

# A Study on the Cognitive Process in Online Revision of Chinese ESL Writing

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**Abstract:** This study investigated the cognitive process of online revision in Chinese students' English writing using keystroke and stimulate recall method, focusing on the completion of online revision problem solving process and the specific reasons behind online revision behavior. The results showed that: 1) most participants' online problem-solving process was relatively complete, including both problem discovery and problem correction. Among them, higher-ability students have a higher percentage of complete revisions than lower-ability students. 2) striving for accuracy was the most common reason for online revisions among all participants. 3) striving for polished language are the second most prominent reasons for higher-ability students and weak writing ability to modify.

## 1. Introduction

In the past few decades, there has been increasing interest in the writing process in the field of second-language writing research (Hayes, 2012; Krapels, 1990). Qualitative research methods, with their in-depth observation and microscopic analysis, have gradually been widely used in the study of writing process (Flower & Hayes, 1980; New, et al., 1999; Wang, 2003), among which, stimulative recall, as a data collection method after task completion, has the advantages of low interference to cognitive activities, and is favored by many researchers of second language writing process (Dzekoe, 2017; Revesz, 2019; Sasaki, 2000; Suzuki, 2008). It has been proved (Williams, 2004) that stimulated recall can effectively reveal information related to the revision process of second language writing.

## 2. Research Methods

### 2.1 Participants

The participants of this study were 62 non-English major college students. They had studied English for more than 10 years and they had all passed CET-4 or CET-6 (English proficiency test in China). According to the test scores in writing section, we select the top 15 students as High ability students (HASs) and the bottom 15 students as Low ability students (LASs). Among them, 8 were boys and 22 girls.

### 2.2 Instruments

The present study investigated the cognitive processes of online revision behaviors by using stimulated recall interviews with keyboard recordings and screen recordings. The reasons of using the keyboard recording and stimulated recall is as follows: the keyboard recordings can objectively show signs of online revision behavior of the relevant data, restore in writing revision behaviors that cannot be observed in the writing products, e.g., scopes, positions, different dimensions of online revisions, thus, enable us to carry on the detailed analysis and discussion. However, the observable objective revision data belong to behavioral data, and these behavioral events cannot directly infer the specific cognitive activities of participants. In other words, the pause and revision events of the keyboard recording can only indicate the possibility of cognitive processing activities, but the specific corresponding cognitive activities of the keyboard recording event are not known. To answer these questions, further data mining is required in conjunction with participants'

introspective reports. Therefore, we can reveal the characteristics of the writing process with the help of keystroke logging, and excavate the specific cognitive process behind learners' online revision behavior with the help of stimulated recall interview, effectively making up for the deficiency of behavioral data. In order to improve the reliability and validity of stimulated recall, we refer to relevant literature and adopt the following suggestions in practical operation: (1) stimulated recall should be carried out immediately after writing (Gass & Mackey, 2000); (2) Videos of online writing revision were played back to help participants recall related cognitive processes (Gass & Mackey, 2000); (3) Appropriate indicators were selected as hints, so as to extract the relevant cognitive processing activities of the participants more accurately (Gass & Mackey, 2000).

The writing task used in this study is a time-limited argumentative essay, and the writing topic is "Are we more connected or more alone". The writing time is 30 minutes.

### **2.3 Data Collection**

The procedures of data collection included two parts. First, Inputlog 8.0.0.5 and Xunjie screen-recording video were used to track and record the online writing and revision process of the participants in real time; Secondly, keystroke logging files were examined carefully and some keyboard recording indicators were selected as cues to conduct stimulated recall interviews. Specific methods were as follows: upon finishing the writing task, participants were asked to recall the writing process while watching the replayed screen-recording video. They were expected to report verbally their cognitive processing at the long pauses, revisions and other important nodes. During this period, participants were encouraged to actively report their thought processes behind the pause and revision, and if they forgot to do so, the researcher would prompt them by asking, "Why were you stopping here?" "What were you thinking?" "Why did you make the change?". To avoid memory loss, all interviews were conducted within 10 minutes after the writing. With the consent of the participants, the whole interview was recorded. The experiment was conducted in a one-to-one mode between the researcher and the participant. Finally, the researcher transcribed and coded the interview recordings of the participants, and analyzed their cognitive process of writing revision.

In the study of writing process based on keyboard recording, it is necessary to select appropriate keyboard recording indicators and explore what kinds of cognitive activity these indicators specifically correspond to. The key-logging indexes selected in this study were pauses and revisions. The choice of pauses is based on the assumption that "(1) the variation of pause duration is a reflection of the complexity of the processing process; (2) pause locations, i.e. the pauses in different layers of text structure, determine the nature of the processing process; (3) The cognitive processing at the place where the pause occurs is related to the text immediately after the pauses; (4) When a high-demanding processing cannot be carried out simultaneously with corresponding execution, a pause occurs" (Zhu Xiaobin, Xing Saichun, Zhang Limiao, 2013:14). The threshold of pauses was set at 2000ms for two reasons. First, 2000ms is twice the normal transition time between two keystrokes for the slowest typist. In other words, a pause above 2000ms may reflect some cognitive processing. Second, some other computer writing studies mostly use 2000ms as the threshold, which facilitates the comparison of results between studies (Wengelin, 2006). In terms of revisions, when the content deleted or added is below the level of words, we will treat it differently according to the specific situation. If the content is typing revision, it will not be included in the analysis, because the typing revisions are mostly caused by typing error, which occurs unconsciously without any specific cognitive processing.

## **3. Data Analysis**

### **3.1 Coding of Stimulated Recall**

After data collection, we transcribed the stimulated recall recordings of all participants. The fragments of revisions and pauses were extracted from the transcribed text. The data to be analyzed

in this study were retained and the recall reports were coded.

The data analysis of online revisions were conducted from two aspects: (1) the completion of the revision process (Flower et al., 1986; Hayes, 1996; Scardamalia & Bereiter, 1983) (see Table 1); (2) Reasons for revision behavior (Falvey, 1993) (See Table 2). In the analysis of the first dimension, we classified coding according to the degree of completion of steps in the online revision process. If the participants only detected the problem but didn't fix it, they were assigned a score of 1, such as, "I didn't know if the spelling of 'entertainment' is correct. I tried to retrieve for the right spelling two or three times in vain, and left it as it was." (S16); If the participants detected and diagnosed the problem but did not correct it, they were assigned 2 points, such as "I did not want to write 'talk about', because this phrase seemed far from sophisticated, but I was unable to retrieve anything advanced" (S16); If the participants detected and diagnosed the problem and made corresponding revisions, a score of 3 points is assigned, for example, "The pause here was because 'people' appears twice, so I replaced the second one with 'person' to avoid repetition" (S16). As for the second dimension, we classified coding according to the specific causes of online revision in the writing process. The coding classification of reasons for revision is based on the functional classification of revision adapted from Falvey (1993), mainly focusing on the online revision of form. The specific reasons for revision are: grammatical correction, language polishing, appropriate expression, clear expression, accurate expression and mechanism. The revision of meaning is not included in the scope of this discussion, so there is no specific classification.

Table 1 Coding Classification Of Online Revision Process (I)

Coding Category(1)	specific indicators	scores	Examples
Completion degree of revision process	1-1 Detection	1	"I didn't know if the spelling of 'entertainment' is correct. I tried to retrieve for the right spelling two or three times in vain, and left it as it was." (S16)
	1-2 Detection and diagnosis	2	"I did not want to write 'talk about', because this phrase seemed far from sophisticated, but I was unable to retrieve anything advanced" (S16)
	1-3 Detection, diagnosis and correction	3	"The pause here was because 'people' appears twice, so I replaced the second one with 'person' to avoid repetition" (S16)

Table 2 Coding Classification Of Online Revision Process (Ii)

Coding category 2	Specific indicators		Examples
Reasons of revisions	Grammar correction		"The first paragraph,I was not sure which one is correct, 'feel' or 'feeling', so I decided to delete it"(S17).
	Language polishing	Sophisticated vocabulary Diversity of vocabulary Complexity of structures	"I'd like to choose anything but 'talk about', because it was far from sophisticated, but I could figure it out"(S16). "With the development of social media. I used 'development' previously, so I replaced it with 'advance' here(S20). "I learned from high school teacher that attributive clauses can make sentence structures more complex, so I'd like to add one here to get higher score"(S19).
	Appropriate expression		"I was not sure whether 'online connecting' is Chinglish?(S19)"
	Clear expression		"I turned 'some person' into 'writer and psychologist Sherry Turkle',because the revised version was more specific and clearer"(S27).
	Concise expression		"I found the manuscript was up to the word limit, so I decided to replace 'pick up your phone',with 'kill your time' to be more concise"(S5).
	Accurate expression		"I was unable to express '好像我们的距离被放大了'in English,so I decided to paraphrase"(S22).
	Mechanisms		spelling, punctuation, case, format, abbreviations and other revisions

### 3.2 Inter-Coder Reliability

In order to establish the reliability between coders, we coded the transcribed stimulated recall material by two coders. The first coder codes all the materials, namely 30 participants' stimulated recall material. The researchers invited a second coder (a doctoral student in applied linguistics) to code 15% of the stimulative recall material which was chosen randomly.

The coders' reliability of the first dimension "completion of online revision" is 95.37% (Cohen's Kappa =.85). The coder reliability of the second dimension "reasons for online revision" is 91.53% (Cohen's Kappa =.80).

## 4. Research Results and Discussion

### 4.1 The Degree of Completion of the Online Revision

In the stimulated recall interview, participants recalled the thought process of revision while watching the screen-recording video of their own writing process. From the stimulated recall data, we found that participants' online revision activities did not always meet the three steps of the problem correction process, namely problem detection, problem diagnosis and problem solving (Flower et al., 1986; Hayes, 1996; Scardamalia & Bereiter, 1983). In other words, some online revision activities of participants can only partially present the problem correction process, such as only including the part of problem detection, or only including the part of problem discovery and diagnosis, etc. Table 3 shows the specific statistical results.

Table 3 Completion of Online Revision Process: Lass, Hass

Completion Degree	Points	LASs		HASs	
		Quantity	Percentage	Quantity	Percentage
1-1 Detection Only	1	76	32%	49	22%
1-2 Detection and Diagnosis	2	41	17%	29	13%
1-3 Detection, Diagnosis and Solution	3	120	51%	145	65%
合计		237	100%	223	100%

As can be seen from Table 3, more than half of the online revision activities included three steps of the problem correction process: problem detection, problem diagnosis and problem solving. On the second rank was the first category, i.e. Detection Only. The second category came in last.

and the proportion was higher in lower-ability students than in higher-ability students (LASs=32%, HASs=22%), indicating that lower-ability students had more difficulties in problem diagnosis and problem solving than higher-ability students.

Sub-processes of revision include problem discovery/diagnosis and problem correction (Butterfield et al., 1996; Hayes, 2004). As for the degree of completion of online writing revision, the analysis results of stimulated recall data showed that more than half of participants were able to identify problems and use certain strategies to correct problems. The proportion was lower in lower-ability students than in higher-ability students (LASs=51%, HASs=65%) (see Table 3). That is to say, more than half of the students have a good completion of the online revision process, indicating that college English learners have a certain ability to review/revise by themselves without external feedback. This finding is consistent with existing research findings (Chanquoy, 2001; Dzekoe, 2017; Elola & Mikulski, 2013; Xu, 2018). This research finding indicates that learners can notice a certain gap between the thought intention they want to express and the produced text in the process of writing output (Schmidt & Frota, 1986; Schmidt, 1993; Swain, 1985, 1995). As a result of this attentional function, the problem correction process of learners' online modification activities, i.e. the process of comparing, diagnosing and performing operations (Flower et al., 1986; Hayes, 1996; Scardamalia & Bereiter, 1983). This finding highlights the role of attention in online writing revision and provides empirical support for the attentional hypothesis (Schmidt & Frota, 1986; Schmidt, 1993; Swain, 1985, 1995), that is, attention to the produced text plays an important role in initiating the online revision of writing. According to attention hypothesis, only the information that is noticed by learners is likely to be further processed.

Stimulant recall data showed that less than half of participants' online revision cognitive processes included only problem presentation, but not strategy selection. To be specific, the online problem revision processes of these participants were incomplete, that is, only the part of problem discovery or problem diagnosis were included, without any corresponding problem correction part. According to the cognitive model of revision process, problem presentation consists of two parts: problem discovery and problem diagnosis. *Problem Detection Only* corresponds to problems that are not clearly defined, and *Detection and Diagnosis* corresponds to clearly defined problems (Flower et al., 1986). Stimulated recall data of this study have shown that the proportion of problems that are not clearly defined was higher both for higher-ability and lower-ability students, indicating that though college English learners have a certain ability to revise, they still can't handle all the revising tasks independently. They may need external intervention in problem diagnosis and feedback. In other words, the responsibility of revision should be shared between learners and teachers, and teachers should never intervene unless it is needed. Teachers should only offer help when learners cannot do by themselves, otherwise these mistakes will remain in the learners' interlanguage system for a long time (Wen & Zhuang, 2005).

## 4.2 Underlying Reasons of Online Revision Behavior

In this study, the second dimension is the reasons behind the online revision behavior or the functions and goals to be achieved through the revision behavior. According to the classification of the revision function in the process of second language writing in existing literature (Falvey, 1993), and combined with the stimulated recall data of this study, the reasons for the online revision behaviors can be divided into the following categories: *correct grammar*, *accurate expression*, *explicit expression*, *polished language*, *concise expression*, *appropriate expression*, *stylistic consistency* and *language specification*.

### 4.2.1 Accurate Expression

The stimulated recall data have shown that *accurate expression* was the most frequent cause of online revision for all participants, and the frequency of *accurate expression* initiated revisions is higher in lower-ability students than that of higher-ability students (HASs=39%, LASs=42%), as shown in the following interview example.

- (1) "I forgot how to express strangers and wrote unknown" (S10)
- (2) "I'm thinking about a list of thousands friends, but I can't think of anything else." (S15)
- (3) "They will not spend more time in it." (S26)
- (4) "I have no energy to spend time with my friends, so I wrote a time." (S25)

Example (1) (2) shows that higher-ability students find problems in the mental representation stage of writing output (i.e. the stage of translating a language into the target language, namely the stage of translation), that is, the inconsistency between what they want to express and what they can express. Because of the limited command of English of the participants, the compensation strategy is chosen as the solution to the problem, that is, simple and familiar language expression is chosen. Example (3) and (4) reflect that lower-ability students choose compensatory strategies to solve the problem when the spelling of target words is uncertain, in other words, replace or restate the words with other expressions with vague and approximate meanings.

It can be seen that for both higher-ability students and those with weak writing ability, *accurate expression* is the most prominent reason for revision, indicating that for Chinese students with English as a foreign language, the limitation of language knowledge and skills has a great impact on writing output. The process of converting thoughts into language, that is, translation, consumes more attentional resources. Accordingly, the attention resources left for meaning processing are rather limited, so the frequency and quality of cognitive activities of meaning revision are affected to a certain extent (Gelderen & Oostdam, 2004; Kellogg, 1996). Besides, lower-ability students had higher frequency of online revision activity caused by accurate expression than higher-ability students (HASs=39%, LASs=42%). *Accurate expression* in L2 writing requires learners to be able to correctly translate from one language to the second language and convert the content of their

mother tongue into an additional language. This finding is consistent with existing research results. Revesz, Michel & Lee (2019) investigated the revision and pause behaviors of second language writers and found that in the data of stimulated recall, the translation process was the most commented by the participants (about 50%), followed by the planning process and monitoring process. It can be seen that the most frequent revision activities are caused by translation in the online revision process of second language writing, indicating that language knowledge and skills have a great impact on second language writing. Second language writers often encounter translation failures when converting their mother tongue into second language because of their language deficiency. When writers notice the gap between what they want to express and what they can express, they will make corresponding revision activities. Usually, they may sacrifice the richness of meaning for the accuracy of form, and the revision strategies adopted are mainly compensatory strategies, such as paraphrasing.

#### 4.2.2 Polished Language

Stimulated recall data show that *polished language* is the second most prominent reason for online revision behaviors with higher-ability students, and the third most frequent reason with lower-ability students. *Polished language* can be divided into three categories: vocabulary upgrading, vocabulary diversity and complex sentence patterns. Specific examples are as follows.

(I) Vocabulary upgrading

(5) “Should it be face-to-face? I thought I was nicer at the shareholders' meeting. (S4)

(6) “Yet, which is more common in serious English journalism, is a little better than but, because I write but too much to write.” (S8)

(7) “I don't want to write talk about, I feel a little low, but I can't write advanced”. (S16)

(8) “The second aspect is to make friends by writing. Thought about it. Got it. More and more people making friends online.” (S26)

Examples (5) to (8) revealed the first subcategory of *polished language* ---- vocabulary upgrading. Examples (5) and (6) showed that the higher-ability students made revising activities in order to upgrade their vocabulary. Student 4 replaced “face-to-face” with “personally”, because the latter is more sophisticated. Student 8 compared “yet” with “but” and decided to choose “yet”, because “yet” appeared more frequently in formal writing and was more advanced than “but”. Examples (7) and (8) demonstrated that lower-ability students tended to initiate revision activities in the hope of upgrading vocabulary in vain due to their limited language ability. Student 16 reported that he attempted to replace the phrasal verb “talk about” with more sophisticated words but failed due to his deficiency in English language commandment. Student 26 admitted that due to limited language ability, only low-level expressions can be used.

(ii) Diversity of vocabulary

(9) “I am thinking whether I should I use ‘However’ or ‘but’, because I used ‘but’ in the previous part, here I choose ‘however’.

(10) “ ‘Through’ is used twice in consecutive sentences, so I changed the last one into ‘via’”. (S5)

(11) “ ‘When’ is used many times in the previous text, so I use another way to express the similar meaning, e.g., members of family” (S18)

(12) “ ‘Rapidly’ is the second time in the text which is not good, so I'd like to change it into another word with similar meaning but failed. I can't remember any.” (S29)

Examples (9) to (12) revealed the second sub-category of *polished language* ---- lexical diversity, which is understood by most participants as avoiding repetitions of the same word. Among them, Examples (9) and (10) indicated that higher-ability students would find word repetition problems and revise them successfully through synonym substitution. Examples (11) and (12) are the reports of lower-ability students about the activities of vocabulary revision. In Example (11), Student 18, a lower-ability student, found that he had used “when” many times in the previous text and attempted to avoid repeated use of the same word. Student 29 was able to notice multiple uses of “rapid” and had a desire to avoid duplication, but failed to do so. It can be seen that all the

participants have the writing knowledge, for example, they could pay attention to achieve the diversity of vocabulary and actively initiate revision attempts to avoid repetition, but the revision results are not the same. Higher-ability students were more likely to be able to revise successfully while lower-ability students could notice problems, but could not solve problems in many cases because of their limited language knowledge. That is, they could not make successful revision and had to give it up. For writing teachers, the only source of information is writing results, but from the writing results, writing teachers cannot know the psychological efforts of lower-ability students make in the process of writing revision. The lack of information may have a certain impact on teachers' feedback and writing revision teaching decisions. In this sense, specific information about the online writing revision process may be of great significance to writing teachers.

(iii) Complex sentence structure

(13) "I would like to modify this by adding an attributive clause". (S6)

(14) "I'd like to add an attributive clause here, because it seems that the sentence pattern is more complicated because of the diversity of long and short clauses. (S19)

Examples (13) and (14) revealed a third subcategory of *polished language* ---- sentence complexity. Student 6 and Student 19 are higher-ability students and lower-ability student respectively. They both chose to use attributive clauses to increase the complexity and enlarge the unit of sentence patterns. Student 6 said that adding an attributive clause could play the role of modification, so as to beautify the language. Student 19 believed that adding an attributive clause could make the sentence patterns more diverse and complex.

#### 4.2.3 Language Specifications

Language norms/specifications were the third most frequently triggered reasons of revision for higher-ability students according to stimulated recall data, while they were the second most prominent reason for online revision among lower-ability students. The revisions of language specifications mainly include spelling, punctuation, capitalization, format, abbreviations, etc., with spelling revision being the majority. The following are specific examples.

(15) "I'm not sure about the spelling of 'circumstance'. After some time, I'm still not sure if it is correct, so I had to leave it as it was." (S5)

(16) "I am not proficient in computer typing. If I wrote it in pen, I might get it right. I'm not sure about the spelling of 'convenience'. Did I miss a letter 'n'?" (S6)

(17) "The spelling of 'technology' escapes me, so I have to get by with other expression." (S20)

(18) "I forgot how to spell 'between' here, so I decided to delete it." (S27)

Examples (15) to (18) revealed the online revision activities caused by language norms, especially vocabulary spelling. Among them, in examples (15) and (16), student 5 and student 6, both higher-ability students, encountered the spelling difficulties of "circumstance" and "convenience" which are in the list of three-star high-frequency words and the list of one-star low-frequency words respectively according to the word frequency table of *Macmillan Advanced English-Chinese Dictionary*. In examples (17) and (18), Student 20 and Student 27, two lower-ability students, had difficulty in spelling words of three-star high frequency words. From the data analysis results, it can be seen that higher-ability students would encounter difficulties in spelling both high-frequency and non-high-frequency words, while lower-ability students would have spelling difficulties mostly in high-frequency words. It can be seen that higher-ability students showed a higher level in vocabulary commandment, therefore, revision activities would occur at a relatively higher level of language (Stevenson et al., 2006).

#### 4.2.4 Correct Grammar

According to the stimulus recall data, *correct grammar* was the fourth most common reason for all participants' online revision activities. Higher-ability students were slightly less likely to initiate online corrections of grammar than lower-ability students (HASs=11.5%, LASs=15%). The specific examples are shown below.

(19) "It should be 'let them be alone' rather than 'being alone' ". (S1)

(20) “I wrote ‘as the developing...’, then I realized it is not right, so I changed it.” (S7)

(21) “I get stuck in writing ‘However, we have entered...’. I’m not sure the past participle of ‘come’, so I decide to choose ‘entered’. (S20)

(22) “When I was writing ‘We can’t imagine that a 20-year old boy’. I was uncertain whether the word ‘youth’ is countable or uncountable noun, so I decided to choose ‘boy’”. (S29)

Examples (19) to (22) reflected the cognitive activities of online revision caused by *correct grammar*. Students 1 and 7 with strong writing ability could not only notice the grammatical problems, for example, one is the proper form of the verb “be” and the other is the usage of the conjunction “as”, but also managed to correct them. Students with weak writing skills are often able to spot problems, but do not have sufficient language knowledge to modify them successfully. The usual practice is to replace it with a more assured expression of a similar meaning, that is, to restate or paraphrase in one’s own words. For example, in (21) Student 20 was uncertain about the past participle of “come”, so it was replaced with the more assured verb “entered”. In example (22), Student 29 was uncertain about the plural form of “youth”. To ensure accuracy, “youth” was replaced with a simpler and more certain noun “boy”. Such revision improves and guarantees accuracy at the cost of vocabulary degradation, which also reflected the trade-offs between accuracy and complexity of learners in the test-oriented second language learning environment (Sengupta, 1998).

#### 4.2.5 Explicit Expression

The stimulative recall data showed that *explicit expression* was the fifth most common reason for online revision among all participants. In terms of the frequency of online revision activity triggered by *explicit expression*, higher-ability students were more likely to do so than lower-ability students (HASs=6%, LASs=2%). Examples are shown below.

(23) “I changed ‘a lot of us’ into ‘a lot of people’ because the latter was clearer and more objective.” (S15)

(24) “I was uncertain which one to choose, ‘play with friends’ or ‘stay with friends’. after thinking for a while, I decided to choose ‘stay with friends’”. (S25)

In Example (23), Student 15, a student with strong writing ability, reported the cognitive activities corresponding to the online revision activities triggered by *explicit expression*. The student changed the first person pronoun “us” into the common noun “people”, and gave the reason that the revised expression was more clear and objective. “People” is a third-person non-specific noun, which is more objective and clear, while the first-person pronoun “us” is more subjective, ambiguous and ambiguous, which is more likely to confuse readers. In Example (24), S25, a student with weak writing ability, replaced “play” with “stay” to express the meaning of “stay together”. The revised expression is clearer and more appropriate. It can be seen that both higher-ability and lower-ability students are capable of carrying out the revision induced by *explicit expression*, but the proportion of the revision induced by *explicit expression* is relatively small. This is inconsistent with the existing research results. Sengupta (1998) investigated the second draft revision of the second language writing of Hong Kong middle school students and found that clarity of expression was the most common reason for revision. The possible reason is that this study investigates the cognitive process of online revision, while Sengupta (1998) focuses more on offline revision (or revision after writing). The two studies have different emphases and main contents.

#### 4.2.6 Appropriate Expression

Appropriate expression is the cause of online revision, which accounts for a lower proportion, ranking sixth. Students with high writing ability made more frequent online revision activities for proper presentation than students with low writing ability (HASs=4%, LASs=1.6%), as shown below.

(25) “The expression of ‘deal with relationship’ seemed a little Chinglish, so I decided to change it into ‘deal with others’”. (S5)

(26) “The grammar is fine, but it feels too colloquial. Foreign teachers advise us not to use such

old fashioned expression like ‘As we all know’, but I think it would be ok for CET-4 level test, so I just left it there.” (S24)

Examples (25) to (26) showed the participants' psychological processing of online revision induced by *appropriate expression*. In Example (25), Student 5, a student with strong writing ability, reported her cognitive process of proper expression. She changed “deal with relationship” to “deal with others”, because the former has a sense of chinglish which does not meet the requirements of this composition task. In example (26), Student 24, a student with weak writing ability, expressed that “as we all know” is colloquial and does not conform to the style of written language, and was rejected by the foreign teacher. However, due to the limitation of language knowledge, it could not be revised reasonably, so it was temporarily shelved. In addition, the scoring standards of CET-4 also lowered her requirements for style.

#### 4.2.7 Concise Expression

*Concise expression* was the least frequent trigger for online revision, with higher-ability students using it more frequently than those with weak writing ability (HASs=3%, LASs=0.4%), as shown below.

(27) “I have just written two paragraphs, which are already too many words. After thinking about it, I decided to change ‘pick up your phone’ into ‘kill your time’, because it's simpler and more concise.” (S5)

(28) “Actually, it feels like a waste of words. Can I just say ‘I agree?’ I felt there was something wrong, but I didn’t have time to think carefully”. (S24)

It can be seen from examples (27) and (28) that both students with strong and weak writing ability are able to notice the problems of repetitions and redundancy in the writing process, but lower-ability students may lack the corresponding language ability to make reasonable revisions, which is similar to the oral production process (Kormos, 2000). As shown in Example (27), Student 5, a student with strong writing ability, driven by *Concise expression*, could consciously find that there was repetition in the writing process, and make revision decisions after thinking to delete redundant expressions. In Example (28), Student 24, a student with weak writing ability, found the problem of tautology in his writing and expressed his wish to cut the tautology, but failed to make reasonable revision due to lack of time. Writing is a complex cognitive processing activity, so is the revision process. It is a multitask and parallel cognitive activity, which requires high cognitive resources. The simultaneous processing of language form and meaning produces competition for limited attention resources, and there is also competition for cognitive resources between the accuracy and complexity of formal processing. Before one of these processing activities is automated, some cognitive activities will consume more cognitive resources, so other processing activities are left less resources available (Gelderen & Oostdam, 2004; Kellogg, 1996), thus, insufficient in time.

### 5. Conclusion

This study investigated the cognitive process of online revision in Chinese students' English writing process based on stimulated recall, focusing on the completion of online revision problem solving process and the specific reasons behind online revision behavior. The results showed that most of the participants had a good completion of the online revision problem solving process, specifically, more than half of the students had a complete online revision process, including both problem detection and problem correction. Among them, higher-ability students have a higher proportion of complete revision than lower-ability students. The study also found that *accurate expression* was the most common reason for all participants to trigger online revision, followed by *polished language* (HASs) and *language specifications* (LASs), *correct grammar*, *explicit expression*, *appropriate expression* and *concise expression*. The second obvious reason for higher-ability students to arouse revision is *polished language*. This result shows that after having a certain language foundation, students tend to improve their language expression in order to achieve

better results in the exam, which also reflects the guiding role of exam-oriented education in English teaching in China. The second more prominent reason for lower-ability students to modify is *language specifications*, mainly spelling revision, indicating that spelling ability in the process of transliteration has a certain impact on writing revision. *Correct grammar* is the fourth common reason for all participants to initiate revision, accounting for more than 10%, indicating that grammar is an important language aspect that students pay close attention to in language output, which should be guided and emphasized in teaching. Students with strong writing skills paid more attention to clarity, appropriateness and conciseness than students with weak writing skills, who barely took into account these three aspects of revision.

Future research can investigate the degree of completion of online revision problem solving and the reasons for revision at different learning stages, so as to reveal understanding of the changes of learners' cognitive process of online writing revision dynamically. In addition, future research can also focus on the differences in individual factors (such as gender, motivation, learning style, writing efficacy, etc.) of learners' online revision of cognitive process, so as to promote researchers to further understanding of the influencing factors of learners' cognitive process in writing revision in second language.

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