Writing on a Computer and Using Paper and Pencil: Is there any Difference in the Internal Cognitive Processes?

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ABSTRACT

The present study attempted to unveil the differences in the cognitive processes employed in writing in a second language while writing on computer, and with paper and pencil. In doing so, eleven upper-intermediate, Persian-speaking English Language learners wrote texts in response to two International English Language Testing System (IELTS) writing tasks on computer and with paper and pencil. The Cognitive Processes Questionnaire (Weir, et al., 2007) and stimulated recall interviews were employed to collect data. The quantitative and qualitative analysis of the collected data indicated that the participants spent less time on pre-writing planning, in the computerized condition, but they paused more often during the writing process for online planning. Furthermore, the participants, in both conditions, spent less time for planning when they wanted to write examples pertinent to their own life experience. The participants, in the computerized writing, tended to evaluate and review the text during the process writing, while in the paper and pencil condition, the evaluation was postponed to the end of the writing process. Longer text revision and a higher number of the rearrangements of sentences and ideas were other features of computerized writing. These findings along with those of other studies can deepen our understanding of second language writing cognitive processes which can benefit second language teachers, curriculum developers, and test developers.

Keywords: English as a foreign language; writing; cognitive processes; paper and pencil writing; computerized writing

INTRODUCTION

Understanding the underlying processes of producing and comprehending a language has always been an appealing research topic for language researchers. The black box of writing, which is reported to be one of the most challenging language skills (Ansarimoghadam & Tan, 2013) has been an interesting area for researchers which have, more or less, been investigated in the recent decades (Lee, 2002). Internal cognitive processes of comprehending and producing language discourse were ignored by the followers of behaviorism; however, the cognitive approach to studying first and second language gave currency to not only the input and output, but also the processes that bridge these two poles. A long-lasting question which has lingered on writing studies has to do with the internal cognitive processes that one goes through to write a piece of writing. Although the research on this concealed part of language production started in the late 1970s, reviewing the scope and aims section of the journals specialized on first and second language writing, we can observe that the investigation of the internal processes is still in vogue.

It is generally believed that writing is a process that involves a set of stages that result in a product which is a piece of writing (Hyland, 2003; Kim & Yoon, 2014). Taking the increasing instances of using computers to write texts in the real life tasks (e.g., email

writing, posting on websites and weblogs) and high-stakes examinations such as TOEFL, iBT and Computerized IELTS, we can add another question: Do writers employ different cognitive processes when writing on a computer and using paper and pencil? Motivated by the tenets of Sociocultural Theory who believes in the effect of symbols, signs, actions, and objects on the formation of humans' higher order thinking abilities in the long-run and the cognitive processes of performing a single task in the short-run (Englert, Mariage, & Dunsmore, 2006; Leontiev, 1932; Vygotsky, 1978), we assumed that the medium with which a second language writer employs to write a text might affect his cognitive processes. In the present study, the effort is exerted to answer this question by examining how Persian-speaking foreign language learners write in English.

A group of researchers who are interested in the result of cognitive processes studies is the language testing community. Language assessment tasks are claimed to be accompanied by several factors which are called test methods or facets (Bachman, 1991). These methods are claimed to affect the performance of language users in a positive or negative manner. Chapelle and Douglas (2006, p. 21) states, "[T]he so-called 'method effect' associated with the procedures by which the test is delivered, the responses processed, and the scores derived can reflect both positive and negative effects on the test performance". These days, computers have become an integral part of high stakes language testing process. Computers are employed for sundry uses such as presenting the input, scoring the text, and easing the process of recording auditory or written materials. The use of computers might affect both the executive cognitive processes (Weir, O'Sullivan, Yan, & Bax, 2007), and the scores as indicators of testees' performance (Chapelle & Douglas, 2006). In the present study, the focus is on the former, i.e., the effect of using computers in writing tasks on EFL learners' executive cognitive processes.

RELATED STUDIES

The inception of the studies on the writing processes dates back to around thirty years ago. Since then, a number of models have been provided based upon empirical studies and theoretical reflections. Here is a brief review of the oft-cited second language writing models. Flower and Hayes (1980) provided the academia with one of the first models of writing which was driven from an empirical study. Their model encompassed three processes which recurred during the process of writing. These stages were planning, translating, and reviewing. Unlike stage models which held a linear manner of planning, writing, and editing which was proposed by the product-based view (Galbraith, 2009), the process model indicated that each of these mental processes could occur at any moment in the writing process. In their model, the text under construction is in constant interaction with the task requirements and the writer's long-term memory which includes the knowledge of topic, audience, and writing plans (Flower & Hayes, 1983). The writing process, based on this model, is made out of the interplay of planning, translating, and reviewing stages, supervised constantly by a component called monitor. Planning includes generating ideas, organization, and goal setting, translating which is defined as the way writers convert the conceptual content into the linguistic form, and reviewing which encompasses evaluating and revising. Around two decades later, Hayes (1996) put a step forward and freed the model from the staged nature and provided a set of components which are at work which are the physical environment, the social environment, affect/ motivation, long and short-term memory, and finally the cognitive processes which ties these components together.

Another well-known writing model is proposed by Grabe and Kaplan (1996). Following the general model of communicative language use provided earlier (Chapelle, Grabe & Berns, 1993), they include both internal and external factors in their models. They take context as the external factor which comprises situation and performance output.

Included in the internal section are internal goal setting, internal processing output, and verbal processing subcomponents which are language competence, knowledge of the world, and metacognitive processing required for assembling the world and knowledge of language. The two layers of internal and external factors are at constant interplay.

Field (2004), too, proposes a model of writing. Using the terminology of Kellogg (1996), he proposes a new model based on information processing models. The first stage, to him, is macro-planning which has to do with employing world knowledge to glean a set of ideas. Organization, another abstract stage, deals with organizing the ideas and assigning importance level to the ideas to be included in the text. Micro-planning has to do with planning at the sentence and paragraph level. Translation is the next stage which has to do with the conversion of the propositional content from abstract to linguistic form. The product in this stage is an array of key words that are of lexical content. The physical process of writing is the next stage which is called execution. While writing the text, the students are constantly monitoring their under-construction texts; this stage is called monitoring and has to do with mechanical, syntactic, and propositional aspects. Editing and revising, also, are employed during and after writing the text to improve different aspects of writing. After monitoring, a set of modifications at different levels might occur until the last version is written by the writer. Weir (2005) also presents a model which is highly inspired by that of Field (2004). Weir's cognitive model of writing focuses on the internal cognitive factors, thus the execution which is the physical is not reflected.

In order to investigate the internal cognitive processes, the Weir's (2005) model and terms are employed in this study. This theory-based section encompasses executive resources and executive processes. The former has to do with linguistic resources and content knowledge, and the latter refers to cognitive processing and includes the procedures of *goal-setting, topic and genre modifying, generating, organizing, translating* and *reviewing*. Along with the proposition of these models, a few number of studies have been conducted quantitatively and qualitatively, on paper and pencil and computerized writing. Amongst these studies, the majority of them have investigated the scoring procedures; these studies have investigated the way the mode of writing affects the scoring process of raters, and fewer studies have directed the cognitive processes of L1 and L2 writing issues in the literature.

With regard to examining the effect of different technological tools on writers' cognitive processes, some studies have been conducted to date which are reviewed here. Collier and Werier (1995) conducted a study to examine how computer writing and writing by hand are different. They compared both the processes and the products to find out any possible difference. The participants of their study were three female adults who were familiar with employing computers for typing. They wrote four papers in a two weeks interval. The results of their study indicated that the writers' style of writing was affected noticeably by the computer; however, these influences were related to individuals and did not exist in the writing behavior of the three participants. The switch to the conventional writing with paper and pencil was a bit difficult for them at the beginning, but they got adopted with the new writing condition and completed the task. With regard to the product, the scores of the participants in the two conditions were not significantly different. In another case study, Li and Cumming (2001) compared the processes that happened when a Chinese EFL learner write on computer, and with paper and pencil. The only participant was required to write on 7 topics on the computer, and with paper and pencil. The result of think-aloud indicated that word-processing was superior over the paper and pencil condition with regard to the number of discoursal and syntactic revisions, and evaluations. To compare the cognitive processes employed by non-native speakers during writing, Lee (2002) used questionnaires and interviews. He found that the processes were unique to each participant. He discovered that in the pre-writing phase, the participants spent more time on planning when they were writing

on paper and pencil. They also found that while writing on computers, the participants made more pauses (for planning). A comprehensive study to pinpoint any possible difference between computerized and conventional writing was conducted by Weir et al. (2007). They compared the cognitive processes by employing a questionnaire. Their study indicated that similar patterns of cognitive processes were involved in writing in these two contexts. No significant difference was found in their quantitative study. A few years ago, Stapleton (2010) studied how an MA student wrote a four-thousand word essay. He used in-depth logs, questionnaires and interviews to find the cognitive processes. Stapleton found that the participant spent time on formulating, researching (over the net), planning, revising, collaborating (use of feedback from a more knowledgeable writer), and evaluating, respectively from the longest duration to the shortest one. Comparing the amount of time allocated to each of these processes with that of paper and pencil studies conducted by other researchers, Stapleton (2010), found that the participant in computerized writing spent considerably less time on formulating. However, his participant spent more time on evaluation as compared to the time recorded for those who wrote with paper and pencil.

Although these four studies have been illuminating, there are some minor deficiencies that are worth-mentioning. The case study of Li and Cumming (2001) was based on the performance of a single case. Investigating just a single case with regard to the issues which can be affected by individual differences such as cognitive processes seems insufficient. Li and Cumming (2001) could study more participants to cater for the individual differences, and provide a more generalizable finding. In the second study, for instance, the low keyboarding skills of some of the participants of Lee's (2002) research could adversely affect their performance. The amount of time in which the participants might have desired to spend on planning, formulating, or evaluating was wasted on finding the keys on keyboard. Thus, to have comparable conditions to find the cognitive processes, those who have acceptable computer familiarity should be included in the study; otherwise, the study will suffer from a major threat to the internal validity of the study. The methodological issues are muddier in the third study conducted by Stapleton (2010). Like Li and Cumming (2001), this research investigated the data gathered from a single case which can delimit the generalizability power of the findings. Furthermore, the researcher used the findings of the previous studies to compare the computerized and paper and pencil writing, but the requirements of the tasks in the previous studies might have been different from that of Stapleton's (2010) study which might lead to fallacious generalizations.

The present study, however, have tried to compensate for these methodological issues. This research goes beyond the mere quantitative investigation of cognitive processes and employs a triangulated design which benefits from both quantitative and qualitative data to find the differences of computerized and paper and pencil writing conditions. Unlike the Stapleton's (2011) study, the present investigation scrutinized the cognitive processes of eight participants to provide more generalizable findings.

SIGNIFICANCE OF THE STUDY

This study is the intersection of different fields viz second language writing, cognitive psychology, and language assessment. This interdisciplinary research employs measures which are used in cognitive psychology such as stimulated recall protocol and questionnaire to uncover the processes in EFL learners' minds while writing texts using paper-and-pencil and on computer. The findings of the present research benefit both language practitioners and language testers. Possible differences in the internal cognitive processes under these two different conditions of writing might enable language practitioners to prepare their students for these two different conditions with different pedagogical measures. In language testing, the comparability of scores obtained from computerized and conventional tests has been a

controversial issue in the last decade. Weir et al. (2007) assert that studies similar to the present investigation which enjoy triangulated designs are required to understand whether different output modes require writers to use different executive processes. Furthermore, the results of the present study can give psycholinguists a better understanding of the cognitive processes under different conditions and relate the failure of some individuals in online writing to their individual differences (e.g., short-term memory). Grabe (2001), argues that this sort of studies can illuminate upon the cognitive processes of second language writers which can, along with other studies, lead to a more comprehensive theory of second language writing.

RESEARCH QUESTIONS

The present study attempts to find the differences between cognitive processes employed by EFL writers when writing on a computer, and when using paper and pencil.
This entails two research questions which aim at investigating the differences between the cognitive processes. The two questions are:

A. What are the differences between pre-writing and planning stages of cognitive processes employed by EFL writers when writing on a computer and using paper and pencil?
B. What are the differences between translating and reviewing stages of cognitive processes employed by EFL writers when writing on a computer and using paper and pencil?

METHOD

PARTICIPANTS

The participants of the present study were eleven upper intermediate English language learners. The results of English language proficiency test (Oxford Placement Test: Allan, 2004) indicated that the mean scores of all participants were between 135 and 149, which is taken as the upper intermediate level or B2 in the Common European Framework. All participants were native speakers of Persian. The participants were BA and MA holders, majoring in non-English, humanistic majors. The participants were chosen based on proficiency in the English language and not degrees held. To assure the homogeneity of the participants with regard to their second language writing ability, the paper and pencil task was scored. The results indicated that the scores were not that remote from the mean score (*M= 64.54, SD= 4.9, min=58, max=73*). The participants were selected based on the availability of the researchers to the samples. All participants were university students who could type with no difficulty in both English and Persian.

MATERIALS AND INSTRUMENTS

OXFORD PLACEMENT TEST

In order to assess the English language proficiency of the participants, Oxford Placement Test (Allan, 2004) was given at the beginning of the study. This measure includes 50 multiple-choice items of vocabulary, structure, and reading comprehension. The participants took this test within a time limit of 40 minutes.

WRITING TASKS

The two tasks which were employed in this study were taken from the book *Improve your IELTS Writing: Study skills* (McCarter & Whitby, 2007). All tasks in this book are similar to those of the IELTS writing tasks. The following two tasks were selected randomly:

You should spend 40 minutes on this task. Write about the following topic:

A. The number of elderly people in the world is increasing. What do you think are the positive and negative effects of this trend?
B. Individuals can do nothing to change society. Any new development can only be brought about by governments and large institutions. How far do you agree or disagree?

Give your reasons for your answer and include any relevant examples from your own knowledge or experience. Write at least 250 words.

Task A was employed in the paper and pencil task and Task B was used in the computerized writing; the assignment of tasks to the two treatments was done randomly.

THE WRITING MODEL

In order to be able to match the participants' observable performance and their claims in stimulated recall interviews with the cognitive processes involved in writing, the researchers employed the theory-based (cognitive) validity section of the Weir's (2005) model. In the theory-based section of writing, the mention is made of executive resources and executive processes. The executive resources include communicative language ability and content knowledge. The executive processes are goal setting, topic and genre modifying, generating, organizing, translating and reviewing.

COGNITIVE PROCESSING QUESTIONNAIRE (CPQ)

Cognitive processing questionnaire (See Appendix A), which is developed by Weir, et al. (2007), asks participants to answer 38 items in the form of Likert-scale. This questionnaire is developed based on the above-mentioned model (i.e., Weir, 2005). This measure was used twice after the administration of the writing tasks.

WRITING RATING SCALE

To assign scores to students' writings, the analytical rating scale developed by Jacobs, Zinkgraf, Wormuth, Hartfiel, and Hughey (1981) was employed. This scale includes 5 dimensions which are content, organization, vocabulary, language use, and mechanics. In order to ensure the consistency of the scoring process, the papers were rated by another rater who was familiar with the scale; the inter-rater reliability index was found to be 0.83.

HARDWARE AND SOFTWARE

In order for the participants to write on computer, an MSI CR420 laptop which has a chicklet (island-style) keyboard which is suitable for typing was provided for them. They could also choose a PC with a professional keyboard which was suitable for typing, but none of them selected the PC. The students had to use Microsoft Office Word-2010; however, the autocorrect and word suggestion (synonyms) functions were disabled.

PROCEDURES

In order to answer the research question, each participant took both writing tasks. They took the writing tasks with a two-week interval. The participants were divided into two groups randomly. The first group, which included both MA and BA participants selected randomly, (N= 5) took the paper and pencil task first, and the other group (N=6) wrote on computer first. After 15 days, the first group took the task on computer and the second group wrote with paper and pencil.

During the paper and pencil task, a video recorder recorded the paper on which the text was being written on; likewise, in the computerized writing task, the screen-recording program recorded the way the participants wrote, paused or revised the text. Due to the

logistic issues, the stimulated recall interview was done 5 minutes after the participants completed their writings. The interviews were conducted in Persian, to enable the participants to express their feelings and thoughts easily. To practice the think-aloud protocol, the participants practiced the procedure with simple mathematics word problems (e.g., the participants were asked to add four digits and talk about the stages that they had to go through to reach the answer). These problems were selected since almost everybody had experienced solving such simple problems and the participants would not have a hard time talking about their cognitive processes solving these problems; this was just a practice to prepare the participants for the retrospective activity related to writing which is more complicated. After each administration, the participants took the questionnaire. The procedure is summarized in Table 1.

TABLE 1. The procedures of data collection

Conventional phase	**Computerized phase**
Retrospective stimulated recall- video recording	Retrospective stimulated recall- screen recording program
Questionnaire	Questionnaire

The response to the questionnaire was analyzed quantitatively. The frequency of responses to different items was calculated for the administration of the two questionnaires. To check the participants' level of agreement with the item, the percentage of *agreed* and *strongly agreed* choices were added up and analyzed.

Stimulated recall interviews and video, and screen videos were also analyzed quantitatively and qualitatively. The data gathered from this section were of two types. The first type was the researcher's observing the recorded writing processes, which was used, for example, for checking the pattern of revisions. The second type of data was obtained from the interviews and the participants' words. This type of information assisted the researcher to understand the nature of pauses for planning, or the reason of a revision.

Although both BA and MA holders participated in the present study, the results of the writing tasks indicated that there was no significant difference between the two groups with regard to their writing ability. Furthermore, no significant difference was found between the cognitive processes of these two groups, so the decision was made not to separate the data pertinent to these two groups.

FINDINGS

In order to answer the research questions, the result of the questionnaire administrations was analyzed. In order to have a better understanding of the results, the percentages of agree and strongly agree responses of both writing conditions were computed and juxtaposed for further analysis. For each phase and sub-phase (proposed by Weir et al., 2007), the participants' percentage of agreement with the statements was computed and reported in Table 2.

TABLE 2. The participants' percentage of agreement with the statements

	Agree and strongly agree %	
	Paper and pencil	**Computer**
Goal setting		
Setting goals and purpose	65.5 %	63.64 %
Topic & genre modifying		
Topic relevance	63.7 %	45.5 %
Genre relevance	50.05%	54.05%
Generating		
Write down ideas or retrieve content from memory	70.42 %	50.94 %
Organizing		

Grouping ideas	63.7 %	54.60 %
Putting ideas in order	63.66 %	57.60 %
Translating		
Putting ideas into appropriate language	63.68 %	60.06 %
Putting ideas into cohesive and coherent language	50.05 %	54.6 %
Reviewing		
Evaluating and revising text development	60.66 %	57.6 %
Evaluating and revising content development	70.45 %	79.57 %
Evaluating and revising written thoughts and statements	68.17 %	75 %
Evaluating and revising unwritten thought and statements	72.8 %	63.7 %

Research question 1: What are the differences between pre-writing and planning stages of cognitive processes employed by EFL writers when writing on a computer and using paper and pencil?

QUESTIONNAIRE

The planning section includes two subsections of goal setting and topic and genre modification. As presented in Table 2, the participants agreed with (in the finding section agree equals agree and strongly agree) the items related to the setting goals and purpose of writing (65.5 % for paper and pencil, & 63.64% for computer). In other words, in both conditions, the participants have an acceptable level of understanding of the topic and instruction. They also stated that they were involved in the process of thinking about what to write and how they were required to write in both writing conditions before they started to write.

With regards to topic and genre modifying, in both conditions, the participants were more or less familiar with the topic. However, it was easier for the participants in the paper and pencil condition to produce ideas for composing the text immediately after encountering the task (63.7 % for paper and pencil & 45.5 % for computer). It seems that in the initial and general idea-generation stage, the participants had an easier task in the paper and pencil task. The participants' knowledge of genre was also reported to be close to each other after different administrations (50.05 % for paper and pencil & 54.05 % for computer).

Generating ideas and organizing the ideas comprise the planning stage. This is the stage in which the signs of difference between paper and pencil and computer conditions become discernable (70.42 % for paper and pencil & 50.94% for computer). The participants, after paper and pencil task, reported that they had managed to generate ideas before jotting them down on a paper; there was only 5.46 % disagreement (disagree is used for both disagree and strongly disagree); however, the level of disagreement was 20.02 % in the computer condition.

Organizing the generated ideas is another subsection of planning. With regards to grouping the ideas, the results indicated that the number of prioritizing ideas and making a mental or written outline before starting to write was higher in the Paper and Pencil task (63.7 % for paper and pencil & 54.6 % for computer). Similarly, the participants reported to have an easier task to put the ideas in an acceptable order when they were planning for writing with paper and pencil (63.66 % for paper and pencil & 57.6 % for computer).

STIMULATED RECALL INTERVIEW

Since the pre-writing and planning phases occur, to a large extent, simultaneously, these two stages are reported in a single section. The time period spent on these two phases, therefore, refers to the time span between the participants' encountering the writing task and starting to write the first sentence. To compare the two writing conditions, the temporal lengths of pre-writing and planning of the participants in both administrations were recorded. The results

indicated that the average time spent on pre-writing and planning was 400 seconds in paper and pencil condition, and 225 seconds in the computerized writing. To check whether the amount of time spent in the two conditions were significantly different, *Wilcoxon Signed Rank Test* was employed. The result indicated that there was a significant difference between the two conditions with regard to pre-writing and planning time ($z= -2.934, p< .01$).

The stimulated recall interview was informative in informing us what the participants were thinking about during the pre-writing of each condition. The interviews supported the existence of both pre-writing (goal setting, & topic-genre modifying), and planning (generating & organizing) phases. The participants in both conditions mentioned that they thought about the required genre. They mentioned that they read the instructions and the topic several times in order to avoid any misunderstanding. The participants in both conditions talked about the audience of the text. Eight out of eleven participants in both conditions talked about the genre and topic modification based on the audience of the product. One of the participants, for instance, said, "It was a text similar to a newspaper article. I had to use difficult words and structures to make my text convincing enough for the newspaper audience. I had to talk for and against the topic to support my ideas".

Unlike the pre-writing phase, the signs of differences in the planning phase were detectable in the participants' words. Although the participants in the paper and pencil condition spent time on writing outlines (6 participants), clustering (4 participants), and brainstorming (1 participant) for the different paragraphs, these same participants, however, in the computerized writing, planned mainly only for the first paragraph's details. Except for two of the participants who wrote outlines of all paragraphs, the participants just planned for the first paragraph exhaustively, and the planning for succeeding paragraphs was limited to just a general idea to be developed later. Three participants wrote single words to be developed in the following paragraphs, but 6 participants did not write even a word. However, all participants in the computerized writing mentioned they had general ideas to be narrowed down later on in the process of writing other paragraphs. As an example, when the researcher asked one of the participants who had not written anything for other paragraphs than the first one, she said, "I knew what I wanted to write in other paragraphs, I just wanted to write the first introductory paragraph to understand how to develop those ideas".

Stimulated recall interviews, evidently, demonstrated the way the written thoughts were changed before starting to write. The changes in the order, addition and deletion of written ideas were observed in both computerized and paper and pencil writing conditions. However, a point that could not be missed was related to the amount of modifications in two different conditions. The amount of time spent on idea modification before starting to write in the paper and pencil writing condition was higher than that in the computerized writing. The average time spent on ordering and reordering the written ideas in the paper and pencil condition was 88 seconds, while it was 21 seconds in the computerized writing condition. The result of *Wilcoxon Signed Rank Order Test* indicated that the difference was statistically significant ($z= -2.936, p<.005$).

Research question 2: What are the differences between translating and reviewing stages of cognitive processes employed by EFL writers when writing on a computer and using paper and pencil?

QUESTIONNAIRE

Translating and reviewing have to do with the incorporation of the mind of writers and the under-construction product. The participants reported to have followed more or less the same processes during translating their thoughts into correct words and sentences (63.68 % for paper and pencil & 60.06% for computer), but there was an item which showed discrepancy

between these two conditions. The participants' answers to item twenty-two, which deals with idea-generating during writing, indicated that, the computerized writing condition led to more online idea-generation. While 81.9 % of the responses showed the participants' agreement with the online idea-generation in the computerized writing; this index was 54.6 % in the paper and pencil condition. With regard to producing a coherent and cohesive text, the participants reported to have the same level of difficulty while writing with paper and pencil or on screen (50.05 % & 54.6 %, respectively).

The last section of the questionnaire concerned the evaluation and revision of the text. The participants found evaluation and revision of the text easy in both writing conditions (60 % agreement for paper and pencil & 57.6 % for computer). Although the level of content evaluation and revision during and after the writing process was almost the same (70.45 % for paper and pencil & 79.57 % for computer), focusing on evaluation and revision during writing indicated a discrepancy between the two conditions of writing. While the participants' agreement level was 63.65 % for the former condition, this index was 86.35 % for the computerized output type. This, evidently, showed that in both conditions, the participants were involved in a continuous process of evaluating and reviewing. Weir, et al. (2007) argues that the high level of agreement for the related items is an indicator of the employment of monitor strategy during the process of composing.

The levels of evaluation and revision of written thoughts across two conditions were also examined. The results indicated that the participants in both conditions reviewed their written thoughts during and after finishing writing (68.17% agreement for paper and pencil, &75.00 % agreement for comp.). However, when while and after revisions are scrutinized separately, the results evidently showed that the participants reported they had revised more during the writing process in computerized writing (77.25%), but the agreement level was 54.55% for online revision in paper and pencil condition. It was, also, found that the participants in both conditions agreed with evaluation and revision after finishing writing the essay (81.8 % for paper and pencil, & 72.75% for computer).

STIMULATED RECALL INTERVIEW

The process of translating what was on the mind of writers into concrete linguistic text took the largest portion of the time. The participants wrote and reviewed their sentences and paragraphs during the process of writing; however, the number and length of pauses were higher in the computerized writing. The participants reported that in order to delve into the nature of pauses, the pauses were put into two types of short and long pauses. In this study, short pauses refer to those, which lasted between 1 second to 5, and long pauses were those, which lasted longer than 5 seconds. The pauses, which took less than 1 second, were taken as the participants' search for the key on the keyboard. Matsuhashi (1982) proposed that long pause is an indicator of multiple decisions, which are related to global and local ones. In order to understand the nature of these pauses and the affordances of each, the number of long and short pauses was calculated. The average of pauses in the computerized writing condition was 61.09, while it was 47.18 in the paper and pencil condition. The averages of pauses in these two conditions were compared; the result of *paired-samples t-test* indicated that the difference between the averages of pauses was significant ($t=3.651$, $p<.05$). While the average of short pauses in the computerized writing was 34.36, this average in the paper and pencil condition was 27.72.The result of *paired-samples t-test* indicated that this difference was not statistically significant ($t= 1.60$, $p<.05$). The average of long pauses in the computerized writing condition was 25.81, while the average of long pauses in the paper and pencil condition was 19.45; the result of paired-samples t-test indicated that the difference between these two conditions were significant (t= 2.562, $p< .05$).

The substantial majority of short pauses (84%) were reported to be used for form-related planning instances, and just a few ones were used for content-related planning (16%); on the other hand, the majority of long pauses were employed for content-related planning (63%). Although the majority of long pauses were used for content planning, some of them were used for form planning. Long pauses were usually used at the beginning of sentences and paragraphs. The pauses at the beginning of paragraphs, especially in the computerized writing, were longer, and were reported to function for both content and form planning. It seems that the participants in the computerized writing split up the planning space. They involved constant planning during the process of writing, while in the paper and pencil writing, the participants did most of the planning before starting to write.

The last section concerned the participants' evaluating and revising patterns. The participants in the computerized writing condition reviewed their preceding sentences more often during the process of writing (74%). Although in the paper and pencil condition, the same participants reviewed their produced sentences and paragraphs during writing (39%), the majority of their revisions were done after completing the whole text (61%). The participants in the computerized writing used copy and paste functions to reorder the sentences. However, the reordering of sentences rarely happened in the paper and pencil condition. Furthermore, the scope of revisions was also different. The computerized writing condition led to longer text modifications with regard to both content and form items. Needless to say, in both conditions, the participants proofread their texts; in the paper and pencil condition, they usually did it at the end of the whole writing process, and in the computerized condition at the end of each paragraph.

DISCUSSION AND CONCLUSION

This study aimed at investigating the possible differences between the employed cognitive processes while writing on computer and using paper and pencil. The responses to cognitive processing questionnaire (CPQ), the analysis of think-aloud protocols, and the observation of the writing processes indicated the validity of Weir's (2005) cognitive model of writing; all phases that had been proposed by Weir were reported by the participants of this study in the written survey and the think-aloud interviews.

The results of both survey and think-aloud interviews indicated that in both computerized and paper and pencil conditions, the participants prepared for writing by planning for the generic structure of the text, form-related, and content-related items which were dictated by the task requirements. However, the findings revealed that with regards to pre-writing planning, the writers spent more time on planning in the paper and pencil condition. In the computerized writing, on the other hand, the writers planned during the process of writing, which is called "online planning" (Ellis, 2003). The reasons that might contribute to this finding might be related to the absence of paper for jotting down the detailed plans for all the paragraphs in the computer writing condition. This study also found that the participants had general ideas and plans at the outset of the composing process, but they formulated those ideas into the linguistic format gradually and as an integrated phase with the translation phase. The interviews revealed that in the computerized writing, the participants planned for each paragraph just before writing it. Furthermore, when the writers wanted to move from one idea to another in a single paragraph, the writers spent more time on planning in computerized writing. A point worth-mentioning is that the planning time was less when the participants wanted to write a life experience example. When compared to other ideas, those examples which were related to their own lives took less time to be formulated. It seems that the participants' access to their own personal experience took less time in comparison to general ideas, and they just spent time on form-related planning.

Another phase of writing which augmented the differences between the two conditions was revision. Although evaluation and revision during writing were reported and witnessed in both conditions, similar to the planning phase, the participants, in the computerized writing, reviewed the text during the process of writing. In addition, due to the nature of the computerized medium, the participants could use the functions of *"copy & paste"* to reorder the sentences and even paragraphs. Lai (1986) states that L2 writers to ease the process of revision stick first to rearrangement, addition, substitution and deletion which are not cognitively demanding. The results indicated that the participants employed the affordances of computers to be less under cognitive pressure. Some of the participants *"zoomed in"* the text so that they could focus merely upon the under-construction paragraph. This might be a reason for their high number of online evaluation and revision within the scope of a single paragraph. The findings with regard to evaluation and revision were in line with those of Li and Cumming (2001) and Lee (2002). As Sociocultural Theory suggests, external means are employed to facilitate the higher forms of memory, attention and decision-making (Leontiev, 1932).

The findings of some researchers were in line with those of the present study (e.g., Hyland, 2003; Lee, 2002; Li & Cumming, 2001). However, some studies, in both first and second language investigations, found no significant difference between the cognitive processes imposed by the two conditions; they found the construct of writing governed by deep cognitive paradigm which is not affected by the medium (Collier & Werier, 1995; Weir, et al., 2007). Collier and Werier (1995), in their case study found that the process and product of their three participants were not affected noticeably by the medium; however, it was found that the participants were more comfortable with the medium with which they were accustomed more.

In concluding this study, we can say that the stages provided by Weir's model (2005) seem legitimate to account for the cognitive processes of Persian-speaking EFL language learners. Furthermore, juxtaposing the findings of this study with those found in other linguistic contexts (e.g., Chinese & Korean languages), we can, cautiously, conclude that, more or less, the native speakers of different languages follow the same patterns while writing with paper and pencil and on screen in a foreign language.

Now we may provide a response to the query raised in the introduction; the results indicated that, unlike the findings of Weir et al. (2007), there are some differences in the process of writing in the two studied conditions. To be more precise, although the phases proposed by Weir (2005) were witnessed in both the survey and interviews, the patterns of pre-writing planning, online planning, online and post-writing revision indicated that writers reach the written product through different paths. With regard to the comparability of computerized and paper and pencil tests, the results cast doubt on the comparability of the different types of IELTS, TOEFL, and other high-stake test results. When the cognitive processes of writing in the two different conditions are not the same, the scores do not represent the same construct. The findings of the in-depth studies in the literature indicates that it seems that computerized and pen and pencil tests through the conditions that they provide, with their facilitative and debilitative features, determine the cognitive processes that we use in the process of writing. As Vygotsky (1981, p. 137) states, "tools alter the entire flow and structure of mental functions", thus, finding participants to use different cognitive processes while using different tools is not unexpectable.

With regard to pedagogical implications, the results suggest that writing programs should provide the learners with sufficient amount of practice in both computerized and paper and pencil conditions. The curriculum developers, textbook writers should take both conditions into account while determining the requirements of the course and designing the tasks. In order to fully prepare the participants for different contexts, the existence of

different conditions of writing which superficially trigger the same cognitive processes seems unquestionable. Language teachers, for sure, have responsibilities to conduct needs analysis studies and determine the possible future writing contexts that students might be required to perform and provide the students with suitable writing tasks. In addition, as the results indicated, the participants spent less time on planning when they wanted to write about their own life experience. Teachers, to lower the level of cognitive pressure, can start with those topics which are familiar for the participants to let them focus on the form-related items for writing. This can also be used when the extension of organizational competence is sought.

Since the use of different tools are reported to affect the cognitive processes of the users (Vygotsky, 1960), both microgenetic and ontogenetic studies can be conducted to find the effects of using different tools on the process of writing. Microgenetic studies can uncover possible effects of different tools on second language writers' cognitive processes while writing a single task, and the latter can disclose the extent to which the employment of a specific medium can frame one's cognitive processes in the long run. Even, if feasible, phylogenetic researches which has to do with the history of human beings can illuminate the influences of tools on the cognitive processes on human beings diachronically. In the same line, studies can be conducted to find the relationship between the amount of exposure to a new tool and possible changes in the processes of writing. The comparison of the cognitive processes of younger and older adults can also shed light on the way our mind processes are manipulated by the tools which are provided to us by the society. Moreover, studies can be conducted to compare the employed cognitive processes by the students of different language ability. The effect of giving tasks with familiar and unfamiliar topics can also be investigated to see if the planning patterns change. The effects of audience on the cognitive processes that might affect the planning and revising patterns can also be investigated.

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APPENDIX A

Cognitive processing questionnaire	
1	I FIRST read the title very slowly considering the significance of each word in it.
2	I thought of WHAT I was required to write after reading the title and instructions.
3	I thought of HOW to write my answer so that it would respond well to the title.
4	I thought of HOW to satisfy readers or examiners.
5	I was able to understand the instructions for this writing test completely.
6	I know A LOT about this topic, ie, I have enough ideas to write about this topic.
7	I felt it was easy to produce enough ideas for the essay from memory.
8	I know A LOT about this type of essay, ie an argumentative essay.
9	I know A LOT about other types of essays, eg descriptive, narrative.
10	Ideas occurring to me at the beginning tended to be COMPLETE.
11	Ideas occurring to me at the beginning were well ORGANISED.
12	I planned an outline on paper or in my head BEFORE starting to write.
13	I thought of most of my ideas for the essay BEFORE planning an outline.
14	I thought of most of my ideas for the essay WHILE I planned an outline.
15	I thought of the ideas only in ENGLISH.
16	I was able to prioritise the ideas.
17	I was able to put my ideas or content in good order.
18	Some ideas had to be removed while I was putting them in good order.
19	I felt it was easy to put ideas in good order.
20	I felt it was easy to express ideas using the appropriate words.
21	I felt it was easy to express ideas using the correct sentences.
22	I thought of MOST of my ideas for the essay WHILE I was actually writing it.
23	I was able to express my ideas by using appropriate words.
24	I was able to express my ideas using CORRECT sentence structures.
25	I was able to develop any paragraph by putting sentences in logical order in the paragraph.
26	I was able to CONNECT my ideas smoothly in the whole essay.
27	I tried NOT to write more than the required number of words in the instructions.
28	I reviewed the correctness of the contents and their order WHILE writing this essay.
29	I reviewed the correctness of the contents and their order AFTER finishing this essay.
30	I reviewed the appropriateness of the contents and their order WHILE writing this essay.
31	I reviewed the appropriateness of the contents and their order AFTER finishing this essay.
32	I reviewed the correctness of sentences WHILE writing this essay.
33	I reviewed the correctness of sentences AFTER finishing this essay.
34	I reviewed the appropriateness of words WHILE writing this essay.
35	I reviewed the appropriateness of words AFTER finishing this essay.
36	I was able to write a draft essay in this test, then wrote it again neatly within the given time.
37	I was able to write a draft essay in this test, then wrote it again neatly within the given time.
38	I felt it was easy to review or revise the whole essay.

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