Young EFL learners' pausing behavior: exploring pause thresholds in two proficiency levels

El comportamiento pausológico en niños estudiantes de inglés como lengua extranjera: explorando el umbral de pausas en dos niveles de competencia

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Abstract

The study of pausological behavior in L2 writing has been a matter of interest in recent years (see Lindgren & Sullivan, 2019), leading to a number of empirical studies which have explored pausing behavior from different angles. Among the many elements of pausological behavior, the pause threshold has aroused controversy in recent years (Alves et al., 2008) given its role in helping to discern lower-level and higher-level cognitive processes associated with L2 writing. While the research intent has focused recently on observing how pausological behavior varies according to the pause thresholds in adult L2 writers (Medimorec & Risko, 2017), this element of writing has not been examined in children L2 writers. For that purpose, this study analyzes pausological behavior and transcription fluency based on a picture-based story task by children L2 writers. Results indicate that pauses at word boundaries were more frequent than at sentence or paragraph boundaries. Likewise, the text boundary effect was not fully replicated, contrary to what studies in adult L2 writers have shown (see Wengelin, 2007).

Palabras clave: L2 writing; pausing behavior; children L2 writers; keystroke logging software.

Resumen

El estudio del comportamiento de pausas en la escritura en L2 ha sido un tema de interés reciente (Lindgren & Sullivan, 2019). Estudios empíricos han examinado el comportamiento de las pausas desde diferentes perspectivas. Un elemento controvertido es el umbral de pausa, que se utiliza para determinar los procesos cognitivos asociados con la escritura en L2 (Alves et al., 2008). Mientras que la investigación se ha centrado en cómo varía el comportamiento de las pausas según el umbral en escritores adultos en L2 (Medimorec & Risko, 2017), este aspecto de la escritura no se ha examinado en escritores infantiles en L2. Este estudio analiza el comportamiento de las pausas y la fluidez de transcripción en escritores infantiles en L2 en una tarea de escritura basada en imágenes. Los resultados indican que las pausas en los límites de palabra son más frecuentes que en oraciones o párrafos. Además, el efecto del límite del texto no se replicó completamente, en contraste con lo que han mostrado los estudios en escritores adultos en L2 (Wengelin, 2007).

Keywords: escritura en L2; comportamiento pausológico; escritura en niños en L2; software de captación de pulsación.

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Introduction

The description of online behaviors of second language (L2) writers has acquired considerable relevance and interest in the last two decades, especially with adult and adolescent L2 writers (see Barkaoui, 2019; Revesz et al., 2019). The observable behaviors in the writing process have been a matter of interest for researchers, who have examined pausing and revision behavior (see Kim, 2020; Revesz et al., 2019; Roca de Larios et al., 2008; Van Waes & Leijten, 2015). The main research intent of these studies has been to test models of L2 writing given the underlying cognitive processes behind pausing and revision behavior (Revesz et al., 2019). Regarding pausing behavior, it has been regarded as a "succession of bursts of written language and pause periods" (Medimorec & Risko, 2017, p. n.d.), whose importance has been revealed in the large percentage of time that L2 writers devote to pausing, amounting to nearly three-quarters of the composition process (Alamargot et al., 2007).

Pauses in L2 writing have been studied mainly in adults, with a focus on frequency, duration, and location (Chenu et al., 2014; Schilperoord, 2002). Previous research has used a pause threshold of 2000 milliseconds, which may not capture lower-level processes (Alves et al., 2008; Barkaoui, 2019; Tiryakoglu et al., 2019). However, recent studies have suggested that lower pause thresholds may be important for understanding L2 writing in young EFL writers, whose keyboarding and spelling skills are not as advanced as those of adults (Medimorec & Risko, 2017; Criado et al., 2022; Garces-Manzanera, 2021).

Thus, building on the need of accumulating more evidence on children's pausing behavior in L2 writing, this study intends to shed light on how using distinct pause thresholds might provide a much more consistent picture of children's pausing behavior. Empirically, our aim is to explore how pauses vary at the different pause thresholds, and the extent to which writing fluency, an important indicator of processing difficulty during writing (see Kellogg, 1996; Kellogg et al., 2013), may condition pause rates.

Pauses in L2 writing

Pauses constitute one of the most important elements in the compositional process, being the core of the writing process since they amount to as much as three-quarters of the time spent on the task (see Alamargot et al., 2007). Additionally, the relevance of pauses has also been reflected in their quantifiable and observable nature. The fact that pauses are traceable allows writing researchers to delve into the reasons behind these pauses on the basis of the frequency, location and duration. More importantly, research has pointed out that pauses cover certain cognitive operations which might, in turn, reflect writing processes (Barkaoui, 2019).

Theories on the role of pauses in detecting underlying cognitive processes in writing are based on speech production research (Spelman Miller, 2006), equating hesitance, false starts, and silent pauses with certain processes such as planning or lexical retrieval. In writing, the only traceable unit is the pause, which may provide evidence of pre-writing operations such as planning content or language, as well as other processes including revisions, lexical search, or formulation (see Spelman Miller, 2006; Wengelin, 2006). The presence of pauses may also indicate the interplay between multiple operations, suggesting that writing is a complex activity involving the coordination of processes. This interplay may be reflected in the transition from one process to another, which may create more cognitive demands for L2 writers and require pausing to accommodate the change (see Xu & Qi, 2017).

Cognitive models of writing, such as Hayes & Flower (1981) and Kellogg (1996), have shown that pauses are an important part of the writing process. These models suggest that all writing processes depend on the central executive, which helps writers switch between processes. Pausing behavior is associated with planning, formulation, and revision. In L2 writing, pauses may be intentional, reflecting the writer's decision to switch processes, or they may be a consequence of limited cognitive capacity (Alamargot et al., 2007; Kellogg et al., 2013).

Pauses in writing are periods of time when writers are not producing written output (Garcés-Manzanera, 2021). These pauses do not necessarily indicate a lack of cognitive activity. In low-proficient writers, such as young EFL learners, pauses may be caused by limited cognitive capacity or an overload of resources. Young writers may also lack the necessary motor skills to write fluently (et al., 2013¸ Olive & Cislaru, 2015).

Espiral. Cuadernos del Profesorado | ISSN 1988-7701 | 2023, *16*(32), 64-75

65

Studies on pausing behavior in L1 and L2 writing have traditionally relied on certain assumptions to interpret the evidence provided by pauses (see Barkaoui, 2019; Spelman Miller, 2006; Wengelin, 2006). Alamargot et al. (2007) proposed four assumptions for studying pausing behavior: (a) pause duration, which signals the struggle that L2 writers might have experienced and the scope of the interruption, (b) pause location, which is relevant because it indicates the textual boundary where the interruption occurred and hints at potential reasons, (c) pause behavior, which is associated with the textual context of the pause or the actions occurring after it, and (d) graphomotor execution, related to the overload of the central executive and difficulty responding to demanding processes.

Previous research on L1 and L2 writing has attempted to provide empirical evidence for what each pause represents (Medimorec & Risko, 2017; Révész et al., 2017; Van Waes & Leijten, 2015). Pauses are not arbitrary and can be regular at certain textual locations. For example, pauses at sentence boundaries have been linked to planning and organization in adult L2 writing (Barkaoui, 2019). The location of the pause is not the only characteristic that allows us to determine the cognitive operation behind it. Pause duration is also important for understanding the cognitive value of where the writer stopped writing. A 1000-ms pause within words may indicate cognitive or motor issues, while a 500-ms pause before words would not have the same implications.

Pause thresholds in L2 writing

The operationalization of pauses in writing has been challenging, with scholars questioning what and when a pause should be considered (Medimorec & Risko, 2017). The boundary defining what a pause is, commonly referred to as the *pause threshold*, has not been clearly defined in the literature. Previous research has selected the most appropriate pause threshold depending on the study's purpose. This threshold has not been claimed to be specific for any particular population or proficiency.

The most used pause threshold in adult L1 and L2 writing, as reviewed by Medimorec & Risko (2017), has oscillated between 1000 and 2000 ms (see Alves et al., 2008; Barkaoui, 2019; Schilperoord, 2002). The main motivation behind these pause thresholds has been based on the claim that pauses above 2000 ms reflect higher-level cognitive processes. Smaller or longer pause thresholds may point to varied and different cognitive processes, such as lower cognitive processes. Van Waes & Leijten (2015) indicate that larger pause thresholds, that is, beyond 2000 ms, are indicative of higher cognitive processes. These 2000-ms pause thresholds have been extensively used in research on pausing behavior with adult L2 writers (see Olive et al., 2009; Tiryakioglu et al., 2019) given the potential underlying cognitive processes that they may help uncover.

Studies which have considered much lower pause thresholds, for instance, 300 ms and 500 ms (Chukharev-Hudilainen, 2014) have precisely focused on aspects other than planning or formulation, but motor skills. A more recent study by Medimorec & Risko (2017) explored intervals of pause thresholds from 300 ms to over 2000 ms in adult L2 writing on the computer. Overall, the relevance of studying pause thresholds lies in the fact that "this could provide additional information about the functions of pauses" (Medimorec & Risko, 2017, p. 1270). In fact, an important contribution to the investigation of pausing behavior and pause thresholds has been precisely the use of different pause thresholds within the same research study for the light it could bring on both low-level and higher-level cognitive processes. It could be argued that the use of a determined pause threshold could be justified since pauses below 2000 ms are merely related to mechanisms of typing (Baaijen et al., 2012; Wengelin, 2006).

Much of this bulk of research on pausing behavior has relied solely on adult or high school L2 writers in a digital environment. However, scarce studies have explored how this may apply to children L2 writers, and thus further empirical evidence has to be accumulated.

Pause variation in L2 writing

As discussed earlier, pause variation may be observed not only at the graphomotor level but also at the text boundary level. Previous research (Wengelin et al., 2009) has shown that adult L2 writers pause more at paragraph and sentence boundaries, potentially indicating a focus on planning or reading backwards in the text. Pauses at word boundaries may be associated with microplanning processes or syntactic processing, while pauses before words may reflect various operations (Conjin et al., 2019; Van

Espiral. Cuadernos del Profesorado | ISSN 1988-7701 | 2023, *16*(32), 64-75

66

Waes et al., 2016). Overall, pause variation in L2 writing equally points to variations in the processing demands (see Schilperoord, 2002), which may be different depending on our limited working memory resources (Kellogg et al., 2013). Pausing unequivocally indicates that certain writing processes could not take place simultaneously, and these have been related to higher-level cognitive processes. Nevertheless, as noted by Medimorec & Risko (2017), "they could be caused by both higher-level components of the writing process (e.g., planning), but also lower-level components, such as lexical access and spelling processing" (p. 1269). The present study intends to fill a research gap concerning children's L2 writing on the computer, and how pausing behavior may vary quantitatively according to the pause threshold selected. Additionally, it has been argued that text genre may eventually influence how L2 writers behave in terms of pausing.

Research on pausing behavior in adult L2 writers has shown that argumentative essays are more cognitively demanding and require more frequent use of certain writing processes (e.g., planning) than others (see Medimorec & Risko, 2017), while narratives tend to be less linguistically complex and require less cognitive effort (see Medimorec & Risko, 2017). However, these studies have only focused on adult populations, leaving a gap in research on younger learners. Although children's writers are not able to write argumentative essays, further research is needed on how similar tasks such as picture-based story tasks may reflect similar pausing behavior in adults.

Aims and Research Questions

The present study aims to explore whether differences exist in the modulation of pause behavior in terms of pause duration and pause location as a function of the L2 proficiency level. Equally relevant, this study also intends to examine whether pause rate is linked to transcription fluency.

In order to provide an answer to these objectives, the following research questions (RQs) guided our study:

RQ1. Do pause rates change significantly as a function of pause location?

RQ2. Does L2 proficiency affect pause rates?

RQ3. Does fluency have an influence on pause rates as a function of L2 proficiency?

Method

Participants and context

Our cohort of participants consisted of 16 young children with an average age of 10-12. In terms of proficiency level, they had an average A2 level according to the Common European Framework of Reference for Languages (CEFRL). Our participants attended a semi-private school located in southern Spain and belonged to Primary 5 (*n*= 8) and Primary 6 (*n*= 8).

This study was conducted in an EFL context where young learners received 3 hours of EFL lessons per week based on a traditional textbook-based teaching methodology. Writing instruction typically involved using the writing sections of the textbook to write letters or stories. The writing skill was predominantly done by hand.

Research design and data collection procedure

Our study was predominantly an exploratory, classroom-based laboratory experimental research (see DeKeyser & Prieto-Botana, 2019) since our participants were part of a regular classroom and were led to a laboratory setting for specific treatment. Our research design followed a 2 between-subject design (Primary 5 vs Primary 6).

The data collection procedure involved that children had to write a picture-based story task as used in previous research (Cánovas, 2017; Coyle et al., 2018). They completed their task on the computer in an MS Word environment with Inputlog (Leijten & Van Waes, 2013), a keystroke-logging software tool. They had to complete it in 30 minutes but had no word limit.

Espiral. Cuadernos del Profesorado | ISSN 1988-7701 | 2023, *16*(32), 64-75

67

Task used

As previously mentioned, the writing task used was a picture description task (shown in Figure 1). Previous research (Coyle et al., 2018) has shown that this type of task allows children to draw on various linguistic resources and helps ease cognitive demands compared to tasks like writing an essay.

Figure 1

The "Scientist" six-picture frame story task (Cánovas, 2017).
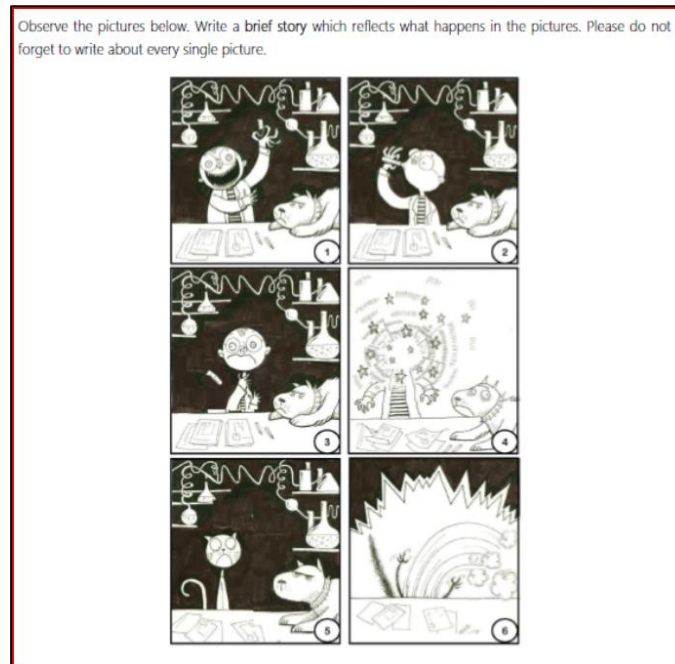
Inputlog

As mentioned in 4.2., children wrote the picture-based story task on the computer with Inputlog (Leijten & Van Waes, 2013). This keystroke-logging software captured online writing processes underlying keyboard presses, pauses and revision operations. Inputlog has been extensively used in L2 writing research with adults (see Barkaoui, 2016, 2019; Révész et al., 2019), and more recently, with children's writers (Garcés-Manzanera, 2021). The use of keystroke-logging software proves to be useful since it allows for observing pausing behavior and other writing operations in an unobtrusive manner. Additionally, its integration into a common text processor such as MS Word (Leijten & Van Waes, 2005) is equally relevant, as writers do not see any distracting features.

Measures

The central objective of the present paper is to shed light on the pausing information provided at different pause thresholds within three-time intervals, as has been done in previous research (see Medimorec & Risko, 2017). Hence, within these three-time intervals, pauses were analyzed using Inputlog as it provided the data on pause location.

Pauses

Inputlog was used to measure pauses in writing by counting the number of pauses at specific text locations, such as between words, sentences, or paragraphs. Pauses that occurred before and after these locations were classified as "between pauses" and were measured in terms of pause rates, or the number of pauses at a given location.

Finally, these pause rates at different pause locations were considered according to the pause thresholds within three specific intervals: (1) 0 – 300 ms, (2) 300 – 1000 ms, and (3) >2000 ms.

Espiral. Cuadernos del Profesorado | ISSN 1988-7701 | 2023, *16*(32), 64-75

68

Fluency measures

The operationalization of fluency in this study considered four different measures, including motoric fluency. These measures include: a) strokes per minute (Van Waes & Leijten, 2015), b) words per minute (refs needed), c) characters per minute, and d) interkeystroke interval. Although the three fluency measures were analyzed in order to observe whether there were any statistical differences between both proficiency levels (that is, Primary 5 and Primary 6), a series of correlation analyses were conducted to examine the degree of multicollinearity between the four fluency measures.

Table 1.

Pairwise Spearman Rho correlations between fluency measures.

Measures	Spearman Rho r
Strokes per minute – Words per minute	.85
Strokes per minute – Characters per minute	.92
Words per minute – Characters per minute	.92
Interkeystroke interval (ms) – Strokes per minute	–.22
Interkeystroke interval (ms) – Words per minute	–.32
Interkeystroke interval (ms) – Characters per minute	–.33

Table 1 shows that all fluency measures are strongly correlated, except for motoric fluency, which does not correlate with any other measures. Therefore, we will use words per minute as a reference for establishing the relationship with pause location within intervals. However, all four fluency measures will be considered for between-group comparison.

Statistical analyses

To answer our research questions, we conducted a series of statistical analyses. Due to the small sample size (N=16), we only used descriptive statistics (mean and standard deviation) and Hedges's g for effect size to compare groups. We used non-parametric Friedman's Tests and Spearman Rho correlations to answer RQ1, which explored whether pause rates change significantly depending on pause location and intervals. To answer RQ2, we used descriptives and Hedges's g to observe the effect of L2 proficiency on pause rates at different text boundaries within each interval. For RQ3, we used descriptives and Hedges's g to observe between-group differences across fluency measures and Spearman Rho correlations to observe the association between fluency (words per minute) and pause rates at each text boundary within the three intervals. Plonsky & Oswald's (2014) benchmarks were used for effect size and correlations: effect size: small (.40), medium (.70), and large (1.0); correlations (rs): small (.25), medium (.40), and large (.60).

Results

RQ1. Do pause rates change significantly as a function of pause location?

As can be observed in Table 1, raw data indicates that the most relevant variations in terms of pause rate between intervals are found between 1000-1999 ms and >2000 ms. Friedman tests were conducted to determine whether pause rates differed across intervals at each pause location. The results show non-significant differences in word, $\chi^2(2) = 2.375$, p = .30, and in paragraphs, $\chi^2(2) = 2.579$, p = .27. Conversely, results were significant in the case of sentences, $\chi^2(2) = 16.769$, p =< .001. Conover's tests for post-hoc comparisons with Bonferroni corrections revealed that differences were statistically significant between interval 2 (1000-1999 ms) and interval 3 (>2000 ms) at sentence boundaries: T-Stat(30): 3.755, p_{bonf} = .002.

Table 2.

Pause rates per text boundary, means and SD, raw data.

Text Boundary	Pause interval (ms)		
	300-999	1000-1999	>2000
Word	.30 (.14)	.31 (.10)	.50 (.20)
Sentence	.04 (.10)	.06 (.29)	.66 (.47)
Paragraph	.11 (.22)	.21 (.28)	.22 (.23)

This first RQ also endeavored to observe whether there were any relevant associations between the pause rates at the text boundaries.

Table 3 shows that there is a strong correlation between pauses above 2000 ms and the first interval (300–999 ms). More moderate correlations were found between the second interval (999-1999 ms) and the third interval (>2000 ms) at word boundaries. Finally, pause rates at sentence boundaries (300-999 ms) were negatively correlated with pause rates at words (>2000 ms).

Table 3.

Correlations among pause rates at different text boundaries across three pause intervals.

Spearman's Correlations

Variable	1	2	3	4	5	6	7	8	9
1. Word300	—								
2. Word999	0.447	—							
3. Word2000	-0.759 ***	-0.550 *	—						
4. Sentences300	0.406	0.306	-0.548 *	—					
5. Sentences999	0.261	0.086	-0.279	-0.068	—				
6. Sentences2000	-0.186	-0.338	0.431	-0.157	-0.341	—			
7. Paragraphs300	-0.014	0.402	0.052	0.026	-0.322	-0.007	—		
8. Paragraphs1000	-0.240	0.248	-0.057	0.324	-0.152	-0.317	-0.035	—	
9. Paragraphs2000	-0.099	0.469	-0.072	-0.061	-0.238	0.059	0.100	0.281	—

* p < .05, ** p < .01, *** p < .001

RQ2. Does L2 proficiency affect pause rates?

As can be observed in Table 4 below, the most important differences between Proficiency 1 (Primary 5) and Proficiency 2 (Primary 6) are found in pause rates at word boundaries within 1000-1999 ms with a nearly large effect size (g = 0.94). In this case, children in Primary 5 paused more at this boundary than those in Primary 6. In the case of sentence boundaries, an important difference is equally observed with a nearly large effect size (g = –0.94), where children in Primary 6 paused more at this boundary within the 1000-1999 ms interval than Primary 5. Finally, children in Primary 5 paused more at paragraph boundaries within the above 2000-ms pause threshold. Such a difference is significant given the large effect size (g= 1.55).

Table 4.

Pause rates per text boundary across proficiency levels at three pause intervals (means and SD). Effect sizes are Hedges' G.

Text Boundary		Proficiency level		Hedges G
		Proficiency 1 M (SD)	Proficiency 2 M (SD)	
Word	300-999	.28 (.13)	.32 (.15)	-0.27
	1000-1999	.35 (.09)	.26 (.08)	**0.94**

Espiral. Cuadernos del Profesorado | ISSN 1988-7701 | 2023, *16*(32), 64-75

70

	>2000	.48 (.19)	.51 (.22)	-0.14
Sentence	300-999	.06 (.12)	.03 (.10)	0.20
	1000-1999	.06 (.12)	.20 (.36)	**−0.94**
	>2000	.80 (.53)	.52 (.38)	0.57
Paragraph	300-999	.22 (.28)	.00 (.00)	**-**
	1000-1999	.22 (.26)	.21 (.31)	0.01
	>2000	.37 (.19)	.07 (.15)	**1.55**

RQ3. Does fluency have an influence on pause rates as a function of L2 proficiency?

This research question attempted to observe the between-groups differences across fluency measures, and to determine the strength of the relationship between fluency (that is, words per minute) and pause rates within the different pause intervals.

Table 5 shows that children in Primary 5 had higher fluency scores in all measures except motoric fluency (i.e. interkeystroke interval). They produced more strokes and words per minute than those in Primary 6, with a moderate effect size (g= 0.87 and g= 0.71, respectively). They also had a higher character count per minute, with a large effect size (g= 1.05). Finally, children in Primary 6 had a longer median time inter-keystroke in motoric fluency, with a large effect size (g= –1.11).

Table 5.

Transcription fluency across proficiency levels, mean values, and Hedges's g.

Measure	Proficiency		Hedges G
	Proficiency Level 1 **M (SD)**	**Proficiency Level 2** **M (SD)**	
Strokes per minute	20.15 (3.91)	15.43 (6.10)	**0.87**
Words per minute	4.59 (1.09)	3.57 (1.56)	**0.71**
Characters per minute	25.45 (5.16)	18.78 (6.78)	**1.05**
Motoric fluency	173.50 (37.49)	212.80 (29.09)	**–1.11**

Table 6 shows that there is a strong correlation between fluency and pause rates at word boundaries within 300-999 ms in Proficiency Level 1 (Primary 5). However, fluency is negatively correlated with pause rates at word boundaries over 2000 ms. Fluency is also correlated positively with pause rates at sentence boundaries within 1000-1999 ms.

Table 6.

Correlations between transcription fluency and pause rates at different text boundaries at three pause intervals (PROFICIENCY 1).

Pause interval (ms) WPM	Text boundary		
	Word	*Sentence*	*Paragraph*
300-999	.73	.21	–.16
1000-1999	.28	.73	.24
>2000	–.71	–.20	.34

Following with the correlations in Proficiency Level 2 (Primary 6), Table 7 displays these data. As can be observed, there is a moderate correlation between fluency and pauses at word boundaries within 300-999 ms. Conversely, a strong negative correlation exists between words per minute and pauses at word boundaries above 2000 ms. This is aligned with a similar finding in Proficiency Level 1.

Espiral. Cuadernos del Profesorado | ISSN 1988-7701 | 2023, *16*(32), 64-75

71

Table 7.

Correlations between transcription fluency and pause rates at different text boundaries at three pause intervals (PROFICIENCY 2).

Pause interval (ms) WPM	Text boundary		
	Word	*Sentence*	*Paragraph*
300-999	.52	.41	-
1000-1999	.47	.21	−.43
>2000	−.92	.10	−.09

Discussion

The present study aimed to expand understanding of L2 children's pausing behavior during writing and the potential variations with different pause thresholds. The findings suggest progressive changes at the sentence level, with a marked increase in lower-level processes. Additionally, pauses above the 2000-ms threshold may be proficiency-dependent, and higher proficiency may influence the number of pauses at text boundaries such as paragraph levels.

Overall, the text boundary effect – longer pauses at higher boundaries – was partially replicated, contrary to previous research with adult L2 writers (Medimorec & Risko, 2017). As expected, differences were significant at sentence boundaries for L2 proficiency, with Primary 6 students producing more pauses than Primary 5 students at the 1000-1999-ms pause threshold. This may be due to more lexical access or lower-level processes like spelling or typing issues in Primary 5. However, Primary 5 students produced more pauses at the 2000-ms threshold at the sentence level, potentially due to a dependence on global planning. This interplay between text boundaries and pause intervals suggests that Primary 5 students may have engaged more in lower-level processes at the expense of higher-level processes, potentially due to a lack of keyboarding skill automatization (Kellogg et al., 2013).

Another finding to be highlighted is the functionally similar role of pauses at word boundaries, which were not affected by the L2 proficiency variable in the 300-999-ms and <2000-ms pause threshold. Such results lead us to consider that lower-level processes may not be that short in duration insomuch as lexical concerns may be not only based on finding the word per se, but also how it is written in terms of spelling. In pausing behavior, the dynamism of writing in adults is dissimilar to children's writing, especially in the L2. Adult L2 writing tends to be more concentrated on pauses before sentences and paragraphs, while in children's writing, it is more likely to find much of the pausing behavior at word boundaries.

Focusing on the findings in L2 proficiency, fifth graders paused longer at paragraph boundaries than sixth graders, which could indicate, as anticipated before, that they were more concentrated on global planning. Additionally, longer pausing at paragraph boundaries could reflect more dependence on the prompt since reading might have given way to more pauses. However, both proficiency levels (fifth and sixth graders) reveal a tendency in their writing. Children are reported to have activated fewer higher-level processes which, in turn, is likely to have paved the way for shorter pauses.

The findings at word boundaries are also related to the construct of fluency (e.g. words per minute). Our study has revealed that decreased fluency is related to increased pause rates at word boundaries, especially at the lowest (300-999 ms) and highest interval (>2000 ms), indicating the activation of higher-level processes. This coincides with previous research on adult L2 writers, relating it to the high demands of transcription (Alves et al., 2007; Medimorec & Risko, 2017; Wengelin, 2007). Children are more likely to increase words per minute when pauses are shorter even though spelling issues or keyboarding issues may be related to it. The high correlation between words per minute and pauses at sentence boundaries in the 1000-1999-ms interval suggests that local planning may be fostered as a result of more fluency. When children plan beforehand, their fluency rate is more likely to increase. This is, however, not the case in sixth graders, where a correlation was not found at sentence boundaries at that pause threshold interval.

Espiral. Cuadernos del Profesorado | ISSN 1988-7701 | 2023, *16*(32), 64-75

72

Overall, we found out that fifth graders were more fluent than sixth graders, which we interpreted as a trade-off effect of an absence of cognitive effort or struggle, which led these children to produce more words in less time. Nevertheless, being more productive in terms of words and time does not equate with more text quality, especially in children writing.

Conclusions

The aim of this study has been to offer an overview of how children's pausing behavior varies according to pause threshold intervals and in terms of L2 proficiency. Among the many findings, the use of different pause thresholds has revealed that pause rates vary depending on the duration of the pause. In fact, our study has shredded much-needed light on children L2 writing in pausing behavior, an underrepresented population in this area of research.

Contrary to previous research on pausing behavior in adult L2 writers (e.g., Barkaoui, 2019; Medimorec & Risko, 2017), our study with children writers found that pauses at word boundaries were balanced regardless of L2 proficiency. Pauses at different locations have been reported to serve different functions in the writing process, both cognitive and motoric. Children writers also paused longer at word boundaries in pauses below the 999-ms interval, potentially indicating typical issues in children's writing such as typing, spelling, or rapid lexical retrieval.

Another important finding was that pause rates at sentence boundaries increase as pause duration augments, partially complying with the text boundary effect which was not fully replicated as in previous research with adults (Alves et al., 2009; Wengelin, 2007). Additionally, when shorter pauses occurred at word boundaries, fifth graders were reported to increase their fluency (i.e. words per minute) in sharp contrast to sixth graders, who were not as fluent. Interestingly, more fluency was positively correlated with pauses at sentence boundaries in fifth graders, which might be a potential direct consequence of global planning.

Despite the contribution of this study to accumulate more evidence as regards children L2 writing, a number of limitations have to be acknowledged. Firstly, our pool of participants was limited, and hence results have to be cautiously taken. Enlarging the pool of participants will surely shed additional light on whether these variations in L2 proficiency and pause threshold intervals are generalized. Likewise, our study relied solely on keystroke-logging data, thus limiting the scope of the interpretation since it is purely based on inferences.

Future research should expand on the present study by increasing the number of participants and extending to other L2 proficiency levels. Comparing different education stages could help determine whether pausing behavior is dependent on L2 proficiency at lower levels, for example by comparing lower-primary with upper-primary students. Using other tasks such as informal letters would also be illuminating. Future research should also explore pausing behavior using other techniques such as verbal protocols (e.g., stimulated recall) as used in previous research with adult L2 writers (e.g. Révész et al., 2019), but caution should be exercised as children are less accurate in their descriptions and may be subject to memory decay (Gass & Mackey, 2017). Finally, pausing studies with children should establish a link between pause rates at different pause threshold intervals and text quality, similar to previous research with adults (Medimorec & Risko, 2017).

Espiral. Cuadernos del Profesorado | ISSN 1988-7701 | 2023, *16*(32), 64-75

73

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74

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75