

Modeling the relationship of metacognitive knowledge, L1 reading ability, L2 language proficiency and L2 reading

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Abstract

This study takes the initiative to use structural equation modeling (SEM) to explore the interrelationships among metacognitive knowledge, first language (L1) reading ability, second language (L2) proficiency and L2 reading comprehension. Data were collected using an L2 proficiency test, L1 and L2 reading tests and strategy questionnaires with 268 sophomore university students learning English as a foreign language (EFL) in China. The results showed that all three predictors had significant, direct, positive effects on L2 reading comprehension. Moreover, metacognitive knowledge exerted indirect effects on L2 reading by means of L1 reading ability and L2 language proficiency. The findings help to refine the framework of L2 reading and elaborate on the mechanism by which metacognitive knowledge facilitates L2 reading. These findings have significant classroom implications, including the integration of strategy instruction and L1 literacy resources into L2 curriculum.

Keywords: structural equation modeling, metacognitive knowledge, L1 reading ability, L2 language proficiency, L2 reading comprehension, indirect effects

Researchers (e.g., Bernhardt, 2005; Yamahata, 1999, 2002; McNeil, 2012) have claimed that reading is a multi-component process that encompasses cognitive and linguistic knowledge. Building on Kintsch's (1998) Construction-Integration Model, Grabe and Stoller (2013) elaborate that higher-level processing involves not only text modeling (forming a network of main ideas and important supporting details) and situation modeling (integrating with background knowledge) but also executive control processing (select attention, resolve confusion and evaluate progress, etc.) (pp. 18–19). In the case of less proficient learners, the construction of meanings requires more cognitive resources, resulting from the lack of language skills, limited processing ability and inadequate automatization of word decoding (de Bot, 1992). The key to unlocking the potential to meet these challenges is metacognitive knowledge, which is the driving force enabling learners to use strategies effectively, as well as draw on prior knowledge in the process of reading (Afflerbach, Pearson, & Paris, 2008; Walczyk, 2000).

Several researchers have proposed theoretical frameworks to illustrate the factors influencing second language (L2) reading. In the Compensatory Model of L2 reading (Bernhardt, 2005), first

language (L1) literacy, L2 language knowledge and unexplained variance account for 20%, 30% and 50% of the variance in L2 reading, respectively. This model highlights the need for research on unexplained variance (p. 142). Extending Bernhardt's model, McNeil (2012) included L1 reading ability, L2 language knowledge, strategic knowledge and background knowledge into the model and called for empirical studies to explore the interplay among the variables. Taking an interaction approach, Bachman and Palmer (2010) proposed a comprehensive model of communicative language ability which outlines the interaction between two components of language ability: language competence and strategic competence. At the internal level, individual attributes such as language knowledge, topical knowledge, affective schemata and personal characteristics interact with strategic competence. At the external level, the individual traits interact with the characteristics of a language use situation. Notable is that this model depicts strategic competence as a set of metacognitive strategies playing a management function in the interaction among individual attributes, as well as between internal traits and external contexts. In turn, language knowledge draws on metacognitive strategies. Therefore, this model suggests that the influence of metacognitive strategies on a specific language use situation (e.g., reading tasks) is mediated by its executive function in language knowledge.

It has been well documented that metacognition makes a direct contribution to L1 and L2 reading (e.g., Schoonen, Hulstijn, & Bossers, 1998; van Gelderen, Schoonen, Stoel, de Glopper, & Hulstijn, 2007) and L1 reading ability and L2 language proficiency are more potent predictors of L2 reading (e.g., Bernhardt & Kamil, 1995; Pichette, Segalowitz, & Connors, 2003; Yamashita, 2002). Moreover, a large body of research has established that learners of high English proficiency and learners of high L1 reading ability have shown higher-level metacognitive awareness and better command of strategies (e.g., Kong, 2006; Mokhtari & Reichard, 2004; Mokhtari & Sheorey, 2002). Previous research has alluded to the intricate relations between metacognitive knowledge and L2 reading due to the multifaceted nature of the constructs. Therefore, more empirical studies are demanded to examine factors that might interact with metacognitive knowledge to influence L2 reading. In particular, for adult EFL learners who have well-developed L1 literacy resources, how metacognitive knowledge interacts with L1 reading ability and L2 language knowledge merits more scrutiny so as to delineate the complex process of L2 reading.

Given that the correlations between cognitive factors, linguistic factors and L2 reading have been well documented, the current study might be the first step to investigate the direct and indirect effects of metacognitive knowledge, L1 reading ability and L2 language proficiency on L2 reading comprehension. Using a robust analytical tool of structural equation modeling (SEM), the generated model represents an extension to previous studies by specifying the direct and indirect linkages among the variables. The findings would advance our knowledge by elucidating the mechanism by which metacognitive knowledge supports L2 reading. In particular, the mediation effects found in this study contribute to our understanding that metacognitive knowledge has an executive function to capitalize on the strength of L1 reading ability and L2 language proficiency. In turn, L1 reading ability and L2 language proficiency provide the basis for metacognitive knowledge to function effectively, as well as magnify the benefits of metacognitive knowledge on L2 reading. Thus, the insights from this study could inform classroom instruction or intervention approaches to target these critical factors appropriately. Furthermore, the findings would improve learners' perceptions of themselves as strategic agents

in reading and promote their awareness of the utility and function of strategies to engage in the thinking process, which could ultimately change their language learning approach.

Literature Review

L1 Reading Ability

The controversial issue has been whether the L2 reading process is cross-linguistic, involving mapping activities between languages. The transfer hypothesis claims that L1 literacy skills, once acquired, are ready to transfer when triggered by L2 text input (Cummins, 1979; Esling & Downing, 1986; Singhal, 1998). The longitudinal study of Schoonen et al. (1998) showed that L1 reading ability explained 38% of the L2 reading scores and the predictive power increased as the students' proficiency improved. Moreover, studies have shown that learners with good L1 reading ability are more likely to become good L2 readers (e.g., Brantmeier, Hammadou, & Strube, 2014; Lee & Shalleart, 1997; Yamashita, 2002) and maintaining active L1 reading activities enables the effective transfer of general strategies to L2 reading (Pichette et al., 2003). After reviewing previous research in L2 reading, Bernhardt (2011) pinpointed that struggling L2 readers are most likely to be less proficient in L1 reading, so more research is needed to provide insights into the impact of L1 literacy skills.

Admittedly, different writing symbols activate different cognitive processes in reading. Studies on alphabetic languages have found a significant and substantial correlation between L1 and L2 reading ability (e.g., Jiang & Kuehn, 2001; Schoonen et al., 1998; van Gelderen et al., 2007). In alphabetic languages such as English, letter-phoneme mapping makes phonics important in word recognition (Bialystok, McBride-Chang, & Luk, 2005). In comparison, logographic languages such as Chinese require the readers to be sensitive to overall visual cues (Koda, 2005, 2007) because each Chinese character represents a morpheme but carries little phonological consistency. The difference in cognitive processing might result in cognitive overload and constrain the transfer of cognitive resources (Paas, Renkl, & Sweller, 2003) because readers need to weave together multiple mental processes such as decoding words, previewing text structure, visualizing events and making inferences (Cartwright, 2015, p. 235; Pollock, Chandler, & Sweller, 2002, p. 63). Thus, reading strategies could be a pathway to reduce the constraints imposed on the cognitive processing (Zhang, 2008).

This research focused on adult EFL learners whose Chinese reading ability was well developed when they began learning English. According to Bachman and Palmer (2010), language knowledge which could be conceived as available information stored in memory for the users to construct meaning or produce discourse (p. 45). Thus, L1 reading ability was operationalized as knowledge about reading developed in L1 reading experiences; for example, knowledge of vocabulary, knowledge of text cohesion and rhetorical organization and knowledge of summarizing main ideas, etc. Moreover, to take the research a step further, this study attempted to scrutinize if L1 reading ability interacts with other factors to influence L2 reading.

L2 Language Proficiency

According to the Linguistic Interdependence Hypothesis, L2 language competency is partly a function of well-developed L1 language competency (Cummins, 1979). Across many studies L1 reading ability has been found to be positively correlated with L2 language proficiency (e.g., Bialystok, McBride-Chang, & Luk, 2005; Jeon & Yamashita, 2014; Jiang & Kuehn, 2001). While some studies have identified L1 reading ability as a predictor of L2 reading, other studies have maintained the predominant role of L2 language proficiency in L2 reading (e.g., Bernhardt & Kamil, 1995; Upton & Lee-Thompson, 2001). Though there is room for speculation in the argument, empirical studies have shed light on it. Research on Chinese EFL learners has shown that L2 language proficiency accounts for more variance in L2 reading (e.g., Jiang, 2011; Tsai, Ernst, & Talley, 2010). However, lower-level L2 learners seem to have trouble employing L1 reading strategies to extract meaning from L2 texts (e.g., Lee & Shallert, 1997; Yamashita, 1999, 2002). To a large degree, the research results were influenced by the instruments to measure language proficiency, such as the cognitive demands of the tasks.

The construct of language proficiency is complicated since it relates to the ability to listen, speak, read and write in appropriate contexts. Among the different facets of language proficiency examined in previous research, lexical knowledge and grammatical knowledge have been included in the models of communicative language ability (e.g., Bachman & Palmer, 1996, 2010; Canale & Swain, 1980; Ellis, 2008). As Stanovich (2009) explained in the concept of reciprocal relationship, vocabulary is a determinant of individual differences in reading ability. Through exposure and experience, readers acquire vocabulary knowledge, which in turn promotes reading ability development. Empirical studies have consistently reported vocabulary size as a crucial predictor of L2 reading comprehension (e.g., Alderson, 2000; Grabe, 2009; Koda, 2005; Perfetti, Landi, & Oakhill, 2005). The findings from the meta-analysis of Jeon and Yamashita (2014) showed a stronger correlation between vocabulary and L2 reading comprehension among adolescents and adults ($r = .84$) than children ($r = .66$). Surprisingly, they found that the correlation between grammar and L2 reading was slightly higher than vocabulary (.85 vs. .79). Similarly, Shiotsu (2010) and Shiotsu and Weir (2007) reported that grammar was a more potent correlate of L2 reading than vocabulary; however, they also found a high correlation between grammar and vocabulary. One concern with their instrument is the pure measure of explicit grammar by a sentence completion test. It is important to measure both implicit knowledge of grammar use and explicit knowledge of grammatical rules to better understand how grammar affects L2 reading.

Based on previous research, this study operationalized L2 language proficiency as vocabulary size, implicit grammar and explicit grammar; although I admit that this is only one aspect of language proficiency. Notable is that this model includes L1 reading ability, L2 language proficiency and metacognitive knowledge as separate constructs. It is consistent with Bachman and Palmer's (2010) model of communicative language ability that separates language competence from strategic competence and hypothesizes that a test taker's language competence interacts with strategic competence to influence test performance.

Metacognitive Knowledge

Cummins (1979) claimed that the conceptual knowledge developed in L1 makes the input in L2 more comprehensible due to the underlying cognitive and academic proficiency across languages. As Cummins illustrated in the metaphor of an iceberg, the cognitive proficiency is the common base under the water, while the language knowledge is the tip of the iceberg above the surface. Despite the language differences, the growth of the emerging tips is rooted in the growth of the submerged base. In the same vein, Bachman and Palmer (2010) noted that language knowledge draws on metacognitive strategies to cope with a demanding task. That is to say, metacognitive knowledge is a higher-order underlying proficiency that controls the ways language knowledge is utilized in L1 as well as in L2.

In the reading context, Schreiber (2005) defined metacognitive knowledge as awareness of strategies and regulation of strategies. For example, readers can deliberately use strategies for planning (setting goals, previewing, and activating background information, etc.), monitoring (selective attention, predicting, making inferences, interpreting ideas and integrating with personal experience, etc.) and evaluating (self-questioning, self-correcting and reflecting, etc.) (Griffith & Ruan, 2005). Thus, metacognitive readers are not only equipped with the knowledge of strategies, but also the ability to apply the knowledge with different text types and orchestrate strategies to actively engage in the thinking process (Anderson, 2012).

The correlation between metacognitive knowledge and language knowledge has been well documented in empirical research findings (e.g., Ardasheva & Tretter, 2013; Sparks, Patton, Ganschow, Humbach, & Javorsky, 2008; van Gelderen et al., 2004). Another line of study comparing the relative contribution of metacognitive knowledge and L1 and L2 knowledge to L2 reading has yielded controversial results. Karimi (2015) reported that strategic processing explained more variance (31.1%) than L1 reading ability in comprehension of multiple L2 texts. However, the findings of Ardasheva and Tretter (2013) showed that L2 language proficiency was a stronger predictor than metacognitive awareness among middle-school learners. In comparison, the longitudinal study by Schoonen et al. (1998) found out that for grade-8 students, language knowledge (vocabulary) had more predictive strength of the correlation between L1 and L2 reading, while metacognition increased its power at grade 10. Similarly, van Gelderen et al. (2007) found out that in L2 reading, language-specific factors (i.e., vocabulary, word recognition, grammar) exhibited stronger explanatory power in grade 8; however, metacognition gained predictive strength in grade 9 and 10. One possible explanation might be that cognitively mature learners are more aware of ambiguity and inconsistency while reading. As a result, they are more likely to make conscious, deliberate efforts to examine discrepancies in understanding and clarify confusions (Baker, 2005; Paris, 2002).

In contrast, using structural equation modeling, Guo and Roehrig (2011) and Purpura (1997, 1998) did not find direct effects of metacognitive strategies on L2 reading. However, one interesting research finding of Purpura (1997) was that metacognitive strategies (planning, monitoring and evaluating) exerted executive functions over cognitive strategies (comprehending, memory and storage) to indirectly influence L2 test performance. Making a step forward, Purpura (1998) tested if the results were consistent in high- and low-ability groups and found some evidence of equivalence across groups. Despite the growing interest in metacognition,

there are few empirical studies exploring the indirect effects of metacognitive knowledge on L2 reading. Due to the inconsistent research results, there is still a need to scrutinize how L1 and L2 knowledge interacts with cognitive abilities in mature L1-literate learners (Koda, 2008).

Focusing on the role of strategies in reading, this study operationalized metacognitive knowledge through the lens of strategies which had been used to describe the conscious and automatic mental activities to process language in a particular situation (Bachman & Palmer, 2010; Purpura, 1997, 1998) and extended the research to explore how metacognitive knowledge indirectly affects L2 reading.

The Present Study

This study aims to investigate the direct effects of metacognitive knowledge, L1 reading ability, L2 language proficiency on L2 reading, as well as ascertain to what extent the effect of metacognitive knowledge on L2 reading is mediated by L1 reading ability and L2 language proficiency among college EFL students. Prior research has well documented the direct effects of metacognition on L1 reading ability and L2 language proficiency. Additionally, a large body of evidence has shown that L1 reading ability and L2 language proficiency are predictors of L2 reading. Thus, three hypotheses were posited:

H1: Metacognitive knowledge, L1 reading ability, and L2 language proficiency make direct, positive contributions to L2 reading.

H2: Metacognitive knowledge indirectly influences L2 reading via L1 reading ability.

H3: Metacognitive knowledge indirectly influences L2 reading via L2 language proficiency.

The main focus of this study was to test three hypotheses against data collected from college EFL students in China. In light of prior theoretical models and empirical research in the field of L2 reading and metacognition, the model was constructed with the hypothesized interrelationships. Figure 1 below was a graphic representation of the conceptual model.

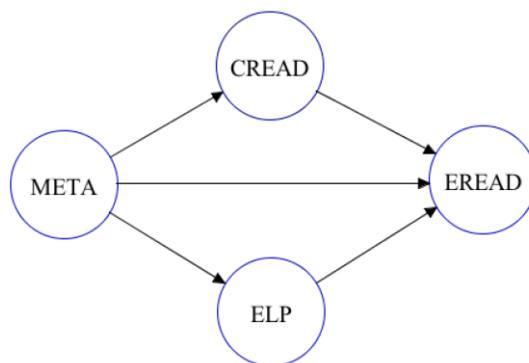


Figure 1. The conceptual model. L1 = Chinese; L2 = English; META = metacognitive knowledge; CREAD = L1 reading ability; ELP = L2 language proficiency; EREAD = L2 reading comprehension.

Method

Participants

For this study, the participants were elicited from a public university in an urban area of southern China. After deleting the missing data and outliers, the final sample size was 268. All the participants were sophomore university students from intact classes taught by four different English teachers. Ethnic background was homogenous, as all participants were of the Han ethnicity (the largest ethnic group in China). Their ages ranged from 20 to 25 ($M = 22.3$). As for gender, there was an almost equal proportion of male and female (male 48.5%; female 51.5%). The length of exposure to learning English was at least 9 years ($M = 9.6$). Learning English as a foreign language, the participants came from 11 academic majors except the English major, and none of them had been abroad.

Instruments

L2 (English) language proficiency test. To avoid overlapping with the reading test, the vocabulary and grammar tests required minimal context-based processing. The rationale was to limit the influence of semantic processing to the minimum (Guo & Roehrig, 2011).

Vocabulary size refers to the number of words that have some meaning to an individual. The Vocabulary Level Test, or VLT (Nation, 1990), was adapted in this study. Based on the grade level of the participants, 10 test items were selected from the VLT. There were two items from the 2000-word level of high-frequency words, three items from the 3000-word level and five items from the 5000-word level. For each test item, there were six words and three definitions. Participants were required to match definitions with the corresponding words within 10 minutes.

Explicit grammar comprises declarative knowledge of grammatical rules, which involves controlled processing (Ellis, 2008). The test of the explicit grammar knowledge was taken from the Paper-Based TOEFL, Section Two (Structure and Written Expression). There were 15 incomplete sentences, along with four multiple-choice items, and the time limit was 10 minutes.

Implicit grammar refers to the knowledge of language use that involves automatic processing without effort (Ellis, 2008). The test of implicit grammar knowledge was adapted from the Grammaticality Judgment Task (Johnson & Newport, 1989). Participants took the written yes or no test consisting of 20 pairs of sentences within 10 minutes. Altogether, 12 basic aspects of sentence structure in English were tested, including past tense, plural, third person singular, present progressive, determiners, pronominalization, particle movement, subcategorization, auxiliaries, yes or no questions, wh- questions and word order. As to each rule type, the grammar error location (beginning, middle or end of the sentence) and the sentence length were balanced.

L2 reading comprehension test (English). L2 reading comprehension was measured by two 700-word expository texts taken from the iBT (Internet-Based) TOEFL. Participants were required to finish 13 multiple-choice questions within 20 minutes for each text, and then they completed the metacognitive strategy questionnaire (English version). This reading test focused on examining readers' abilities in word comprehension (vocabulary, pronoun reference), text comprehension

(factual information, negative fact, sentence simplification, summary and schematic table) and critical comprehension (making inferences, rhetorical purpose and inserting text).

L1 reading comprehension test (Chinese). To measure reading comprehension ability in Chinese, two 500-word expository texts were taken from the Matriculation Chinese test (MCT), which is China's national standardized exam that measures students' reading and writing skills in Chinese before they can be admitted by public universities. In this study, the expository texts examined students' knowledge of reading in topic comprehension (summarizing main idea), detail comprehension (vocabulary knowledge, knowledge of text organization and cohesion), and critical comprehension (recognizing writer's purpose and tone, integrating information and making inferences). Participants were given 40 minutes to finish the test.

Metacognitive awareness of reading strategies inventory. Metacognitive knowledge was measured by the widely used Metacognitive Awareness of Reading Strategies Inventory (MARSİ) (Mokhtari & Reichard, 2002). It contains 30 items, and the Cronbach's alpha for internal consistency is .93. Participants respond on a Likert scale: 1 (*almost never used*), 2 (*rarely used*), 3 (*fairly used*), 4 (*often used*), and 5 (*always used*). The score indicated the frequency of strategy use.

In this study, the categories of strategies followed Mokhtari and Reichard's (2002) study, which included global reading strategies, problem-solving strategies and supporting strategies (See Table 1 below). The translated MARSİ was administered after L1 reading test. The English version of MARSİ was translated into Chinese by the researcher. To check the accuracy and clarity, the translated version was reviewed by four English instructors who were proficient in both English and Chinese. After deliberation and discussion, the final Chinese version was agreed on among the instructors. The rationale behind using a translated questionnaire was to give participants a specific language use context to invoke their reflective process of using strategies (Bachman & Palmer, 2010), which could help to capture the distinction between the strategies they used in reading Chinese texts and reading English texts. Participants were given 30 minutes to complete each questionnaire.

Table 1. *Strategy category, description and item number*

Category	Description	Item Number
Global reading strategies (GLOB)	The generalized techniques to set the stage for reading.	1, 3, 4, 7, 10, 14, 17, 19, 22, 23, 25, 26, 29
Problem-solving strategies (PROB)	The localized strategies enable readers to regulate, manipulate their reading comprehension or even repair their misunderstanding when faced with difficult texts.	8, 11, 13, 16, 18, 21, 27, 30
Supporting strategies (SUP)	The practical techniques of using reference materials, taking notes and asking for help.	2, 5, 6, 9, 12, 15, 20, 24, 28

Data collection procedure

Data collection was conducted in Spring 2013 at a public university in southern China. Based on personal contact, I visited an English instructor and informed her about the purpose and the design of the study. With her help, three other English instructors were willing to cooperate. The

voluntary participants were recruited from the four English instructors' classes. All the tests were administered in classes with the guarantee of the participants' anonymity and confidentiality. First, the L2 language proficiency test was administered. A short orientation was given by the English instructors before the test to make sure the participants understood the task requirements and follow the directions. During the test, participants were required to finish each section (vocabulary, explicit grammar and implicit grammar) within the limited amount of time. The instructors kept track of the time and gave students verbal directions to turn to the next page. In case some students finished earlier, they could double-check their answers, but they needed to wait for the instruction to begin the next section. Second, in the following week, the participants took the English reading comprehension test. To best capture participants' thinking process of how they use strategies in the reading process, the questionnaire (i.e., MARSII) was administered immediately after the exam. In the same way, one week later, they took the Chinese reading comprehension test and then completed the Chinese version of MARSII.

Data analysis

The current study first used the SPSS 19.0 software package for data screening. A significance level of .05 ($p < .05$) was set. Descriptive statistics were produced to display mean, standard deviation, skewness and kurtosis. Missing data and the outliers were deleted and the reliability (Cronbach's alpha) and the correlation among all the variables were reported.

SEM was used to ascertain the direct effects of metacognitive knowledge, L1 reading ability and L2 language proficiency on L2 reading comprehension, as well as the indirect effects of metacognitive knowledge on L2 reading comprehension by means of L1 reading ability and L2 language proficiency. SEM was used because it is more advantageous than traditional regression analysis to test the relationships between observed variables and their underlying constructs as well as the relationships among a set of constructs. Data analysis was run through Mplus version 8.1 with Maximum Likelihood Estimation to fit the models.

Results

Descriptive Statistics

First, all cases with missing observations on any indicator were removed. Listwise deletion resulted in the dropping of 14 cases among the original 300 cases, leaving a sample size of 286. Second, by looking at the standardized score (-3, +3), 11 univariate outliers were identified. To determine if there were multivariate outliers, Mahalanobis distance was used to sort all the cases. Through the inspection of the probability estimate ($p < .001$), seven cases of multivariate outliers were identified and deleted. Third, the univariate skewness and kurtosis values fell within the acceptable ranges. Mardia's coefficient of 1.185 suggested multivariate normality. The final sample size was 268.

Means, standard deviations, correlations and reliabilities are shown in Table 2. All the correlations among the individual measures of metacognitive knowledge, L1 reading ability, L2 language proficiency and L2 reading comprehension were significant at the .05 level.

Table 2. Descriptive statistics and correlations among observed variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
EWORD															
ETECT	0.840*														
ECRIT	0.824*	0.779*													
CTOP	0.871*	0.821*	0.828*												
CDET	0.790*	0.810*	0.766*	0.753*											
CREF	0.809*	0.761*	0.861*	0.823*	0.737*										
SIZE	0.832*	0.802*	0.808*	0.863*	0.769*	0.801*									
EXPLICIT	0.826*	0.776*	0.812*	0.896*	0.756*	0.831*	0.815*								
IMPLICIT	0.788*	0.754*	0.830*	0.787*	0.727*	0.817*	0.770*	0.770*							
EGLOB	0.756*	0.709*	0.716*	0.759*	0.710*	0.679*	0.661*	0.692*	0.702*						
EPRO	0.745*	0.712*	0.722*	0.755*	0.685*	0.710*	0.651*	0.696*	0.704*	0.910*					
ESUP	0.795*	0.728*	0.687*	0.744*	0.700*	0.679*	0.661*	0.670*	0.679*	0.787*	0.772*				
CGLOB	0.729*	0.709*	0.683*	0.715*	0.669*	0.675*	0.608*	0.633*	0.687*	0.914*	0.894*	0.781*			
CPRO	0.741*	0.710*	0.693*	0.743*	0.676*	0.699*	0.635*	0.657*	0.674*	0.881*	0.892*	0.769*	0.883*		
CSUP	0.878*	0.741*	0.763*	0.775*	0.724*	0.742*	0.740*	0.758*	0.741*	0.723*	0.725*	0.759*	0.690*	0.704*	
Mean	26.19	27.62	29.02	16.07	19.12	9.30	16.43	21.02	23.93	3.63	3.71	2.86	3.71	3.86	3.00
Median	26	27	30	16	18	10	17	21	24	3.67	3.78	2.85	3.75	3.88	3.02
SD	2.03	4.99	4.57	2.68	5.81	2.38	4.70	8.99	7.11	0.14	0.13	0.09	0.12	0.08	0.03
Skewness	-0.29	-0.13	-0.50	-0.19	0.10	-0.59	-0.19	-0.17	-0.66	-0.69	-1.13	-0.01	-0.58	-1.11	-0.42
Kurtosis	-0.19	-0.12	-0.55	-0.52	-1.34	-0.37	-0.55	-0.93	0.61	-0.49	-0.13	-1.48	-0.55	0.19	-0.79
Range	9	24	18	11	20	12	19	33	36	0.64	0.42	0.29	0.50	0.27	0.13
Minimum	21	15	18	10	9	2	5	3	0	3.24	3.41	2.72	3.40	3.67	2.94
Maximum	30	39	36	21	29	14	24	36	36	3.88	3.83	3.01	3.90	3.94	3.07
Cronbach's alpha	0.76	0.69	0.83	0.79	0.71	0.76	0.84	0.83	0.80	0.74	0.72	0.77	0.66	0.75	0.73

The Measurement Model

A confirmatory factor analysis (CFA) was used to establish the measurement model and confirm the fit of the data to the hypothesized three-factor model (metacognitive knowledge, L1 reading ability and L2 language proficiency) in the measurement part of the model. Though the chi-square statistic was significant ($\chi^2 = 228.49$, $df = 51$, $p < .05$), it should not be considered as the decisive factor because the chi-square test depends largely on the sample size (Lomax & Shumacker, 2012). Thus, other model fit indices were used in this study, including comparative fit index (CFI), Bentler-Bonett Nonnormed Fit Index (NNFI) and root mean squared error of approximation (RMSEA). NNFI is also known as Tucker-Lewis index (TLI). It was suggested that the values of the CFI, NNFI higher than .95 indicate a good model fit. As with the RMSEA, values lower than .05 are deemed acceptable (Hu & Bentler, 1999). Other indices of the model were close to the cut-off values (RMSEA = 0.021; CFI = 0.973; NNFI = 0.963). Therefore, the goodness-of-fit statistics suggested that the three-factor model provided a fit to the data.

Both the reliability and construct validity were checked and the results are given in Table 3. Firstly, to examine the reliability, Cronbach's alpha and Composite Reliability (CR) were assessed. The values of Cronbach's alpha were .70 and above, except ETEXT (.69) and CGLOB (.66), and the CR values ranged from 0.77 to 0.82, indicating the reliability of the scales.

Table 3. *Standardized coefficients, Composite Reliability and Average Variance Extracted*

Construct	Indicator	β	CR	AVE
META	EGLOB	0.93*	0.82	0.96
	EPRO	0.93*		
	ESUP	0.85*		
	CGLOB	0.95*		
	CPRO	0.94*		
	CSUP	0.84*		
CREAD	CTOP	0.92*	0.77	0.91
	CDE	0.83*		
	CREF	0.88*		
ELP	SIZE	0.90*	0.79	0.92
	EXPLICIT	0.91*		
	IMPLICIT	0.85*		
EREAD	EWORD	0.93*	0.82	0.93
	ETEXT	0.88*		
	ECRIT	0.90*		

Note: * = $p < .05$. β = standardized coefficient; CR: Composite Reliability; AVE = Average Variance Extracted; L1 = Chinese; L2 = English; META = metacognitive knowledge; CREAD = L1 reading ability; ELP = L2 language proficiency; EREAD = L2 reading; EGLOB = L2 global reading strategies; EPROB = L2 problem-solving strategies; ESUP = L2 supporting strategies; CGLOB = L1 global reading strategies; CPROB = L1 problem-solving strategies; CSUP = L1 supporting strategies; CTOP = L1 Topic comprehension; CDET = L1 Detail comprehension; CREF = L1 Inference comprehension; SIZE = L2 vocabulary size; EXPLICIT = explicit grammar; IMPLICIT = implicit grammar; EWORD = L2 word comprehension; ETEXT = L2 text comprehension; ECRIT = L2 critical comprehension.

Next, to examine the construct validity, the standardized factor loading and the Average Variance Extracted (AVE) were assessed. All indicators loaded significantly ($p < .05$) and substantively (standardized coefficients within the range of .83 to .95) on their associated constructs, signaling that the indicators were good representations of the constructs. Also, the AVE values ranged from 0.91 to 0.96, which met the guideline ($AVE > .50$) (Fornell & Larcker, 1981). Furthermore, AVE of each construct was compared with the squared correlations of that construct with other constructs in the model (Fornell & Larcker, 1981). The results showed that the AVEs for each construct were greater than their squared correlations, with all other constructs ranging from 0.62 to 0.76. Thus, the indicators were more correlated with their corresponding construct than with all other constructs in the model, indicating adequate construct validity.

Taken together, the results showed that metacognitive knowledge, L1 reading ability and L2 language proficiency were separate constructs and the three-factor model fit the data. The next section evaluated the goodness of fit of the full structure model.

The Full Structure Model

The SEM results showed that the hypothesized model appeared to be a good fit to the data. In spite of the significant chi-square statistic ($\chi^2 = 235.38$, $df = 85$, $p < .05$) which is sensitive to sample size, other model indices were close to the cut-off values (RMSEA = 0.043; CFI = 0.964; NNFI = 0.951). Due to the good fit of the data to the model, no post-hoc modifications were conducted. Figure 2 was a graphic representation of the model.

Looking closely at the model, it could be seen that all the hypothesized paths reached statistical significance ($p < .05$), which suggested that each construct made a direct contribution to the variance in L2 reading. Metacognitive knowledge ($\beta = .18$, $p < .05$), L2 language proficiency ($\beta = .54$, $p < .05$), L1 reading ability ($\beta = .29$, $p < .05$) all exerted direct, positive influences on L2 reading, indicating that learners with higher level of metacognitive knowledge, L1 reading ability and L2 language proficiency are more likely to be skilled readers.

The second hypothesis, that the relationship between metacognitive knowledge and L2 reading was mediated by L2 language proficiency, was supported ($\beta = .88$, $p < .05$). In addition, the third hypothesis, that metacognitive knowledge indirectly influences L2 reading by L1 reading ability, was supported ($\beta = .83$, $p < .05$).

To ascertain the indirect influences of metacognitive knowledge on L2 reading, a Sobel test was used to test the structural model in Figure 2. The Sobel test is basically a type of test to determine whether the relationship between the independent variable and the dependent variable is an indirect effect due to the effect of a mediator and whether the mediation effect is significant. The Sobel test statistics of the mediation effects was shown in Table 4. It could be seen that the indirect effect of metacognitive knowledge on L2 reading comprehension by means of L1 reading ability was significant ($Z = 3.24$, $p < .05$). Additionally, the indirect effect of metacognitive knowledge on L2 reading comprehension via L2 language proficiency was significant ($Z = 3.36$, $p < .05$). Thus, the research hypotheses that the influences of metacognitive knowledge on L2 reading were mediated by means of L1 reading ability and L2 language

proficiency were confirmed.

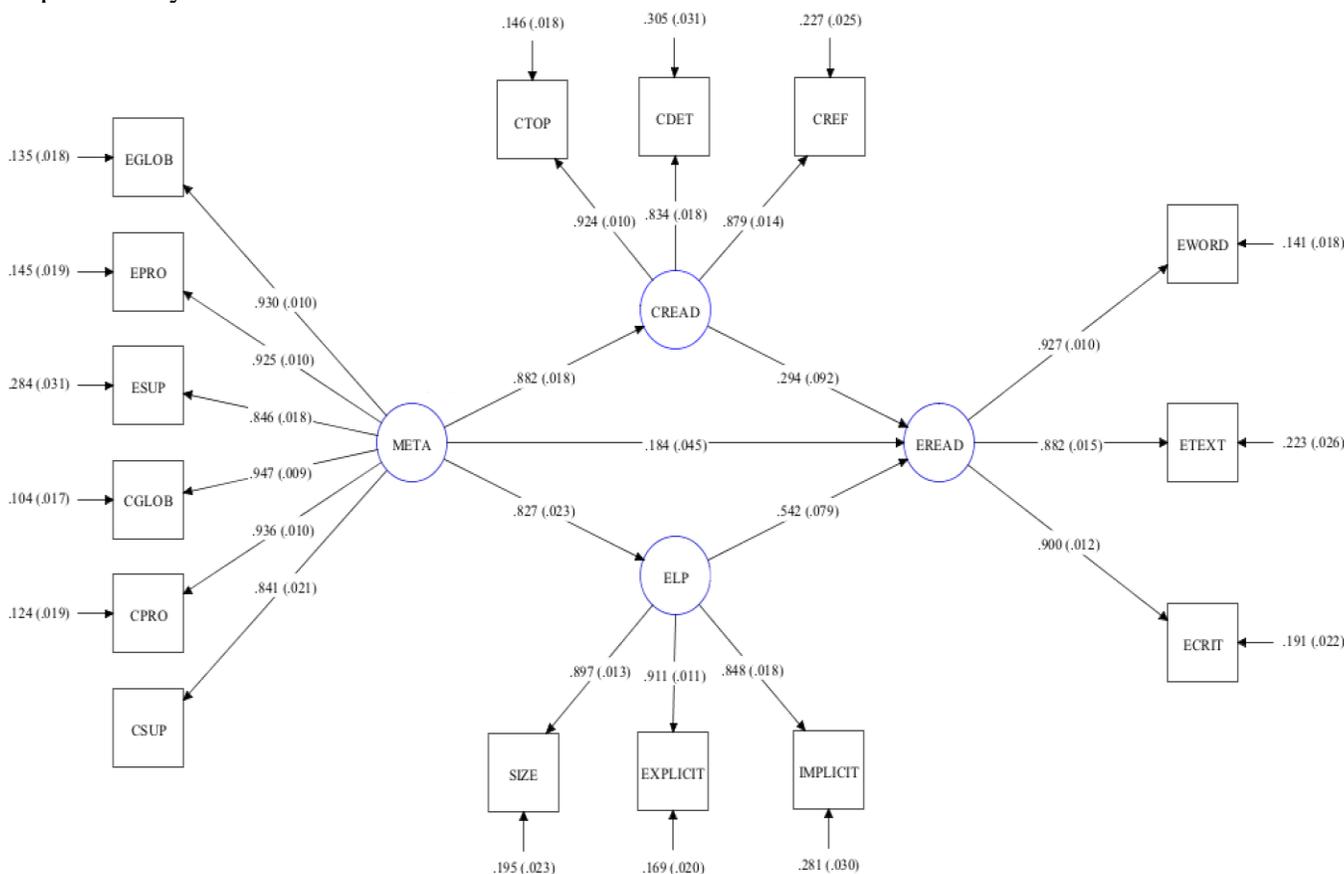


Figure 2. The full structure model. $N = 268$. $p < .05$. L1 = Chinese; L2 = English; META = metacognitive knowledge; CREAD = L1 reading ability; ELP = L2 language proficiency; EREAD = L2 reading; EGLOB = L2 global reading strategies; EPROB = L2 problem-solving strategies; ESUP = L2 supporting strategies; CGLOB = L1 global reading strategies; CPROB = L1 problem-solving strategies; CSUP = L1 supporting strategies; CTOP = L1 Topic comprehension; CDET = L1 Detail comprehension; CREF = L1 Inference comprehension; SIZE = L2 vocabulary size; EXPLICIT = explicit grammar; IMPLICIT = implicit grammar; EWORD = L2 word comprehension; ETEXT = L2 text comprehension; ECRIT = L2 critical comprehension.

Table 4. Sobel test statistics of the mediation effect of L1 reading ability and L2 language proficiency

Mediator	Paths	Unstandardized Coefficient	Standard Error	Z-value	p-value
CREAD	a: META→CREAD	16.52*	0.81	3.24*	0.001
	b: CREAD→EREAD	0.22*	0.07		
ELP	a: META→ELP	26.35*	1.55	3.36*	0.000
	b: ELP→EREAD	0.24*	0.04		

Note. $Z\text{-value} = a*b/\text{SQRT}(b^2*s_a^2 + a^2*s_b^2)$. * = $p < .05$. CREAD = Chinese reading ability; ELP = English language proficiency; META = metacognitive knowledge; EREAD = English reading comprehension.

In terms of the total effects, it was noteworthy that metacognitive knowledge manifested a substantial predictive strength of L2 reading. As shown in Table 5 below, the total effects of metacognitive knowledge outweighed L2 language proficiency and L1 reading ability, which suggested metacognitive knowledge of strategies plays a crucial role in facilitating L2 reading. With respect to the magnitude of the direct effects on L2 reading, L2 language proficiency outperformed L1 reading ability, indicating that L2 vocabulary and grammar knowledge are important to construct meaning of L2 texts and provide strong support for metacognitive knowledge to function effectively.

Table 5. *The standardized indirect and total effects on L2 reading*

Predictor	Mediator	Indirect Effect (SE)	Total Effect (SE)
META	CREAD	0.827* (0.018)	1.893* (0.023)
	ELP	0.882* (0.023)	
CREAD			0.294* (0.092)
ELP			0.542* (0.079)

Note. * = $p < .05$. The number in the parentheses is the standard error; META = metacognitive knowledge; CREAD = Chinese reading ability; ELP = English language proficiency.

Discussion

This study aims to explore the interrelationships among metacognitive knowledge, L1 reading ability, L2 language proficiency and L2 reading. In addition to the direct effects of all the constructs on L2 reading, it was found that metacognitive knowledge exerted indirect effects on L2 reading by means of L1 reading ability and L2 language proficiency. The mediation effects found in this study support Bachman and Palmer's (2010) model of communicative language ability in which metacognitive strategies manage the ways language knowledge is applied in a specific language situation. Moreover, the findings refine our understanding of previous models (e.g., Bernhardt, 2005; Cummins, 1979; McNeil, 2012) by suggesting that metacognitive knowledge, an underlying proficiency, has an executive function to monitor the utilization of L1 reading ability and L2 language proficiency to support L2 reading. Moreover, the results indicate that L2 language proficiency is the cornerstone of the learner's strategic behavior and magnifies the benefits of metacognitive knowledge on L2 reading. Thus, to improve L2 reading ability, educators could incorporate explicit strategy demonstration and modeling into the regular class instruction that enlightens learners to attend to a wide array of strategies (Cummins, Stewart & Block, 2005, p. 278). Since readers who are reflective of the effectiveness of strategies would be more self-directed to operate their skills and resources (Cross, 2015; Kormos & Csizér, 2014), the goal of strategy instruction is to develop strategic readers who could automatize their use of metacognitive knowledge.

The results confirmed the first research hypothesis that metacognitive knowledge, L1 reading ability and L2 language proficiency all make direct contributions to L2 reading. More importantly, metacognitive knowledge was found to exert indirect effects on L2 reading via L1 reading ability and L2 language proficiency, which corroborates Anderson (2002) that strategy use is at the interface of individual attributes and task characteristics. Concurring with previous

studies (e.g., Cohen & Upton, 2006; Karimi, 2015; Mokhatari & Reichard, 2004; Rupp, Ferne & Choi, 2006), the results suggested that metacognitive knowledge is a crucial contributor to L2 reading. More importantly, the indirect effects could be explained with respect to the executive function of metacognitive knowledge, which corresponds to the literature in metacognition. As a higher-order cognitive proficiency, metacognitive knowledge empowers readers with cognitive flexibility to shift attention between text details and enhances their inhibition ability to ignore irrelevant information and suppress distracting behavior (Cartwright, 2015). It has been proposed that the executive control function plays a critical role in resolving representational conflicts and promoting alternative interpretations during comprehension (Vuong & Martin, 2014). The focus on the executive control is compatible with the studies by Purpura (1997, 1998) which found that metacognitive strategies had an executive function over cognitive strategies to influence L2 reading test performance. In this study, participants were mature college students characterized by having two languages at their disposal and extensive practices of applying strategies in L1 reading. As Bachman and Palmer (2010) stressed, the integration of individual attributes enables the language users to appropriately produce and interpret meanings in a given situation (p. 49). Thus, it is plausible that higher-order metacognitive knowledge, an underlying cognitive proficiency, not only manages L2 language knowledge but also leverages available L1 literacy resources in L2 reading process.

On the one hand, metacognitive knowledge had an indirect effect on L2 reading through L1 reading ability, which confirmed the second research hypothesis. This finding echoes the claim of Geva and Ryan (1993) that “the underlying proficiency, which is mediated through the child’s first language, can then resurface as transfer of relevant concepts and skills to another language” (p. 6). In other words, metacognitive knowledge, when mediated by L1 reading ability, facilitates the transfer of the knowledge about reading (e.g., knowledge of text structure, cohesion and conceptual knowledge) developed in L1 reading experiences to optimize L2 reading performance. Considering that the Chinese literacy of the participants was well developed when English language learning began, they were more attuned to access reading strategies acquired in Chinese reading experience when they approached English texts. It may be that learners drew on metacognitive knowledge to appraise their available L1 resources and determine the relevant knowledge to be employed for coping with task demands (Bachman & Palmer, 2010). The transfer of L1 reading strategies to tackle contradictions and discrepancies in L2 reading comprehension has been reported in Chinese EFL learners (e.g., Jiang, 2011; Tsai et al., 2010). There is also evidence that using L1 vocabulary knowledge helped to resolve the ambiguities in L2 words and ideas (Seng & Hashim, 2006), and the text-based translation strategies helped the acquisition of L2 vocabulary (Laufer & Girsai, 2008). Therefore, consistent with prior studies, this study underscored the significance of maintaining L1 literacy skills to benefit L2 reading development. On the flip side, the mediating effects implied that for L1 reading ability to facilitate L2 reading, the cognitive proficiency of metacognitive knowledge of strategies should be well developed (Grabe & Stoller, 2013, p. 49).

On the other hand, L2 language proficiency mediated the relationship between metacognitive knowledge and L2 reading, so the third research hypothesis was confirmed. The results support the view that strategies could be used more effectively if the readers have a higher degree of language knowledge, which determines how the readers allocate their resources (e.g., Baker, 2005; Griffith & Ruan, 2005). It may be that as the language proficiency improves, readers can

free the constraining impacts on the strategic process and direct more cognitive resources for higher-level skills (e.g., Perfetti et al., 2005; Pressley, 2002; Pintrich & Zusho, 2002). Moreover, the mediation effects lend support for Bachman and Palmer's (2010) conceptualization that both language knowledge and higher-order strategic competence, which monitors linguistic resources, are involved in completing a demanding task. Previous longitudinal studies have demonstrated that a good command of language knowledge adds to the benefits of metacognitive knowledge in the reading process. Schoonen et al. (1998) found that higher-proficiency ESL readers benefited more from metacognition shared by both languages. In the same vein, van Gelderen et al. (2007) found that metacognition gained predictive strength as learners' proficiency improved. Moreover, a parallel pattern was found in L1 reading. Taken together, the mediation effects indicate that L1 reading ability and L2 language proficiency work in tandem with metacognitive knowledge, as well as boost the benefits of metacognitive knowledge on L2 reading.

Both L1 reading ability and L2 language proficiency were found to exhibit positive, direct effects on L2 reading, which supports Bernhardt's (2005) Compensatory Model of L2 reading. In line with a large body of studies, the results from this study provide further evidence that L2 language proficiency outperformed L1 reading ability to make a substantial contribution to L2 reading. The results support the view by Pichette et al. (2003) that a good level of L2 language knowledge enables L1 reading ability to be a predictor of L2 reading. Otherwise, the limited lexical-grammatical knowledge short-circuits the activation of previously acquired literacy skills (Clarke, 1980). Also, the results highlight that L2 language proficiency provides primary linguistic support for metacognitive strategies to function effectively. Furthermore, the strong predictive power of L2 language proficiency could be explained with reference to the increase of L2 input (Ardasheva & Tretter, 2013), which promotes the interplay between L1 and L2 linguistic skills (Koda, 2007). It may be that the participants in this study had been exposed to a wide variety of academically challenging texts at college, which not only improved their L2 language knowledge, but also enriched their repertoire of strategies acquired in L1 reading experience. Thus, the findings help to explain the view that the coexistence of L1 and L2 resources enables learners to connect the two resources in the reading process (Cook, 2001; Koda, 2007). As discussed before, it is likely that metacognitive knowledge, an underlying cognitive proficiency, coordinates the available and relevant L1 and L2 resources to maximize L2 reading performance.

Limitations and Recommendations for Future Research

Although this study has produced a number of powerful insights, some limitations must be noted. First, in the current model, the arrows suggest that the two factors are causally related with the cause in the direction of the arrow. Thus, the results of this study should be interpreted with caution. Next, this study used a homogenous sample of university sophomore EFL learners in China. Future research could use a cross-sectional design to examine participants from diverse sociocultural backgrounds, age groups and first languages, which will yield more precise results regarding individual differences. Second, in this study, L2 language proficiency was narrowly operationalized as vocabulary and grammar. Future research could explore the multiple facets of L2 proficiency, such as morphology and phonological awareness. Moreover, one caveat in the present study is that both L1 and L2 reading ability were measured by multiple-choice questions.

It would be better for future research to use a broader range of measures, such as sentence completion and short-answer questions. Also, the Matriculation Chinese Test has a lower difficulty level than TOEFL. Thus, an alternative instrument to measure Chinese reading ability of college students is needed. Finally, it is interesting to note that metacognitive knowledge has substantial indirect effects, but a small direct effect, on L2 reading. Future research could illuminate the components of metacognitive knowledge that exert the unmediated influence on L2 reading (thank one of the reviewers for this suggestion).

Theoretical and Pedagogical Implications

Despite the limitations, the outcomes of this research afford significant theoretical and pedagogical implications. This conceptualized model depicts the interrelationships among metacognitive knowledge, L1 reading ability, L2 language proficiency and L2 reading, which has significant theoretical implications for adding metacognitive knowledge into the L2 reading model as an essential component.

The pronounced contribution of metacognitive knowledge has the important pedagogical implication of incorporating metacognitive instruction into L2 curriculum to enhance L2 reading. Previous studies (e.g., Cohen, 2003; Fung, Wilkinson, & Moore, 2003; Song, 2005; Zhang, 2008, 2009) have recorded that strategy instruction is a pathway to identify L2 reading difficulties and promote L2 reading comprehension. Educators should encourage learners to engage in conscious and deliberate practices which are crucial to form the habits of mind; as a result, strategic activation becomes more internalized and less effortful when learners reach the stage of automaticity (DeKeyser, 2007; Donndelinger, 2005, p. 241). One effective tool to raise students' metacognitive awareness is reflective journals in which students write about how they engage in the cognitive process of planning, selecting, monitoring, combining and evaluating strategies when completing a demanding reading task (Anderson, 2012).

The positive impact of L1 reading ability on L2 reading points to another pedagogical implication that the L2 reading instruction should take into consideration learners' L1 literacy resources (Ardasheva & Tretter, 2013). The study of Scott and Fuente (2008) discovered that allowing students to draw on their L1 resources in cognitively challenging tasks resulted in more integrated discussion with substantial content, coherent collaboration and confident expression. For example, teachers could encourage lower-proficiency students to check related resources in their L1 before they read L2 text, which could increase those students' processing speed, as well as comprehension accuracy, because it prevents students from literal translation of the text or imposing inadequate background information on the text representation (Grabe & Stoller, 2013). Additionally, the L2 reading curriculum could incorporate reading materials that focus on students' native culture. The familiarity of the content enables students to check comprehension, introspect and ask questions while keeping track of the reading goal and progress, which is part of metacognitive knowledge (Samuels, Ediger, Willcutt & Palumbo, 2005, p. 55).

Conclusion

This study aims to delineate the direct and indirect effects of metacognitive knowledge, L1 reading ability and L2 language proficiency on L2 reading. Apart from confirming the direct effects of each construct on L2 reading, this study found that metacognitive knowledge indirectly affected L2 reading through its influences on L1 reading ability and L2 language proficiency. The findings support Bachman and Palmer's (2010) model of communicative language ability in which metacognitive strategies are higher-order skills that manage language knowledge and other cognitive activities (p. 48). Moreover, the mediation effects indicate that L1 reading ability and L2 language proficiency work in concert with metacognitive knowledge and L2 lexical-grammatical knowledge provides the solid basis for metacognitive knowledge to function effectively in L2 reading. Thus, this study argued that metacognitive knowledge does not function as a stand-alone cognitive ability but serves as a central executive that leverages available and relevant language resources to facilitate the reading process. These findings help us to understand the mechanism by which metacognitive knowledge supports L2 reading. Such understanding is of great importance for us to embed metacognitive instruction and L1 literacy resources into L2 curriculum to enhance L2 reading.

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