AN EXPLORATORY STUDY OF PAUSES IN COMPUTER-ASSISTED EFL WRITING

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The advance of computer input log and screen-recording programs over the last two decades has greatly facilitated research into the writing process in real time. Using Inputlog 4.0 and Camtasia 6.0 to record the writing process of 24 Chinese EFL writers in an argumentative task, this study explored L2 writers' pausing patterns in computer-assisted writing settings and how their pausing patterns related to writing time allocation, writing fluency, and text quality. Results suggest that while the skilled writers allocated significantly less time to the prewriting stage, they paused significantly longer yet less frequently than the less-skilled group in this stage; however, the two groups displayed no significant difference in pause frequency or duration in the composing stage. Text quality was found to correlate positively with prewriting pause duration and writing fluency but negatively with the prewriting time. Web search and dictionary use were identified as important extra writing activities that gave rise to the observed time allocation and pausing patterns. These findings suggest that computer-assisted L2 writing has features distinct from pen-and-paper writing and that L2 writers need to be informed of how to coordinate and regulate writing resources in an electronic environment.

INTRODUCTION

The working memory model of writing (Baddeley & Hitch, 1974; Kellogg, 1996) posits that written language production draws on a single, limited pool of attentional resources with different writing processes competing for such resources under the constraints of a central executive. If the resources are exceeded, some processes will be suspended or even sacrificed to accommodate the immediate call for other processes (DeKeyser, 2001). A possible strategy writers adopt at such moments is pausing, by which they may free up attentional resources for the processes that call for priority in writing. For researchers, pausing opens a window to gain insights into problems writers encounter in the course of language production (Wengelin, 2006), such as "phrasing, memory search, decision, feedback, conceptual integration, and so forth" (de Beaugrande, 1984, p. 166).

With the advent of computer keyboard writing, computer input log programs have helped make the logging and analysis of pausological features in writing much easier. Yet the writing process in an electronic environment may be more complex as writers have quick access to ample online resources, which also entails the demanding task of managing these resources. In the case of pausing, it is no longer confined to the halt of text production in a word processor but becomes an observable period of inactivity in any of the writing-related windows. In the research on online writing pauses, although various input log programs help to quantify pauses, there is still a need to examine pauses in their dynamic features and to explore the activities that may give rise to the observed pausing patterns. Screen Recorder, by running

backstage, can record the writing process in an unobtrusive manner and may permit possible explanations for the pausing behavior. Of particular interest to the present study is to take advantage of two computer programs, Inputlog 4.0 (Leijten & Van Waes, 2006) and Camtasia 6.0, a screen-recording program developed by TechSmith[©] Cooperation, to examine how writing skill affects the pausological features of second language (L2) learners in computer-assisted writing settings and the extra writing activities such as web search and dictionary use that may give rise to these features.

RELATED LITERATURE

Writing Pauses

Previous pausological studies in pen-and-paper settings tend to have long pausing thresholds for practical reasons and have focused on the linguistic locations of pauses. Schumacher, Klare, Cronin, and Moses (1984) videotaped the writing process of 22 high school graduates and 20 college students in a 30-minute writing assignment. Setting the pause threshold at 10 seconds, the study found no difference in pause frequency for the two groups but the college group paused shorter on average than the high school group. Further dividing the writing session into equal intervals, the average pause duration remained unchanged for both groups. The posttask interview showed the college group carried out more cognitive activities instead of grammatical activities per pause break and produced final texts of better quality than the high school group.

Other studies (Matsuhashi, 1981, 1987; Schilperoord, 1996) largely focused on first language (L1) and L2 writing pauses or the grammatical locations of pauses, such as pauses at the clause, sentence and t-unit boundaries, leaving the temporal features of pausing such as pause frequency and duration to future research. A more recent study by Beauvais, Olive, and Passerault (2011) examined pauses at different writing stages. By employing think-aloud protocols and reaction-time (RT) tasks, the researchers investigated the relationship between students' online management of the writing processes and text quality in pen-and-paper settings. The study found that text quality positively correlated with the prewriting pause length and the amount of time spent on planning, suggesting that "students composing an argumentative text benefit more from spending time on the planning processes, in other terms, in conceptual processing, than creating formal text using the translating processes" (p. 420).

Enlightening as these findings on writing pauses are, different pause thresholds make it difficult to compare results across various studies. In addition, researchers of L2 writing processes have raised methodological concerns about the reactivity issue of think-aloud protocols (Stratman & Hamp-Lyons, 1994), the intimidating nature of video cameras (Levy & Ransdell, 1996) and the reliability issue of self-generated interview data (Spelman Miller, Lindgren, & Sullivan, 2008).

With computer input log tools, researchers have further pushed the boundaries of writing pause research by setting shorter pausing thresholds. Using Keytrap[1], Van Waes and Schellens (2003) examined how writing mode, computer keyboard writing or pen-and-paper writing, affected the pausing behavior of experienced writers. Defining pauses as inactive periods of three seconds or longer and dividing writing into segments of 10 minutes, the researchers found that the long pauses for keyboard writing evenly distributed throughout the writing process while for pen-and-paper writing, half of the long pauses were concentrated at the beginning of the process. The study suggests that keyboard writers tend to start writing sooner and pause more frequently than pen-and-paper writers, leading to the speculation that the use of a word processor may result in a more fragmented writing process.

Using JEdit, Spelman Miller and her colleagues conducted a series of studies on writing pauses by setting the pausing threshold at two seconds. Spelman Miller (2000) contrasted the pausing patterns of L1 and L2 writers and found that L2 writers paused longer across all grammatical locations and that key lexical items caused L2 writers to pause more as well as caused them considerable difficulty. In 2005, Spelman

Miller reported a case study on how language backgrounds affected writers' pausing and formulating behavior. The study confirmed previous findings that L2 writers tend to plan less globally (Jones & Tetroe, 1987) and that L2 writers were less productive (Hall, 1990). A more recent study by Spelman Miller et al. (2008) adds to the mixed findings about pause frequency and duration in L2 writing. By tracking how year(s) of study affected the pausing behavior of EFL writers over a 3.5-year period, the study found that as the writing abilities increased, "the writers required fewer, but equally long pauses and decreased their total pause time over the period" (p. 444).

Illuminating as it is, the existing literature seems to have overlooked the individual differences in pausological features of L2 writing (Ackerman, 2003; Robinson, 2005; for a review, see Kormos, 2012). An indiscriminative analysis of the general pausing behavior throughout the writing event or in preset time segments may not be sensitive to pausing features unique to the functional stages like prewriting and composing. To gain a comprehensive view of L2 writing pauses, research is needed to examine pauses at the prewriting and composing stages separately.

A second observation from the literature is that pause has been defined as a nonproductive period in text production. However, in keyboard writing settings, writers may actively engage in web searching and reading efforts when writing in the word processor is suspended. These activities may place considerable demands on working memory, and pauses in the word processor are no longer confined to planning or revising contemplation (Alves, Castro, & Olive, 2008). As online management of writing processes is a fundamental component of writing skill (Levy & Ransdell, 1996), it is necessary to examine pauses in multiwindow settings since online resources may affect writing processes and consequently change the nature of these pauses.

Extra Writing Activities

Another unanswered question in L2 writing is how writers manage various writing resources in addition to text production on paper or on a word processor. This becomes more complex in online writing settings, where abundant resources are made instantly accessible by computer and particularly, Internet technology. Research on activities for managing writing resources focuses mainly on dictionary use and pertinent to the current study is research on L2 writers' strategies with electronic dictionaries. Using Système-D, Scott and New (1994) investigated dictionary use by intermediate American learners of French in their L2 writings. They found that the participants were "clearly English-French dictionary dependent" (p. 44) and that writers who produced better texts were either less dependent on the dictionary or used the French-English dictionary more creatively than those who wrote poorly.

Using think-aloud protocols, Chon (2008) investigated the electronic dictionary use of 10 Korean university students in two computer-assisted writing tasks. The results suggest that the dictionary did not help writers solve lexical problems immediately due to their lack of knowledge of the L2 words offered; rather, it prompted follow-up lexical problems within the dictionary entry. In summary, most studies on dictionary use reported the misuse or hindering effects of dictionary rather than its scaffolding effects (Chun, 2001; Rundell, 1999; Sun & Chang, 2012).

As an exception to the research focus on dictionary use, Stapleton (2010) reported a case study on the writing processes of a 23-year old graduate student in a 4000-word L2 essay-writing task. The study found that web search took up 24% of the total task time, proving itself an indispensable part of computer-assisted writing. Nevertheless, the actual effects of web search on L2 writing await further research. The present study aimed to examine both dictionary use and web search in computer-assisted L2 writing and more importantly, to relate these activities to writing pauses, writing fluency and text quality.

The Present Study

Using Inputlog 4.0 and Camtasia 6.0 to record the writing process, this study set out to investigate the

pausing behavior of 24 Chinese EFL writers in a computer-aided argumentative writing task. It specifically examined how writing skill affected pausing in the prewriting and composing stages. Following the pause threshold in previous studies (Spelman Miller, 2000, 2005; Sullivan & Lindgren, 2002; Wengelin, 2002), pause was defined as inactivity of two seconds or longer in any window, including the word processor. The study attempted to address the following research questions:

1. Do skilled and less-skilled EFL writers differ in their writing time allocation, pausing patterns, writing fluency, and text quality?

2. How do pausing patterns relate to writing fluency and to text quality?

3. How do web search and dictionary use relate to the pausing patterns of both skilled and less-skilled EFL writers?

METHOD

Participants

As computer experience may substantially affect strategy use in computer-assisted writing, 24 students with at least four years of computer experience were recruited from a pool of 116 first-year full-time undergraduate science majors at a Chinese university. The students were selected according to their writing scores in the English placement test they took upon entering college. The test was modeled on CET 4, a nation-wide English proficiency test given biannually for college students across China. The test has an essay writing section with a total score of 15 points. Guided by the rating rubric for CET 4 writing (See Appendix), experienced CET 4 writing raters holistically marked the students' writings. Eventually, 11 students who scored 12 or above were selected to form the skilled group and 13 students who scored eight or below formed the less-skilled group. For the qualitative part of the study, 10 participants, five from each group, were selected on a voluntary basis and their writing processes, as shown by the Camtasia video, were examined for web search and dictionary use.

All the participants were 17 to 19 years old at the time of data collection and they had been learning English as a foreign language in the Chinese context for a minimum of six years. Generally, the participants had few opportunities to use English for communicative purposes outside the classroom and their English writing practice was largely limited to classroom instruction and assignments. To better motivate the participants, the researchers promised to provide individual feedback on their writing problems after the study.

Writing Task

The writing task was to develop an argumentative essay on *whether drunk drivers should be imprisoned for their first offense*. This topic was chosen because just before this study, there had been a serious drunk driving case in town, in which five people were killed and four injured. The case was widely covered by local and national media and aroused great social concern. In addition, before the study, the participants had not been exposed to classroom instruction on English argumentation.

Procedures

All the data were collected in the computer lab where the participants regularly had their classes. They were told to write on the computer and to access the Internet and local resources on the computer whenever they felt necessary. Other resources, however, were prohibited to preclude activities that could not be captured by Inputlog or Camtasia (e.g., pen-and-paper drafting, paper dictionary consultation, and/or peer discussion).

The participants were told to take as much time as they needed to complete an essay of whatever length they liked. To avoid possible misunderstanding, all the instructions were given in the participants' L1,

Mandarin Chinese.

Prior to data collection, Inputlog and Camtasia were installed on the desktop computers and set on stand by. After showing the topic and task instructions on the projection screen, the teacher started Camtasia recording on all desktops from the monitoring computer. At the same time, the participants were asked to activate Inputlog by clicking the "Start Recording" button and click the "Stop Recording" button when they finished, which marked respectively the beginning and ending of the writing session. After the writing event, all the participants were informed of the Inputlog and Camtasia recording procedures and signed the agreement of participation on a voluntary basis.

Quantitative Data Coding and Analysis

Identifying Pauses at the Prewriting and Composing Stages

The Inputlog and Camtasia files of each writing session were examined to identify the prewriting and composing stages for each participant. The prewriting stage is routinely defined as the generation and arrangement of ideas before a writer starts drafting. In this study, it was operationalized as the period that spanned from the beginning of a writing event (the initial logging of Inputlog) to the logging of the first letter of any complete sentence other than a restatement of the given topic. A restatement of the topic was not recognized as the beginning of the composing stage because most participants typed the topic in the word processor as a first step, followed by an observable period of inactivity or web browsing for topic-related information. The composing stage was defined as the period following the prewriting stage up to the end of the writing event.

Pause frequency and pause duration were examined both globally in each writing event and separately for the prewriting and composing stages. To make pauses at the two stages comparable, pause frequency at each stage was standardized to the number of pauses in a 10-minute segment by following the formula below:

Stage pause frequency = (Raw Number of Pauses/ Stage Length (seconds)) * 600(seconds)

Computing Writing Fluency and Scoring Texts

Writing fluency was calculated as the number of words produced per minute (Chenoweth & Hayes, 2001) in pen-and-paper settings. Although letter was an easier unit to calculate in keyboard writing, writing fluency was denoted by the number of words produced per minute in this study to align with possible findings from previous studies in pen-and-paper settings and more importantly, to relate to text quality.

Two experienced writing raters independently scored the final texts and the rating rubric for CET 4 was provided to both raters (see Appendix). The interrater reliability using Cronbach's alpha was performed to check consistency between the two raters and it reached .94. The two scores for each text were then averaged and used as the final text score for further analysis.

Statistical Analysis

As nonparametric tests do not require any particular distribution of the data and the current study has a small sample size, a series of Mann-Whitney U tests were run to check if the two groups differed significantly and correlations were computed to see how text score related to pausing patterns and writing fluency.

Qualitative Data Coding and Analysis

The Camtasia video data were designed to supplement the Inputlog data on the writers' two specific activities, web search and dictionary use. Web search was defined as the participants' engagement in accessing web information for task completion. Each web search was identified by being preceded and followed by another website or window. One dictionary use referred to one look-up entry in the dictionary during the writing event. Dictionary use was further categorized into Mandarin-English

dictionary use (hereafter referred to as L1-L2 dictionary use) and English-Mandarin dictionary use (hereafter referred to as L2-L1 dictionary use). L1-L2 dictionary use referred to the student writer's behavior of inputting a Chinese item to look for its corresponding English expression and L2-L1 dictionary use referred to the behavior of looking up an English item for its Chinese meaning or usage.

As a measure of reliability, three researchers first discussed the coding procedures for web search and dictionary use, and two of them coded the video data for one participant as a trial run. Differences in coding were then discussed and resolved. By dividing each video file into clips of 10 minutes, the two researchers coded the remaining 9 student writers separately and the interrater reliability reached .87. Then differences were resolved for each 10-minute segment through discussion and full agreement was reached.

RESULTS

Writing Time Allocation

Table 1 summarizes the descriptive statistics for the participants' time allocation throughout the writing event and separately for the prewriting and composing stages. As the sample size for this study was small and the data spread out widely, the means did not suggest a good measure of the central tendency and some SDs were large. Therefore, mean ranks instead of means were compared in Mann-Whitney U tests to examine group differences. A Mann-Whitney U test on the writing event time showed that the two groups did not differ significantly, ($U = 54$, $z = -1.01$, $p = .31 > .05$, $r = .21$), suggesting that the two groups spent similar amount of time on the task.

Table 1. *Writing Time for Skilled and for Less-Skilled Groups*

	Skilled group ($n = 11$)		Less-skilled group ($n = 13$)	
	Mean	*SD*	Mean	*SD*
Event time*	3962	496	3774	563
Prewriting time	479	157	943	393
Composing time	3483	487	2831	421

Note: time shown in seconds

Table 1 also shows that the two groups allocated different amounts of time to different writing stages. The mean of the prewriting time was 6'59" (479 seconds) for the skilled group and 15'43" (943 seconds) for the less-skilled group, but the skilled group had longer composing stages (*Mean* =3483, *SD* = 487) than the less-skilled group (*Mean*= 2831, *SD* = 421). The Mann-Whitney U tests on the prewriting time and the composing time confirmed that, compared with the less-skilled group, the skilled group allocated significantly less time to prewriting ($U = 25$, $z = -2.69$, $p = .007 < .05$, $r = .55$) but significantly more time to composing ($U = 20.5$, $z = -2.96$, $p = .003 < .05$, $r = .60$).

This suggests that, although skilled and less-skilled L2 writers spent a similar amount of time on the task, they allocated a significantly different amount of time to their prewriting and composing stages. In general, the less-skilled writers experienced longer prewriting stages while the skilled writers had longer composing stages.

Pausing Patterns

Table 2 summarizes the pause frequencies and durations of the two groups throughout the writing event. Mann-Whitney U tests suggest the two groups did not differ significantly in terms of pause frequency ($U = 64$, $Z = -.44$, $p = .66 > .05$, $r = .09$) or pause duration ($U = 45.5$, $z = -1.51$, $p = .13 > .05$, $r = .31$).

Table 2. *Pause Frequencies and Durations for Skilled and for Less-skilled Groups*

	Skilled group ($n = 11$)		Less-skilled group ($n = 13$)	
	Mean	*SD*	Mean	*SD*
Total pause frequency	39.4	6.4	40.9	7.5
Total pause duration	7.6	2.2	6.3	1.0

*Note: frequency is shown as number of pauses of two and more seconds; duration is shown in seconds.

The pausing behavior was further examined at the two functional stages and the descriptive statistics were summarized in Table 3. Mann-Whitney U tests suggest that at the prewriting stage, the skilled group paused significantly less frequently than the less-skilled group ($U = 35$, $z = -2.12$, $p = .03 < .05$, $r = .43$) and potentially longer than the less-skilled group as the group difference in pause duration approached the significance level, ($U = 38.5$, $z = -1.91$, $p = .056$, $r = .39$). In the composing stage, the two groups did not display any significant difference in pause frequency ($U = 64.5$, $z = -.41$, $p = .69 > .05$, $r = .08$) or pause duration ($U = 51.5$, $z = -1.16$, $p = .25 > .05$, $r = .24$).

Table 3. *Prewriting and Composing Pause Frequencies and Durations*

	Skilled group ($n = 11$)		Less-skilled group ($n = 13$)	
	Mean	*SD*	Mean	*SD*
Prewriting pause frequency	27.5	11.0	35.5	8.3
Prewriting pause duration	15.5	13.8	7.2	2.9
Composing pause frequency	41.0	7.2	42.3	8.0
Composing pause duration	7.2	2.0	6.1	1.1

*Note: frequency is shown as number of pauses of two and more seconds; duration is shown in seconds.

Writing fluency, text quality and pausing

Table 4 presents the means and standard deviations of writing fluency and text score. Mann-Whitney U tests suggest that the skilled group wrote significantly more fluently than the less-skilled group ($U = 37$, $Z = -2.00$, $p = .047 < .05$, $r = .41$) and produced significantly better final texts ($U = 31$, $Z = -2.36$, $p = .02 < .05$, $r = .48$).

Table 4. *Writing Fluency and Text Score for Skilled and for Less-skilled Groups*

	Skilled group ($n = 11$)		Less-skilled group ($n = 13$)	
	Mean	*SD*	Mean	*SD*
Writing Fluency	3.9	1.1	3.2	0.7
Text Score	9.5	2.4	7.2	1.8

Two-tailed Pearson Correlation Coefficients were computed to assess the relationship between writing fluency, text score and pausing statistics. The results suggested that text scores correlated positively with prewriting pause duration ($r = .43$, $N = 24$, $p < .05$) and composing time ($r = .57$, $N = 24$, $p < .05$) but correlated negatively with prewriting time ($r = -.42$, $N = 24$, $p < .05$). In addition, the positive correlation between text score and writing fluency approached the significance level, ($r = .39$, $N = 24$, $p = .06$). To sum up, increases in prewriting pause duration and writing fluency result in increases in text score while

increases in prewriting time correlated with decreases in text score.

Web Search and Dictionary Use

Web search and dictionary use were examined respectively at the prewriting and composing stages. The skilled and less-skilled writers displayed very different priorities and strategies in the two stages, as indicated by both how frequently and for what purpose the participants departed from the word processor. Three observations were made. First, the two groups demonstrated different language preference in web use, with the skilled group having engaged in more L1 web search while the less-skilled group, more L2 web search. Table 5 shows, in the prewriting stage, the ratio of L2/L1 web search for the skilled group was two to eight and the corresponding ratio for the less-skilled group was 29 to 19. In the composing stage, although both groups accessed L1 websites 13 times, the less-skilled group accessed L2 websites 51 times while the skilled group did not access any L2 website.

Table 5. *L2 and L1 Web Search for Skilled and Less-skilled Writers*

	Skilled Writers (*n*=5)	Less-skilled Writers (*n*=5)
Prewriting L2 web	2	29
Prewriting L1web	8	19
Composing L2 web	0	51
Composing L1 web	13	13

Second, the two groups displayed different degrees of dependence on web information. As shown in Table 5, during the prewriting stage, the skilled group initiated fewer web searches, but exhibited more focused reading of the websites as shown by the Camtasia video. In contrast, the less-skilled group featured more web searches, more websites visited, quick shifts between different websites and consequently, less focused reading of web content. In the composing stage, the skilled group mainly focused on text production in the word processor, with occasional reference to previously visited L1 websites for specific information. However, the less-skilled group engaged in new searching efforts and displayed observable writing anxiety by their quick shifts between different websites and the word processor, focusing neither on website reading nor on writing in the word processor.

Take the Skilled Writer One (hereafter referred to as S1) and the Less-skilled Writer Four (hereafter referred to as LS4) to exemplify the differences between the two groups. S1, whose prewriting stage spanned 13'21" (801 seconds), visited five websites in total, two in English and three in Mandarin. After the writing event began, following some long pauses in the word processor, S1 used *Drunk drivers should be imprisoned on their first offense* as the keywords to search in Google. He quickly decided on one link, clicked it and stayed on it for 5'1" (301seconds) to do detailed reading, as shown by his occasional highlighting some of the sentences. For his second search, S1 used Mandarin keywords on drunk driving and displayed attempts to access three links. For the first link, when opened, he saw it was a video clip and immediately turned it off. Then he tried a second link, but the website did not pop up quickly enough before he turned it off. He then went back to the video-clip link that he had accessed earlier. Without watching the video clip, he directly scrolled down for the written description for 23 seconds and then resumed the word processor for focused writing, marking the end of his prewriting stage. In this stage, S1 referred to an L2-L1 dictionary once. In his composing stage, S1 did not initiate any new web search but did refer back to the L1 web, leaving this stage focused on text production, with frequent references to L1 and L2 dictionaries.

LS4, by contrast, initiated six new web searches, and used the web 16 times in the prewriting stage, which lasted for 23'53" (1,433 seconds). First, he searched in English *Drunk drivers should be imprisoned on*

their first offense on Baidu, a popular search engine in China. With a glance over the many links on the screen, he scrolled down to the *searches relevant* option at the bottom of the webpage and clicked *drunk drivers* to launch a new search. Again, he did not access any website but went to *searches relevant*. This time, he clicked *Compositions on drunk driving*, for which he still did not access any website before turning it off. After a quick and unproductive shift on the word processor, he used *Drunk drivers should be imprisoned on their first offense* as keywords to search in Google. Interestingly, he chose the same website as S1, but he closed it 10 seconds later in an attempt to access the translated version of the same website, which unfortunately did not pop up. Thus, LS4 went back to access the English website again and spent the next 3'18" (198 seconds) on about one third of the webpage, which S1 seemed to have covered more thoroughly. During this reading, LS4 referred to L2-L1 dictionary nine times for unknown words on this website. This was only part of his web use in the prewriting stage. In the composing stage, LS4 accessed L2 websites six times and an L1 website once, without slowing down to read any of them. For dictionary use, he used his L1-L2 dictionary 21 times and his L2-L1 dictionary 17 times. Consequently, the composing stage of LS4 frequently broke down due to shifts back and forth between different websites, dictionaries and the word processor.

Finally, both groups displayed heavy reliance on dictionaries during the writing event, indicating that language frequently posed problems for L2 writers. As shown in Table 6, in the prewriting stage, the skilled group consulted L2-L1 dictionaries five times and L1-L2 dictionaries seven times. The corresponding figures for the less-skilled group were 26 and 10 respectively. The composing stage featured frequent dictionary consultation by both groups. The skilled group referred to L2-L1 dictionaries 28 times and L1-L2 dictionaries, 74 times, while the numbers for the less-skilled group were 45 and 105 respectively.

Table 6. *Dictionary Use for Skilled and for Less-skilled Writers*

	Skilled Writers (*n*=5)	Less-skilled Writers (*n*=5)
Prewriting L2-L1 Dictionary	5	26
Prewriting L1-L2 Dictionary	7	10
Composing L2-L1 Dictionary	28	45
Composing L1-L2 Dictionary	74	105

*Note: L2-L1 Dict.: English-Mandarin Dictionary Use; L1-L2 Dict.: Mandarin-English Dictionary Use.

Nevertheless, the Camtasia video suggests that the two groups had different strategies for their dictionary use. First, the skilled writers bypassed the language barrier in the prewriting stage by taking advantage of L1 websites and thus relied less on dictionaries while the less-skilled writers had to depend on L2-L1 dictionaries for L2 website reading. In this stage, the less-skilled group referred to L2-L1 dictionaries 26 times, far outnumbering the five times of the same kind for the skilled group. Second, in the composing stage, the skilled writers exhibited a tendency to look up words or short expressions. In contrast, the less-skilled writers seemed to be hoping that the "*whole text translation*" function, supported by some online dictionaries, would do the language magic. The less-skilled group typically typed long strings of Chinese characters such as complete Chinese sentences or even a Chinese paragraph for translation. Finally, the two groups differed in their dictionary consultation process. The skilled writers decided quickly on options suggested by a dictionary. As Camtasia video reveals, they also used dictionaries for spelling check and collocation check after they had produced the right expressions in the word processor. Consequently, the dictionary-consultation process of this group was brief and efficient. In contrast, the less-skilled group exhibited difficulties in deciding among the options suggested in L1-L2 dictionaries. These student writers, more often than not, found a possible English equivalent to a Mandarin expression

first, and used it as a new look-up entry in the L2-L1 dictionaries for its possible usages, which resulted in frequent and time-consuming dictionary consultations for this group.

DISCUSSION

The analyses of writing time allocation, pauses, writing fluency, final text, and extra writing activities reveal interesting differences in the writing behavior of both the skilled and less-skilled EFL writers in computer keyboard writing settings.

Writing Time Allocation

What appears striking and unexpected in this study is that, although the two groups spent similar amounts of time on the writing event, the less-skilled writers allocated significantly more time to the prewriting stage than the skilled writers. Compared with previous findings in pen-and-paper L2 writing studies that experienced writers spent more time on prewriting planning than novice writers (de Larios, Manchón, Murphy, & Marín, 2008; de Larios, Marín, & Murphy, 2001; Sasaki, 2000, 2004), this study suggests an almost reversed time allocation pattern for prewriting and composing between the skilled and less-skilled writers, showing that time allocation in computer-assisted L2 writing is potentially different from that in a pen-and-paper setting (Silva, 1993).

There could be two reasons for the observed time allocation pattern. First, the less-skilled writers could have realized the importance of clear planning for good writing and strived hard for it by engaging in extensive online searching. However, this goal was hindered by their lack of ability to make a choice over different websites and to engage in focused reading once a choice is made. Another possibility is that the less-skilled writers may lack control over information mining on the Internet and become information-drowned with neither efficient screening of websites nor proper management of web information.

Whatever the case may be, the fact that the prewriting time negatively correlated with writing fluency suggests that although the less-skilled group spent significantly more time in the prewriting stage, this time was not rewarded in the composing stage, as demonstrated by their less focused text production in the word processor, quick shifts between different windows and observable writing blocks. In sum, the less-skilled L2 writers may need more guidance on management of writing resources in an electronic environment to make their prewriting stage more rewarding and their composing stage more productive.

Pausing, Writing Fluency, and Text Quality

Another interesting finding of this study is how pauses might be affected by writing skill. While confirming the previous finding that writing skill did not affect the overall pause frequency and duration (Schumacher et al., 1984), this study found that writing skill did affect pausing in different writing stages. The skilled writers paused longer and less frequently in the prewriting stage than the less-skilled group, but the two groups were not statistically different in either pause frequency or pause duration in the composing stage. The positive correlation between the prewriting pause duration and text score further suggests that L2 writers may benefit from long pauses in the prewriting stage (Beauvais et al., 2011).

The Camtasia videos showed that long pauses in the prewriting stage frequently involved conceptualization and planning on the global level and focused reading of web information, which produced positive effects in the composing stage. In the composing stage, the skilled group focused on text production on the word processor with frequent references to dictionaries for the translation of ideas; in contrast, the less-skilled group frequently departed from the word processor for new search efforts, showing insufficient global planning in their prewriting stage. This was also evidenced by their low writing fluency and less conceptually developed final texts. The correlation between writing fluency and text score confirms that writing fluency may be an important predictor of writing quality for university students (Ransdell & Levy, 1996; Thorson, 2000).

Two extra writing activities—web search and dictionary usage—help explain the relationship between the pausing patterns, writing fluency, and text score. By engaging in more focused reading of online resources and the conceptualization of ideas, the skilled writers paused longer but less frequently in the prewriting stage. This led to a more focused composing stage with less dependence on web resources, displaying short and frequent pauses in text production for local translation problems. However, the less-skilled writers engaged in excessive web search and dictionary use in both stages, and such excessive engagement may have consumed much of the attentional resources that would otherwise have been available for global planning of content or organization. This resulted in a fragmented composing stage, marked by frequent departures from the word processor for web search or dictionary use, and consequently, short and frequent pauses in this stage.

This result confirms previous findings that less-skilled L2 writers engaged in less global planning and their low-level linguistic concerns may overload their working memory (de Larios et al., 2001; Jones & Tetroe, 1987; Silva, 1993). The study also suggests pausing as a strategy for the skilled L2 writers to manage the competing demands of composing in the prewriting stage (de Beaugrande, 1984; Spelman Miller, 2005). One implication here for writing instruction is that L2 writers need to be taught about the practical goals of each writing stage and the possible means of meeting these goals so as to avoid cognitively overloading the working memory in the writing process.

Web Search and Dictionary Use

The participants' use of websites both in L1 and in L2 shows that the two groups may have had different concerns and/or priorities guiding their language preference in web usage. For skilled EFL writers, web searches were aimed at information mining for global conceptualization at the prewriting stage. L1 websites may help meet this purpose by freeing up attentional resources from L2 language processing. By contrast, the less-skilled EFL writers tried to search L2 websites for some ready-made L2 texts online that they could piece together to make their own compositions. For this purpose, this group strived to read L2 websites with frequent use of L2-L1 dictionaries, displaying great concern over language priming even in the prewriting stage. As Lynch and McLean (2000) suggest that L2 proficiency level may mediate learner priority over form or content in oral production, the current study suggests a similar mediating function of writing ability on learner priority over content or form in written production, with skilled writers focusing on content planning in L1 and less-skilled writers struggling with their L2 for language priming.

There have been both theoretical speculations and empirical findings that inhibition of conceptual processing occurs more often in L2 than in L1 writing (Kellogg, 1994; McCutchen, 1996; Stevenson, 2005). In this study, by using L1 web sites, the skilled writers achieved conceptualization in the prewriting stage, leaving the composing stage more focused on the transformation of ideas. In contrast, the less-skilled writers tried to access and read L2 websites in the prewriting stage and repeatedly launched new web searches for topic-related information in the composing stage, suggesting that this group still confronted macro-conceptual issues in the composing stage. Although these students spent more time on the prewriting stage, the time spent was not awarded fruitfully as was demonstrated by their fragmented and unproductive composing stage. In addition, their language concern early in the prewriting stage was not rewarded in the final text.

While Lay (1982) reported that more L1 use in L2 writing resulted in better text, it remains unclear what "more L1 use" actually means (van Weijen, van den Bergh, Rijlaarsdam & Sanders, 2009, p. 236). This study suggests that L1 use in the prewriting stage may help student writers bypass L2 language problems and concentrate on their conceptualization of ideas. The fact that the skilled group benefited from their conceptualization in L1 suggests that L2 writers should concentrate first on "how to make meaning" (Zamel, 1983, p. 180). This lends further support to previous findings that L1 may have a role to play in L2 writing to make it less cognitively loaded and more conceptually developed (Cohen & Brooks-Carson, 2001; Knutson, 2006; Woodall, 2002). Although the literature does not provide a consensus on whether

L2 writers benefit more by planning in their L1 or their L2 (van Weijen et al., 2009; Wang & Wen, 2002), the fact that the skilled writers had a way with conceptualization in L2 writing while the less-skilled were striving for a method testifies to the scaffolding role of L1 in L2 writing.

The finding that both groups relied heavily on L1-L2 dictionaries in the composing stage shows language continues to pose problems for L2 writers. Previous studies suggest that attention to lower-level linguistic demands during L2 writing may take up a large amount of the writer's cognitive capacity, leaving less available for higher-level processing like content, audience and style (Scott, 1996; Whalen & Ménard, 1995). This proves particularly true with the less-skilled writers in the current study, who encountered language difficulties early in the prewriting stage, resulting in less conceptualized writing plans. Moving to the composing stage, this group lacked sufficient L2 knowledge to decide among the options in the dictionaries, resulting in lengthy and inefficient dictionary-referencing process. The skilled group, nevertheless, stayed more focused on the transformation of ideas in the composing stage and displayed varied and efficient dictionary use.

This finding confirms that low-proficiency L2 writers were more occupied with attempts to compensate for interlanguage deficits (de Larios, Manchón, & Murphy, 2006) and this could, to a large extent, inhibit conceptualization at the global level. One pedagogical implication here is that bilingual dictionaries, though a necessary part of L2 writing, is not always beneficial (Chon, 2008) and good timing for dictionary use could be an important factor in limiting excessive concern over language in L2 writing.

CONCLUSION

Through Inputlog and Camtasia, the present study explored the writing process of Chinese EFL writers at the skilled and less-skilled levels and in the prewriting and composing stages. It has yielded several important findings. First, when writing in an electronic environment, less-skilled writers may spend more time than skilled writers in the prewriting stage. The negative correlation between the prewriting time and text quality suggests that online resources may pose potential challenges for L2 writers with information mining and management. L2 writers need to better manage writing resources in the different stages of writing so as not to overload their working memory. The positive correlation between prewriting pause duration and text quality suggests that L2 writers are more likely to benefit from focused conceptualization and reading activities in the prewriting stage. Within the current writing theory and practice, this study suggests that computer-assisted L2 writing has placed more competing demands of attentional resources on the working memory and that L2 writers need strategic plans to meet these demands.

Second, low-level linguistic concerns in the early stages of writing may distract L2 writers' attention from global planning and result in fragmented composing stages and less-conceptually developed final texts. As writing is primarily about making meaning (Zamel, 1983), L2 writers need to meet this primary goal first. The "one at a time" problem-solving strategy may help avoid overloading the working memory with both conceptual planning and linguistic concern at the same time.

Third, this study methodologically integrates input logging and screen recording in studying the L2 writing process, showing that this method promises unobtrusive inquires into the online writing process both quantitatively and qualitatively. As L2 text quality may strongly correlate with efficiency of writing strategies (Whalen & Ménard, 1995) and that writing strategies can be promoted to a more conscious level to guide writing, the replay of the input log and screen video data may hold new pedagogical possibilities for promoting strategy use, learner self-assessment, metacognitive awareness, and learner autonomy in L2 writing.

LIMITATIONS AND SUGGESTIONS

First, findings of this exploratory study may not be generalized to other EFL writers in vastly different

settings. As Prior (1998) explicitly points out, the writing process is "locally situated, extensively mediated, deeply laminated and highly heterogeneous" (p. 275), factors like the participants' background, motivation, anxiety, engagement in the task, task characteristics, and computer lab facilities may all have contributed differently to what was found in this study. Future research may take these factors into account and investigate to what extent or under what circumstances the findings of this study can be generalized.

A second concern is that pause is defined in this study as an inactive period of two seconds and longer in multiwindow settings. While the data permit a comprehensive view of the genuine pausing patterns of the writing event, this study did not look into pauses that happened only in the word processor, making it difficult to align findings directly with previous pausological studies. Future studies could distinguish between pauses in the word processor and those in other windows.

Finally, as pause threshold in this study was set at two seconds, a relatively inclusive but short threshold, the study did not examine how pause frequency and pause duration relate to specific cognitive activities in the writing process hierarchically. Future studies could vary pause thresholds to examine the correlation between the pausing behavior and the possible cognitive activities involved.

NOTE:

1. The basis of the Keytrap program was developed by IBM, Brussels. Dr. H. Pauwels (University of Antwerp, UFSIA) updated the program and wrote the necessary application programs. For a detailed description of the program, see Van Waes and Schellens (2003).

APPENDIX. Rating Rubric for CET4 Writing

Points	Organization	Content	Language
2	No focus; disorganized	Ideas random, inappropriate or illogical	Incomplete or incorrect sentences; severe errors that affect meaning
5	Attempts to focus; minimal organization	Ideas mixed; few transitions	Monotonous sentence structures; numerous errors that interfere with meaning
8	Single focus; some lapses or flaws in organization	Ideas not well supported or elaborated	Little variety in syntax; some evident errors
11	Single focus; logical organization	Ideas appropriate and varied	Varied sentence structure; few errors
14	Single, distinct focus; logical progression of ideas	Details effective, vivid, explicit and pertinent	Very few, if any, errors

Note: This rubric assigns each text into one of the five levels above, and minor deviations from the description for each level may result in the loss or gain of one point. Thus, a perfect score is 15 and the lowest score is zero.

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