyboarded text in the allotted time.

## 2.2. Measures

The French writing tasks were administered by trained undergraduate and graduate research assistants proficient in French. Data collection took place virtually via Zoom and in-person for some children. The input mechanism used was a keyboard sourced from either a laptop or an iPad. Children were not allowed to use resources, such as online or paper dictionaries, and they were monitored throughout this task to check for compliance. Children completed one of the two writing tasks in two separate sessions as part of a larger project. Each session took 1 h, 30 min of which were allotted to the writing task.

### 2.2.1. Parental Demographic Questionnaire

Parents completed the Alberta Language Environment Questionnaire (ALEQ; [Paradis et al. 2011](#)), providing information about their family background (i.e., parental education and family composition) and features of the home language environment (i.e., languages spoken, amount of exposure to each language).

### 2.2.2. Receptive Vocabulary

The Echelle de Vocabulaire en Images Peabody (EVIP) ([Dunn et al. 1993](#)), a tool for evaluating French receptive vocabulary, was utilized. Given that this test was standardized using a French-speaking population, we started all students at the first item, disregarding the basal rule. The test comprised 170 items of escalating difficulty. The child was instructed to choose one of four images that most accurately represented a word presented orally by the researcher. The testing was stopped when the child committed 6 errors within a set of 8 items. The scores are indicative of the count of correct answers.

### 2.2.3. Written Expression

The script and stimuli prompts of the Written Expression subtest of the Wechsler Individual Achievement Test (WIAT-II, CDN-F; [Wechsler 2005](#)) were used to elicit two narratives in French, one handwritten, the second using a keyboard. The prompts (*Quand il pleut, j'aime...* 'When it rains, I like...' and *Mon jeu préféré est...* 'My favourite game is...') were counterbalanced across modalities. An oral think-aloud composed of five questions preceded the writing phase of the task (see [Appendix A](#)). It was intended to help children organize their thoughts on the given topic ([Barkaoui 2016](#)). The child responded orally to each question before writing down ideas in the same modality in which they wrote their narrative. No feedback or other form of assistance was provided by the researcher. Once all five prompts were presented, children were encouraged to proceed with the task independently. No further support was provided beyond repeating instructions when needed. Students completed one composition within a maximum of 30 min in each of two test sessions. Children were not prevented from using the spell check feature in the keyboarding condition, nor were they encouraged to do so. All instructions were offered in both French and English to ensure that the children understood what was being asked of them.

## 2.3. Procedures for Scoring

Two research assistants proficient in French each scored one half of the writing samples for the total number of words and the total number of correctly spelled words. To ensure reliability, 20% of the samples were randomly selected and re-scored by the second research assistant. Interrater reliability was calculated using the following formula:  $[\text{number of agreements} / (\text{number of agreements} + \text{disagreements})] \times 100$  ([Sackett 1978](#)). This yielded 87.2% for writing samples produced in the handwriting mode ( $n = 400$  words) and 93% in the keyboarding mode ( $n = 420$  words). The proportion of correctly spelled words was then calculated.

## 2.4. Statistical Analyses

This paper involves two sets of analyses to answer our research questions. In the first set of analyses, we examined within-subject differences based on modality through descriptive statistics and analyses of variance (ANOVAs). Specifically, this first section comprises three one-way repeated measures ANOVAs comparing students' writing samples on measures of total number of words, number of correctly spelled words, and proportion of correctly spelled words across modalities. The second set of analyses examine the impact of spell check use during the keyboarding condition on total number of words, number of correctly spelled words, and proportion of correctly spelled words. First, independent sample T-tests were run to investigate whether students who did and did not use spell check were equivalent in age and in French receptive vocabulary knowledge. Once we established whether students were comparable, ANOVAs were run to investigate the effects of spell check between groups. The primary analyses in this paper were frequentist, explored through T-tests and ANOVAs. In cases where these statistics were not significant, Bayesian statistics were run to see whether the insignificant effect was due to true equivalence or whether the insignificant effect was attributable to other factors, such as lack of power and sample size. Frequentist statistics are often used to look for difference, whereas Bayesian statistics are used to look for equivalence (please see [Fornacon-Wood et al. 2022](#) and [Pek and Van Zandt 2020](#) for more information).

## 3. Results

### 3.1. Descriptive Statistics

Table 1 presents the descriptive statistics for each measure in this study by modality (i.e., paper vs. keyboarding). There were a total of seven moderate outliers across all conditions (two for the total number of keyboarded words and two and three for the number of correctly spelled handwritten and keyboarded words, respectively). However, these outliers did not significantly affect the results and were therefore retained in the analysis. There were no extreme outliers across all measures. Skewness and kurtosis values were well within the acceptable range of  $+/-3.29$ , as established by [Tabachnick and Fidell \(2007\)](#). There were no missing data points for the three variables of interest (total number of words, number of correctly spelled words, and proportion of correctly spelled words). The data were normally distributed, as assessed through boxplot and Shapiro–Wilk tests ( $p > 0.05$ ), respectively. The assumptions of linearity and normality were established using the statistics program IBM SPSS 28. As can be seen in Table 1, the mean was higher in the keyboarding condition on all three measures.

**Table 1.** Descriptive statistics by modality.

	Paper				Keyboard		
	N	M	SD	Range	M	SD	Range
Total Number of Words	47	43.64	23.34	5–98	46.66	23.85	10–124
Number of Correctly Spelled Words	47	31.09	21.02	3–90	37.32	23.97	6–111
Proportion of Correctly Spelled Words	47	0.69	0.19	0.15–1.00	0.76	0.20	0.27–1.00

### 3.2. ANOVA Results

To answer our questions regarding potential effects of modality on text length and spelling, we conducted a series of repeated measures ANOVAs by entering modality as a fixed factor. ANOVA effect sizes were interpreted according to guidelines provided by [Huck \(2009\)](#) (i.e., small  $> 0.01$ , medium  $> 0.06$ , large  $> 0.14$ ). To further investigate whether the two modality conditions were equivalent, Bayesian statistics were used to examine whether non-significance was attributable to low sample size or true equivalence. Bayes Factors (BF01) were interpreted according to the criteria proposed by [Andraszewicz et al. \(2015\)](#). Generally, Bayes Factors smaller than 1 are in favour of the null hypothesis (equivalence),

whereas Bayes Factors greater than 1 are in favour of the alternative hypothesis (difference). The further these numbers are from 1, the stronger the evidence is.

### 3.2.1. Total Number of Words

A one-way repeated measures ANOVA was conducted to determine whether there was a statistically significant difference in the total number of words by modality. The effect of modality was not statistically significant  $F(1, 46) = 0.776, p = 0.383$ , partial  $\omega^2 = 0.017$ . As a follow-up to the insignificant main effect, a Bayes Factor was calculated. The Bayes Factor for modality for the total number of words was  $BF01 = 0.189$ , indicating moderate evidence in favour of the null hypothesis (equivalence).

### 3.2.2. Number of Correctly Spelled Words

A one-way repeated measures ANOVA was conducted to determine whether there was a statistically significant difference in the number of correctly spelled words by modality. The effect of modality was statistically significant  $F(1, 46) = 4.973, p = 0.031$ , partial  $\omega^2 = 0.098$ . This is a medium effect size according to Huck (2009). As a follow-up to the main effect, a Bayes Factor was calculated. The Bayes Factor for modality for the number of correctly spelled words was  $BF01 = 1.517$ , indicating anecdotal evidence in favour of the alternative hypothesis (difference).

### 3.2.3. Proportion of Correctly Spelled Words

A one-way repeated measures ANOVA was conducted to determine whether there was a statistically significant difference in the proportion of correctly spelled words. The effect of modality was statistically significant  $F(1, 46) = 7.492, p = 0.009$ , partial  $\omega^2 = 0.140$ . This is on the border between a medium and large effect size according to Huck (2009). The Bayes Factor for modality for the proportion of correctly spelled words was  $BF01 = 4.762$ , indicating moderate evidence in favour of the alternative hypothesis (difference).

## 3.3. Spell Check Analyses

In this study, 22 students used spell check in the keyboarding condition, and 25 did not. As a result, we conducted additional analyses to determine the effects of spell check use on our results. Table 2 presents the descriptive statistics for the number of words and the number and proportion of words correctly spelled in the keyboarding condition as a function of spell check use. Notably, there were no significant difference between students who did and did not use spell check regarding age in months [ $F(1, 45) = 0.082, p = 0.776$ , partial  $\omega^2 = 0.002$ ] and receptive vocabulary in French [ $F(1, 45) = 0.061, p = 0.806$ , partial  $\omega^2 = 0.001$ ].

**Table 2.** Descriptive statistics for keyboarding condition by spell check use.

	Spell Check Used (n = 22)			Spell Check Not Used (n = 25)		
	M	SD	Range	M	SD	Range
Total Number of Words	48.00	18.86	26–112	45.48	27.85	10–124
Number of Correctly Spelled Words	39.41	20.43	11–103	35.48	27.00	6–111
Proportion of Correctly Spelled Words	0.80	0.21	0.31–1.00	0.72	0.19	0.27–1.00
Receptive Vocabulary	53.52	23.07	17–108	51.73	24.47	22–91
Age (In Months)	103.84	9.20	86.29–125.59	103.00	10.77	87.49–127.13

Three ANOVAs were conducted to determine whether there was a statistically significant effect of spell check use on the total number of words, the number of correctly spelled words, and the proportion of correctly spelled words, respectively. The effects of spell check were not statistically significant for all three outcomes, including  $F(1, 46) = 0.128, p = 0.722$ , partial  $\omega^2 = 0.003$  for the number of total words,  $F(1, 46) = 0.310, p = 0.581$ , partial  $\omega^2 = 0.007$  for the number of correctly spelled words, and  $F(1, 46) = 1.892, p = 0.176$ , partial



$\omega^2 = 0.040$  for the proportion of correctly spelled words. As a follow-up to the insignificant main effect, a Bayes Factor was calculated. The Bayes Factors for modality for the total number of words, the number of correct words, and the proportion of correct words were 0.121, 0.133, and 0.283, respectively, indicating moderate evidence in favour of the null hypothesis (equivalence) for all three outcomes.

#### 4. Discussion

According to the Not-So-Simple View of Writing (Berninger 2002), transcription skills (handwriting/keyboarding and spelling) are key components of the composition process. However, very little is known about the influence of transcription modality on word-level markers of compositional quality among L2 learners. Therefore, in the present study, we considered the effects of transcription mode (i.e., handwriting versus keyboarding) on productivity (i.e., text length measured in number of words) and spelling accuracy (i.e., the number and proportion of correctly spelled words) in the context of French (L2) composition among FI students in Grades 2 to 4. Our results revealed an advantage for the keyboarding condition over the handwriting condition in terms of the average number of correctly spelled words and the proportion of correctly spelled words that the children generated in their compositions. Conversely, there was no statistical difference due to modality in the total number of words produced. Taken together, our results suggest that in the early to middle elementary years, L2 learners may experience some benefit when composing text via keyboard compared to pen and paper where spelling accuracy, but not productivity, is concerned.

With respect to text length, our finding of no difference in the average number of words generated via handwriting and keyboarding contributes to the small body of literature examining modality effects on productivity among elementary-aged children and the even smaller body of literature examining those effects in elementary-aged L2 learners. Our finding is consistent with that reported by Spilling et al. (2022). Conversely, it contrasts with those reported by Berninger et al. (2009) who reported a modality effect favouring handwriting, on the one hand, and Barrera et al. (2001) and Yamaç et al. (2020), who found a modality effect favouring keyboarding among monolinguals. Our finding of no difference in text length across conditions contrasts, as well, with the finding of Dahlström and Boström (2017), who reported a modality effect on text length favouring keyboarding in a small sample of L2 learners in Grade 4, the only study of which we are aware that examined modality effects on composition among children learning to write in an additional language.

The disparities in results may largely be explained by differences in methodology across studies. Notably, in the previous studies reporting a positive effect of keyboarding relative to handwriting, children were provided with formal keyboarding instruction prior to testing either within the classroom or as part of the study intervention. Moreover, multiple compositions generated by each child over an extended period of time were examined in these studies. Thus, we speculate that the effect of both instruction and practice in keyboarding over time may have contributed to the finding of superior performance in productivity in these studies, suggesting that keyboard use may support the compositional writing process as children acquire skill and automaticity in the mechanics of keyboarding, including children learning to write in their L2.

When interpreting our finding of equivalent performance in productivity across modality, it is important to consider the broader social and educational context within which our data were collected. We had children complete the writing task during the second of two extended school closures due to COVID-19. School closures required a pivot to virtual learning, a digital 'baptism of fire' for many children (Dobrin-De Grace et al. (2023) in press). At this point in time, computer use in the classroom had become fairly ubiquitous and children had had some opportunity to familiarize themselves with the keyboard and keyboarding mechanics, albeit in the absence of mandatory and systematic keyboarding instruction and assessment of student learning. Our result suggests that, overall, the children had achieved

a level of proficiency in keyboarding, largely through unguided practice, that allowed them to generate texts of equivalent length to those generated using pencil and paper. Thus, keyboarding did not constrain composition length. However, as previous studies indicate, explicit keyboarding instruction followed by deliberate practice in keyboard use may be essential to developing the level of automaticity required for children to realize significant benefit from keyboarding relative to handwriting (e.g., [Connelly et al. 2007](#)).

Whereas modality appeared to be independent of word-level productivity, our findings revealed an advantage for keyboarding over handwriting related to spelling accuracy. Ours is one of only two studies of which we are aware that specifically examined modality effects on spelling accuracy within the context of composition. Our finding of superior spelling performance in the keyboarding condition is inconsistent with that of [Spilling et al. \(2022\)](#), who found no difference in the number of correctly spelled words children produced when composing on a keyboard and on paper. Thus, our data do not align with Spilling et al.'s suggestion that spelling accuracy is independent of modality, although important differences in our study populations may account, at least in part, for the discrepancy in our findings. Notably, [Spilling et al. \(2022\)](#) tested monolingual children in early Grade 1 shortly after the initiation of literacy instruction, so performance on the outcome measure may have been constrained by developmental factors, irrespective of modality. Moreover, because the Norwegian orthographic system is characterized by fairly systematic phoneme–grapheme correspondence ([Hagtvet et al. 2006](#)), spelling may pose a lesser challenge in Norwegian than in French, minimizing the role of modality in supporting accuracy. Our finding points to the potentially beneficial effect of keyboarding over handwriting on spelling accuracy within the context of composition among early to middle elementary school L2 learners of French.

In addition to the modality effect found for overall spelling accuracy, our results revealed a significant difference in the overall proportion of correctly spelled words in the children's compositions in the keyboarding condition relative to the handwriting condition. To our knowledge, no previous study assessing modality effects on composition has assessed spelling accuracy in relation to productivity. Yet past research has shown spelling accuracy and text length measured in words to be positively correlated ([Kim et al. 2011](#)). By calculating the proportion of all words that were correctly spelled (versus the absolute number) in this particular analysis, we were able to factor out the effect of productivity and specifically assess modality effects on spelling accuracy. Taken together, our results related to spelling accuracy suggest that keyboarding may assist children in overcoming challenges related to spelling that arise when composing text. Importantly, we report the effect of modality in a sample of L2 learners of French, a language characterized by an opaque writing system that is particularly difficult to acquire (e.g., [Leray and Tyne 2016](#)). Consistent with the Not-So-Simple View of Reading ([Berninger 2002](#)), we speculate that the less onerous mechanics of keyboarding compared to handwriting may have reduced the cognitive load associated with text composition, allowing students to allocate greater processing capacity to spelling (if not to higher-order ideation, as evidenced in our results related to text productivity). Again, research is needed to further explore the relationship between keyboarding (compared to handwriting) and spelling performance among novice L2 writers in the context of composition and to identify the exact mechanisms through which technology may impact writing skills more broadly ([Little et al. 2018](#)), particularly among L2 writers.

Clearly, our results related to spelling must be considered while keeping spell check use in mind. We allowed the children to use spell check in the keyboarding condition of our study, despite its potential to confound our spelling results, in order to preserve the task's ecological validity. By allowing spell check use, we intended to simulate a more naturalistic writing situation that is in keeping with how children typically approach the task of composition using a keyboard. To explore its impact on outcomes, we ran post hoc analyses that revealed no significant differences in the number of correctly spelled words between children who used spell check in the keyboarding condition and those who

did not. This finding suggests that spell check use had minimal impact on outcomes in this study. However, future studies will examine its influence on composition under more tightly controlled conditions.

Given the number of children worldwide who learn to write in school in a language other than the home language, there is a need to prioritize research examining writing processes in an L2 (Miller and McCardle 2010). The process of generating text calls into play several high-level cognitive, metacognitive, and linguistic skills, in addition to lower-level transcription skills (Berninger 2002). It can be challenging for all learners and may be even more so for L2 learners who face the additional challenge of expressing themselves in writing in a language in which they have limited oral proficiency. Oral language proficiency has been shown to impact writing among monolingual children, constraining children's ability to convey their thoughts in print in a manner that accurately reflects their communicative intent (e.g., Dockrell and Connelly 2009). The same may very well be true of L2 writers. Clearly, our findings cannot speak directly to the potential contribution of language factors, such as proficiency and skill in composition. However, we cannot exclude the possibility that differences in productivity failed to emerge because linguistic factors interacted with modality to minimize the purported advantages of keyboarding over pen and paper. We believe that future research is needed comparing L1 and L2 compositions on a broad range of surface and substantive markers of quality to determine possible proficiency effects on writing skill. Moreover, research comparing L1 and L2 text quality may be useful to inform theoretical models that more adequately capture the component skills that distinguish L1 and L2 compositional writing. With its focus on additive bilingualism, FI would be an ideal context within which to begin exploring such comparisons.

#### 4.1. Educational Implications

Research on second-language writing can inform effective writing instruction for L2 children who may face distinct challenges when learning to write. The results of our study suggest the importance of transcription instruction in the French L2 classroom. Research demonstrates the importance of handwriting for writing development (Feng et al. 2019). At the same time, intervention studies highlight the benefits of keyboarding skills to improve writing outcomes (e.g., Yamaç et al. 2020). Systematic classroom instruction in the mechanics of both modalities is needed to ensure children develop a level of automaticity in transcription that allows them to reallocate processing capacity to the higher-order skills implicated in composition that impact overall quality. Systematic spelling instruction is also critical in the FI classroom given the complexity of the French orthographic system. Beyond explicit instruction in transcription and spelling, teachers should provide ample opportunities for practice by embedding written expression in authentic learning tasks that support the communicative goals of FI.

#### 4.2. Limitations and Future Directions

When interpreting the results of the current study, it is important to consider its limitations. First, the small sample size may have reduced statistical power to detect differences due to modality. Our findings should thus be considered preliminary. Additionally, we did not control for keyboarding and handwriting proficiency (assessed, for example, on the basis of timed copying tasks) or general spelling ability, both of which may have exerted some influence on our results. Future research controlling for transcription and spelling proficiency is needed to better understand how modality contributes to compositional quality. Although spell check was used to simulate a naturalistic keyboarding environment, future studies controlling for spell check use would provide a clearer picture of the impact of spell check on spelling accuracy.

Finally, our study is limited by its small sample size and the inclusion of participants from Grades 2 to 4. This broad age range means that some learners had received more immersive instruction than others, likely affecting their writing and spelling abilities. Ad-

ditionally, considering the opaque orthography of the French language, which necessitates prolonged periods for mastery, grouping second-graders—who are still acquiring basic reading and writing skills—with fourth-graders—who have had two more years of practice and a stronger command of the French language—may introduce variability that could impact the main analyses of the study. Future research is needed to investigate the differences across age and grade ranges in FL.

In conclusion, our study is the first study to date to examine the effects of transcription mode on text length and spelling accuracy among French L2 learners. Our results suggest that keyboarding may offer some advantage over handwriting to support spelling accuracy and encourage further exploration in the area of L2 compositional skill.

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## Appendix A

### *Think-Aloud Questions Supporting Writing Prompts*

Prompt 1: Quand il pleut, j'aime. . . (When it rains, I like to. . .)

Qu'est-ce que tu aimes faire quand il pleut? (*What do you like to do when it rains?*)

Pourquoi est-ce que tu aimes faire ça? (*Why do you like to do that [name of activity]?*)

Tu aimes faire ça avec qui? (*Who do you like doing it [name of activity] with?*)

Où est-ce que tu aimes faire ça? (*Where do you like doing it [name of activity]?*)

Quand est-ce que tu aimes faire ça? (*When do you like doing it [name of activity]?*)

Prompt 2: Mon jeu préféré est. . . (My favourite game is. . .)

À quel jeu est-ce que tu aimes jouer? (*What do you like to play?*)

Pourquoi est-ce que tu aimes jouer à ce jeu? (*Why do you like to play [name of game]?*)

Avec qui aimes-tu jouer à ce jeu? (*Who do you like to play [name of game] with?*)

Où est-ce que tu aimes jouer à ce jeu? (*Where do you like to play [name of game]?*)

Quand est-ce que tu aimes jouer à ce jeu? (*When do you like to play [name of game]?*)

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