

Syntactic Complexity in RA Writing of Chinese EFL Learners: A Corpus-Based Study of RA Abstracts

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Abstract

As a reliable measurement of language development, second language (L2) proficiency and writing quality, syntactic complexity has received considerable attention in research about L2 acquisition and English academic writing. However, few comparative studies have been conducted on the RAs (research articles) of Chinese EFL learners at undergraduate, graduate and PhD level using fine-grained indicators. Therefore, this study aims to examine the differences in syntactic complexity of academic output of Chinese across-proficiency L2 learners, as well as indicators with great predictive power towards English academic writing quality. Based on a self-constructed corpus, this study analyzed the abstract sections of 90 theses of Chinese EFL learners at undergraduate, graduate and PhD level in the field of Applied Linguistics. Using TAASSC, these samples were analyzed using 14 holistic metrics and 163 fine-grained metrics covering multiple dimensions of syntactic complexity. Significant differences in syntactic complexity among these cross-proficiency Chinese EFL learners in three groups were found. At the global level, syntactic complexity differs in the length of production units, the use of complex nouns and verb phrases per T-unit. At the fine-grained clausal level, syntactic complexity differences are reflected in the undefined subordination and auxiliary verbs per clause. At the fine-grained phrase level, syntactic complexity features differ in the subordinate components and six specific phrase subordination types. In addition, metrics that can effectively distinguish English L2 academic writing quality are revealed, namely, dependent clauses per clause, dependents per nominal subject (standard deviation) and adjectival modifiers per direct object (no pronouns). Results of this study can not only enrich the current study in terms of research subjects and indicators, but can also provide pedagogical implications for English for Research Publication Purposes (ERPP) teaching in China.

Keywords: syntactic complexity, academic writing, Chinese EFL learners

1. Introduction

With the burgeoning academic interests in English for Academic Purpose (EAP) research and L2 development, special attention has been paid on L2 research article (RA) writing. Syntactic complexity, defined as the degree of variation, sophistication, and elaboration of the syntactic structures used in language production, is considered to play an important role in L2 development and writing quality evaluation (Crossley, S.A. & McNamara, D.S., 2014; Kyle, K., Crossley, S. & Verspoor, M., 2021; Lu, X., Casal, J.E. & Liu, Y., 2020; Ortega, L., 2003).

Previous study of syntactic complexity in L2 writing has primarily two lines. The first line of research focused on syntactic complexity in L2 writing across L2 proficiency, clarifying the relationship between syntactic complexity, language proficiency and writing quality (Kuiken, F. & Vedder, I., 2019; Lahuerta Martínez, A.C., 2018). The second line examined how variation across language backgrounds, disciplines, genres, writing tasks, and other relevant factors affects syntactic complexity in L2 writing (Ziaeeian, E. & Golparvar, S.E., 2022; Wu, X., Mauranen, A. & Lei, L., 2020). Common examples include comparisons between L1 and L2 learners, and between hard science and soft science disciplines.

Meanwhile, the complex syntactic features have also proved to be a prominent feature of academic writing (Lu, X., Casal, J.E. & Liu, Y., 2020; Biber, D., Gray, B. & Poonpon, K., 2011). The study of syntactic complexity in ERPP related texts has also attracted considerable attention. Some learners have adopted a cross-disciplinary perspective to study syntactic complexity in ERPP writing (Dong, J., Wang, H. & Buckingham, L., 2023; Lu, X., Casal, J.E., Liu, Y., et al., 2021), as well as studies from a cross-part genre perspective to specifically or comparatively analyze various parts of RAs, with the most studied part being the main body of RAs, including the four IMRD (introduction; method; result; discussion) sections (Lu, X., Casal, J.E. & Liu, Y., 2020; Ziaecian, E. & Golparvar, S.E., 2022; Casal, J.E., Lu, X., Qiu, X., et al., 2021; Saricaoglu, A., Bilki, Z. & Plakans, L., 2021; Yin, S., Gao, Y. & Lu, X., 2023). More recently, comparisons of academic outputs at different academic levels have also received more attention (Ansarifar, A., Shahriari, H. & Pishghadam, R., 2018; Yin, S., Gao, Y. & Lu, X., 2021).

However, there remains a gap in the current research in terms of the study participants, namely, the lack of research on syntactic complexity of academic writing of Chinese EFL learners majored in Applied Linguistics at undergraduate, graduate and PhD level. There also exists a lack of studies that precisely analyze the abstract section. In terms of indicator selection, based on the situation that most of the previous studies have used more generalized and large-grained indicators, the research indices remains to be refined for recent studies.

By addressing these gaps, this article will serve as a supplement to the existing research on syntactic complexity. In order to reduce the influence of other variables, we only selected RAs of learners in the English Applied Linguistics field. From the undergraduate, graduate to the PhD level, the L2 proficiency of EFL learners in Applied Linguistics field gradually strengthens, with their academic writing skills also improving. By analyzing the syntactic complexity of RA abstracts of cross-proficiency L2 learners, the difference of syntactic complexity of learners' academic writing at each level will be compared. This will not only serve as a test of the existing research on the relationship between syntactic complexity and second language writing and proficiency, but also as a reference for learners of Applied Linguistics to improve their academic writing skills. By performing stepwise regression analysis on each indicator, the indicators were also analyzed to determine those with high predictive power of English academic writing quality. In addition, pedagogical implications can also be drawn from this study, as it can help to adopt specific teaching methods according to the characteristics of syntactic complexity at different stages.

2. Literature Review

Syntactic complexity, as an important component of linguistic complexity, is considered to be an effective gauge of L2 proficiency (Biber, D., Gray, B. & Staples, S., 2016; Biber, D., Gray, B., Staples, S., et al., 2020; Lu, X., 2011), language development (Atak, N. & Saricaoglu, A., 2021; Bulté, B. & Housen, A., 2014; Yoon, H. & Polio, C., 2017), and L2 writing quality (Kyle, K. & Crossley, S.A., 2017; Kyle, K. & Crossley, S.A., 2018; Yang, W., Lu, X. & Weigle, S.A., 2015; Zhang, X., Lu, X. & Li, W., 2022). It is also an explicit feature of academic writing (Lu, X., Casal, J.E. & Liu, Y., 2020; Biber, D., Gray, B. & Poonpon, K., 2011).

Recent research on syntactic complexity in L2 writing contains basically two lines. The first line, from the perspective of language assessment and second language development, clarifies the relationship between syntactic complexity and language proficiency and writing quality. Lahuerta Martínez (2018) collected the writing of 188 EFL learners of secondary education across proficiency levels in her study and analyzed the syntactic complexity features based on eight indices selected from the sentential, the clausal, and the phrasal levels. It was found that EFL learners with different proficiency levels showed different degrees of syntactic complexity, with those with higher proficiency levels showing higher levels of syntactic complexity. At the same time, by comparing the holistic rating of L2 writing quality with the syntactic complexity indices, Lahuerta Martínez found a strong positive correlation between the L2 writing holistic rating and the indices representing syntactic complexity, suggesting that syntactic complexity measures are also effective for second language writing quality assessment. A similar conclusion was reached in a study by Lei et al. (2023) that syntactic complexity increased with L2 proficiency in Chinese EFL learners, correlating with higher writing scores.

Taking a view of L2 acquisition, development, or testing, the second line of research examines the impact of variation in language background, discipline, genre, writing task, and other relevant factors on the syntactic complexity of L2 writing. Ziaecian & Golparvar (Ziaecian, E. & Golparvar, S.E., 2022) compared the features of syntactic complexity across disciplines by selecting RA introductions from three fields: Applied Linguistics, Chemistry and Economics, and found significant disciplinary variation in syntactic complexity. At the sentence level, introductions from the fields of Economics and Applied Linguistics tend to present more complexity than those from Chemistry, while the opposite is true for phrasal level, with Chemistry texts often presenting higher complexity than Economics and Applied Linguistics texts. The study by Wu et al. (2020) took into consideration the language background differences. They compared the syntactic complexity features between academic discourse of L1 and L2 writers and found that ELF writers contained more coordinate phrases, more complex

nominals, longer sentences and clauses, and fewer subordinate clauses.

ERPP, as a significant focus in the second language field, has been studied by large array of researchers. Biber & Gray (2010) introduced the use of phrasal-level syntactic complexity to assess the value of written academic discourse, following which research on the syntactic complexity of L2 ERPP writing has sparked attention in the academia.

Recently, some scholars have adopted a cross-disciplinary perspective to examine the syntactic complexity in ERPP writing. For example, Dong et al. (2023) found significant disciplinary variation in syntactic complexity through quantitative and qualitative analyses of students' written academic texts across four disciplinary groups and 31 disciplines, based on the British Academic Written English (BAWE) corpus. Lu et al. (2021) conducted a comparative analysis of the syntactic complexity and rhetorical functions of academic texts in core social science disciplines and engineering disciplines. By selecting the introduction sections of 400 published academic articles in four disciplines (Anthropology, Sociology, Chemical Engineering, and Electrical Engineering), it was found that the sentences implementing the six common rhetorical move steps in the introduction sections had significant disciplinary differences in syntactic complexity.

There are also studies under a cross part-genre perspective that analyze various parts of RAs specifically or comparatively, with the most studied parts being the main body of RAs comprising the four IMRD (introduction; method; result; discussion) parts. For example, Casal et al. (2021) built a corpus with 240 published RAs and conducted a syntactic complexity analysis based on genres, including introduction, methods, results, and discussion sections. Zhou et al. (2023) also conducted rhetorical function and syntactic complexity analyses on the introduction part of 300 RAs in different domains. The syntactic complexity indicators were found to be stable across hard-pure and hard-applied disciplines.

Noticeably, the comparison of academic outputs across academic levels has also received greater attention in the recent past. For example, Ansarifar et al. (2018) examined the phrasal modification features in the abstract section by analyzing RAs of L1 Persian authors in the field of applied linguistics at the master's and doctoral levels and published writers in the field. They found that master's students differed significantly from published writers in the use of modifiers, while doctoral students did not differ significantly from published writers except for multiple prepositional phrases as noun post-modifiers. Yin et al. (2021) conducted a comparative analysis of syntactic complexity between 30 emerging international publication (IP) writers' RAs and 30 expert IP writers' RAs in the field of Applied Linguistics. Significant differences in syntactic complexity metrics were found between these two groups under different RA part-genres.

As three crucial learning stages for students toward academic publication, it is of interest what kind of syntactic complexity characterizes the dissertations of Chinese EFL learners majored in Applied Linguistics at undergraduate, graduate and PhD level respectively, as well as how such characteristics differ and evolve. Although some academic attention has been paid to the value of undergraduate, graduate and PhD students' dissertations, there is still a gap in the study comparing syntactic complexity of all these three stages. At the same time, it should be noted that most of the existing studies focused on the IMRD part of RAs with a lack of exploration on abstract section. Therefore, this paper will examine the abstract part of theses written by Chinese EFL learners at all three stages of undergraduate, graduate and PhD level as a supplement to the existing studies.

In terms of metric selection, most of the extant studies have employed traditional large-grained metrics. With numerous studies conducted, the validity of large-grained syntactic complexity indicators has been demonstrated in measuring second language writing and language proficiency (Ortega, L., 2003; Lahuerta Martínez, A.C., 2018; Lu, X., 2011).

However, there exists the following drawbacks in adopting large-grained metrics in syntactic complexity analysis. Firstly, the broad nature of large-grained metrics makes it difficult to obtain information about changes in the specific language structure during the learners' language development process. An array of scholars have criticized the granularity of large-grained metrics in their research, arguing that such metrics are not sufficiently sensitive (Kyle, K. & Crossley, S.A., 2018; Larsen-Freeman, D., 2009; Norris, J.M. & Ortega, L., 2009; Wolfe-Quintero, K., Inagaki, S. & Kim, H.Y., 1998). Kyle (2018) argues that there is a diversity of syntactic structures that can result in changes in large-grained syntactic complexity indices, whilst the use of fine-grained syntactic complexity indices can capture details about such changes and therefore provide a clearer understanding of the relationship between syntactic complexity and L2 writing ability. Secondly, traditional large-grained metrics focus excessively on the clausal level of complexity, lacking an emphasis on the phrasal level, which also matters. For example, Biber et al. (2021) summarized the linguistic features based on a corpus of informal speech and academic writing, suggesting that clausal complexity is a distinctive feature of informal talk, while phrasal complexity is a distinctive feature of academic writing. Biber & Gray (2016), through a diachronic study of written discourse, draw to a conclusion that as the grammatical structure of a sentence becomes more complex, the number of nominalizations and passive constructions used also increases. Casal &

Lee (Casal, J.E. & Lee, J.J., 2019) found that phrase-level indicators of complexity had a significant effect on differentiating the quality of college students' writing, which was not evident for sentence-level indicators.

In order to address the above shortcomings, both the traditional large-grained metrics and fine-grained metrics are adopted in this paper. A multi-dimensional perspective is also employed to ensure a relatively comprehensive consideration of syntactic complexity, including the global, clausal, and phrasal level.

In view of the scant research on syntactic complexity of Chinese EFL learners at the undergraduate, graduate and PhD level and most research adopting large-grained metrics, this study aims to investigate the differences of syntactic complexity in RA abstracts written by Chinese EFL learners in the field of Applied Linguistics at the above three stages with both large-grained and fine-grained indices. The predictive power of indicators will also be analyzed to determine indicators that can effectively predict English academic writing quality. Specifically, research questions of the current study are as follows.

(1) Are there significant differences in RA abstracts of Chinese EFL learners majored in Applied Linguistics at undergraduate, graduate and PhD level? If yes, what are the differences?

(2) What are the indices that can effectively distinguish the English L2 academic writing quality?

3. Method

3.1 Corpus Design

This paper self-constructs a corpus containing the abstract part of theses written by Chinese EFL learners majored in Applied Linguistics at undergraduate, graduate and PhD level. Our data were obtained from the university's graduation thesis system and CNKI database. Theses from the three stages of EFL learners were divided into three groups (group 1-3 representing undergraduate, graduate and PhD level RAs), and six theses published in each year between 2017 and 2022 were randomly selected to ensure that there were 30 theses in each group, for a total number of 90.

Since TAASSC requires the input files to be in pure txt format, we edited the abstracts of the selected 90 theses into 90 pure txt files and named the documents with four digits (the first digit represents the group number; the second and third digits represent the last two digits of the year of theses; the fourth digit represents the name order of the RAs in that year in A-Z order; e.g. file-3216 represents the 6th file in year 2021 in group 3). The title items Abstract and Keyword are used as markers to distinguish the content of the abstract sections. In order to minimize possible errors caused by disciplinary differences and to take into account the importance of ERPP writing for learners in this field, all papers were selected from the field of English Applied Linguistics. The selected authors were checked for their names, majors, and graduation schools to ensure the relative consistency of their status as Chinese EFL learners and their majors.

3.2 Syntactic Complexity Indices

In this study, both large-grained and fine-grained metrics were selected, including the global, clausal, and phrasal levels. Firstly, at the global level, parameters identified and labeled by Lu (2010) in L2SCA were selected, including a total of 14 metrics such as mean length of T-unit. As for the fine-grained clausal and phrasal syntactic complexity metrics, according to the 163 fine-grained complexity metrics proposed by Kyle (2016), 31 clausal complexity metrics and 132 phrasal complexity metrics in TAASSC were selected in this paper.

3.3 Data Analysis

After processing the texts of three groups in TAASSC, we obtained Excel files with specific data on each indicator for each group. The subsequent series of processing will be performed in SPSS or SPSSAU.

To answer the first research question, descriptive statistics on the results of the TAASSC were firstly performed. Kruskal-Wallis tests were then performed for large-grained and fine-grained metrics to measure the degree of variation of each metric across the three groups. Since some of the fine-grained phrasal indicators had values of 0 in all 90 RA abstracts across the three groups, 25 metrics were excluded. Only 138 meaningful fine-grained indicators and 14 traditional global indicators were analyzed for subsequent analysis.

To answer the second research question, following Kyle & Crossley (2018), we first conducted a Kolmogorov-Smirnov test on 138 meaningful fine-grained indicators and 14 traditional global indicators. The 49 screened indicators that fit the normal distribution will be subjected to stepwise regression to eliminate the effect of multicollinearity. In this study, in line with previous studies (Rivard, L.P. & Gueye, N.R., 2023), we roughly considered Chinese EFL learners majored in Applied Linguistics at undergraduate, graduate and PhD level as three groups of cross-proficiency EFL learners, and their RAs to be at three English academic writing quality levels.

4. Results and Discussion

4.1 Syntactic Complexity Variation Across 3 Groups

4.1.1 Differences in Large-Grained L2SCA Metrics

Significant differences of syntactic complexity can be found in terms of the 14 traditional holistic L2SCA metrics.

At the global level, Table 1 displays the descriptive and statistical characteristics, as well as the Kruskal-Wallis test results of 14 global L2SCA metrics among three groups. It can be seen that all the indicators showed an increasing trend except for C/S, T/S, and CT/T. Based on the results of Kruskal-Wallis test, a total of six indicators showed significance ($p < 0.05$) among the three groups, including MLS ($p = 0.014 < 0.05$), MLT ($p = 0.001 < 0.05$), CN/T ($p = 0.035 < 0.05$), VP/T ($p = 0.026 < 0.05$), DC/C ($p = 0.022 < 0.05$), DC/T ($p = 0.025 < 0.05$).

Table 1. Kruskal-Wallis test results of 14 L2SCA metrics

Measures	Group1 (n=30)	Group2 (n=30)	Group3 (n=30)	<i>H</i>	<i>p</i>
	M (SD)				
MLS	28.67(16.896)	29.207(5.809)	31.892(9.333)	8.570	0.014*
MLT	22.414(4.693)	23.669(4.715)	27.739(6.626)	14.893	0.001**
MLC	15.604(3.244)	16.125(1.826)	17.285(3.214)	5.808	0.055
C_S	1.853(1.007)	1.822(0.366)	1.873(0.546)	2.337	0.311
VP_T	2.102(0.486)	2.146(0.507)	2.455(0.555)	7.284	0.026*
CN_C	2.457(0.69)	2.488(0.382)	2.595(0.547)	1.269	0.530
C_T	1.456(0.251)	1.473(0.274)	1.622(0.349)	4.644	0.098
CN_T	3.522(0.986)	3.663(0.855)	4.181(1.121)	6.729	0.035*
DC_C	0.277(0.096)	0.3(0.102)	0.432(0.09)	7.658	0.022*
DC_T	0.421(0.206)	0.467(0.253)	0.576(0.253)	7.388	0.025*
T_S	1.289(0.719)	1.244(0.193)	1.145(0.161)	3.718	0.156
CT_T	0.367(0.153)	0.361(0.129)	0.38(0.129)	0.566	0.753
CP_T	0.818(0.356)	0.887(0.413)	1.074(0.419)	5.825	0.054
CP_C	0.579(0.268)	0.605(0.247)	0.671(0.258)	1.372	0.504

* $p < 0.05$ ** $p < 0.01$.

Firstly, two indicators regarding the length of production units increased significantly in the thesis abstracts at the undergraduate, graduate and PhD levels (MLS, $M = 28.670, 29.207, 31.892$; MLT, $M = 22.414, 23.669, 27.739$). Such an increase in mean length of sentence and T-unit is consistent with the findings of Ortega (2003) and Lu (2010) that the length of language units contributes to the quality of L2 writing in English. This also justifies the idea that as English proficiency increases, learners tend to produce longer sentences and T-units. By analyzing the specific content of samples, we found that the longer length of production units may stem not only from the increased L2 English proficiency, but also from the reasoning requirements of essays due to the increased academic difficulty. The longer sentences and T-units are used to meet the higher demands of academic reasoning.

Excerpt 1 Therefore, using a questionnaire survey, this study intends to examine the initiative of English/Business English majors to improve their pronunciation after class. (1185, group 1).

Excerpt 2 This study employs action research integrated with quantitative and qualitative methods to carry out the cultivation of critical thinking in reading classes of non-English majors, aiming at probing into effective instructional modes of cultivating students' critical thinking. (2184, group 2).

Excerpt 3 The present research represents a tentative exploration of primary school EFL teacher expertise in whole-class scaffolding from the macro-level (i.e., the selection and sequencing of pedagogical activities) and the micro-level (i.e. the interactional patterns and the interactional scaffolding strategies) to explore the nature of teacher expertise from the sociocultural perspective so as to enrich the fairly scant studies from this angle, which will eventually enhance our understanding of EFL teacher expertise within the scope of teaching as assistance and shed some light on the ESL/EFL classroom teaching and teacher education. (3195, group 3).

In terms of overall phrasal complexity, learners from the undergraduate to the PhD level tend to use more complex nominals per T-unit and verb phrases per T-unit (CN/T, $p = 0.035 < 0.05$; VP/T, $p = 0.026 < 0.05$). Current

research has found more complex nominals and verb phrases per language production unit in writings of higher English L2 proficiency (Biber, D., Gray, B. & Poonpon, K., 2011; Kim, J.Y., 2014). The significant increase in RA abstracts on complex nominals and verb phrases among the three stages of learners in this paper echoes this opinion. Meanwhile, studies on syntactic complexity of English academic writing have concluded a distinctive feature of nominal style, namely the greater use of nominative structures than verbal structures in academic writing (Lu, X., Casal, J.E. & Liu, Y., 2020; Biber, D., Gray, B. & Poonpon, K., 2011; Biber, D. & Gray, B., 2010; Halliday, M.A.K. & Martin, J.R., 1993). Each of the three stages of RA abstracts in this paper showed more complex nominals than verb phrases (CN/T, $M=3.522, 3.663, 4.181$; VP/T, $M=2.102, 2.146, 2.455$). It was found by the excerpts that this feature may result from the tendency of L2 learners with higher proficiency to condense expressions, expressing information in the form of multiple complex nominals, with more complex nominals used by more proficient authors.

Excerpt 4 The traditional teacher-centered methodology and teaching content have long been the focus of concern to the teachers, but teacher talk, especially the effectiveness and resources of teacher talk, has not been stressed properly. (1183, group 1).

Excerpt 5 Based on relevant theories of amplifiers and interlanguage, this study adopts the method of Contrastive Interlanguage Analysis (CIA) and uses self-built corpora to explore the use of amplifiers in academic writing by Chinese English majors. (2191, group 2).

Excerpt 6 Based on social-culture theory, activity theory and “post-process” writing theory, this study constructed a blended learning mode for mobile English writing, and conducted a two-month teaching experiment of English persuasive writing to study students’ mobile English writing learning behaviors (MEWLBS), with the aim of answering three research questions. (3175, group 3).

On clausal subordination, the RA abstracts of three stages also showed significant differences, as can be seen by more dependent clauses per clause or per T-unit (DC/C, $p=0.022<0.05$; DC/T, $p=0.025<0.05$). In contrast to previous studies that believe learners with higher English proficiency will use a lower proportion of dependent clause subordination structures (Jiang, J., Bi, P. & Liu, H., 2019) in the present study, finite subordination represented by dependent clauses per clause or per T-unit increased as proficiency rises. This may result from the different content of our selected sample. This paper focuses on the RA writing of English L2 learners, of which finite subordination has an important functional role. It has been found that novice academic writers use finite subordination less often than expert academic writers (Yin, S., Gao, Y. & Lu, X., 2023). The significant increase of DC/C indicator in academic writing of the present study among the present learners is in line with the characteristics of L2 academic writing in English.

Additionally, it was found that the T/S indicator gradually decreased between the three stages (T/S, $M=1.289, 1.244, 1.145$). Dong (2023) found fewer T-units embedded in RAs of social science studies when analyzing syntactic complexity across disciplines and suggested the reason for this to be the need for condensed information transfer. We selected three excerpts from the samples on summarizing previous research and found that such decline may be due to the rise in academic level leading to more fluid and coherent thinking and longer idea units.

4.1.2 Differences in Fine-Grained Clausal and Phrasal Metrics

Remarkable differences in syntactic complexity can also be seen with respect to fine-grained clausal and phrasal metrics.

Among 163 fine-grained indicators, a total of 37 showed significance ($p<0.05$), as can be seen in Table 2.

Table 2. Fine-grained Metrics Showed Significance ($p<0.05$)

Measures	Group1 (n=30)	Group2 (n=30)	Group3 (n=30)	<i>H</i>	<i>p</i>
	M (SD)				
<i>Clausal complexity</i>					
dep_per_cl	0.049 (0.061)	0.129 (0.084)	0.092 (0.041)	19.709	0.000**
aux_per_cl	0.198 (0.105)	0.143 (0.068)	0.194 (0.073)	7.532	0.023*
<i>Phrasal complexity</i>					
av_nsubj_deps	1.084 (0.411)	1.340 (0.359)	1.330 (0.243)	9.386	0.009**
av_nsubj_deps_NN	1.151 (0.430)	1.399 (0.342)	1.432 (0.292)	9.349	0.009**
av_nsubj_pass_deps	0.995 (0.852)	1.617 (0.641)	1.605 (0.387)	10.812	0.004**

av_nsubj_pass_deps_NN	1.031 (0.901)	1.659 (0.758)	1.694 (0.414)	9.409	0.009**
av_pobj_deps	1.545 (0.411)	1.660 (0.197)	1.694 (0.150)	7.94	0.019*
av_agents_deps	0.820 (1.118)	1.524 (1.532)	1.804 (0.830)	11.132	0.004**
av_agents_deps_NN	0.780 (1.111)	1.462 (1.489)	1.778 (0.826)	11.555	0.003**
nsubj_stdev	1.038 (0.312)	1.221 (0.203)	1.288 (0.255)	10.52	0.005**
nsubj_NN_stdev	1.046 (0.313)	1.231 (0.204)	1.274 (0.281)	8.612	0.013*
nsubj_pass_stdev	0.691 (0.640)	1.098 (0.473)	1.174 (0.395)	9.164	0.010*
nsubj_pass_NN_stdev	0.702 (0.624)	1.041 (0.467)	1.166 (0.391)	8.934	0.011*
agents_stdev	0.242 (0.481)	0.281 (0.495)	0.592 (0.451)	12.931	0.002**
agents_NN_stdev	0.223 (0.446)	0.308 (0.564)	0.620 (0.481)	14.049	0.001**
dobj_NN_stdev	1.177 (0.414)	1.305 (0.256)	1.370 (0.208)	6.706	0.035*
pobj_NN_stdev	1.109 (0.299)	1.242 (0.141)	1.256 (0.136)	6.607	0.037*
poss_all_nominal_deps_struct	0.032 (0.031)	0.020 (0.018)	0.042 (0.035)	8.918	0.012*
poss_all_nominal_deps_NN_struct	0.034 (0.033)	0.020 (0.018)	0.044 (0.037)	8.752	0.013*
poss_pobj_deps_struct	0.025 (0.035)	0.016 (0.020)	0.043 (0.045)	12.002	0.002**
poss_pobj_deps_NN_struct	0.026 (0.035)	0.016 (0.020)	0.043 (0.045)	11.832	0.003**
conj_or_all_nominal_deps_struct	0.002 (0.005)	0.003 (0.005)	0.004 (0.005)	7.115	0.029*
conj_or_all_nominal_deps_NN_struct	0.002 (0.005)	0.002 (0.005)	0.004 (0.005)	7.079	0.029*
conj_or_pobj_deps_struct	0.001 (0.006)	0.003 (0.005)	0.005 (0.008)	10.489	0.005**
conj_or_pobj_deps_NN_struct	0.001 (0.006)	0.003 (0.005)	0.005 (0.008)	10.489	0.005**
amod_nsubj_deps_struct	0.181 (0.132)	0.280 (0.153)	0.284 (0.129)	9.946	0.007**
amod_nsubj_deps_NN_struct	0.202 (0.144)	0.296 (0.156)	0.315 (0.140)	9.373	0.009**
prep_nsubj_deps_struct	0.184 (0.120)	0.294 (0.165)	0.251 (0.138)	7.438	0.024*
prep_nsubj_deps_NN_struct	0.203 (0.133)	0.312 (0.170)	0.284 (0.171)	7.087	0.029*
vmod_all_nominal_deps_struct	0.026 (0.026)	0.038 (0.026)	0.045 (0.029)	7.882	0.019*
vmod_all_nominal_deps_NN_struct	0.025 (0.023)	0.037 (0.027)	0.044 (0.030)	7.463	0.024*
vmod_nsubj_deps_struct	0.012 (0.032)	0.025 (0.032)	0.027 (0.030)	9.729	0.008**
vmod_nsubj_deps_NN_struct	0.012 (0.033)	0.027 (0.036)	0.030 (0.033)	9.96	0.007**
vmod_pobj_deps_struct	0.024 (0.043)	0.036 (0.030)	0.050 (0.050)	13.828	0.001**
vmod_pobj_deps_NN_struct	0.024 (0.043)	0.036 (0.031)	0.050 (0.050)	13.405	0.001**
advmod_pobj_deps_struct	0.004 (0.010)	0.010 (0.012)	0.011 (0.011)	10.749	0.005**
advmod_pobj_deps_NN_struct	0.004 (0.011)	0.010 (0.012)	0.011 (0.011)	10.759	0.005**

* $p < 0.05$ ** $p < 0.01$

At the clausal level, 2 indicators reached significance ($p < 0.05$) including undefined dependents per clause and auxiliary verbs per clause.

Undefined dependents per clause indicator increased between the undergraduate and graduate students, and decreased between graduate and PhD level students (dep_per_cl, $M = 0.049, 0.129, 0.092$). Undefined dependents, defined as the syntactic dependents in a sentence that cannot be properly identified due to poor wording or grammatical errors, are often used to measure the clarity and coherence of a sentence. In terms of syntactic complexity, more undefined dependents indicates higher degree syntactic complexity. This may result from the fact that more undefined dependents increase the difficulty of language processing and require more cognitive effort for syntactic understanding. For academic writing, undefined dependents tend to cause ambiguity and difficulty in comprehension, which affects the transmission of information. Therefore, attention should be paid to reduce the occurrence of undefined dependents during L2 and ERPP teaching in order to ensure the clear content and logic of the text.

Auxiliary verbs per clause were quite similar at the undergraduate and PhD level, but there appeared a

significant decrease at the graduate level (aux_per_cl, $M=0.198, 0.143, 0.194$). Auxiliary verbs refer to verbs that are used in conjunction with other verbs to create different verb forms, tenses, moods, or voices or other grammatical features. When multiple auxiliary verbs are used in a clause, they create more complex syntactic structures. For Chinese EFL learners at the graduate level, the ability to use complex verb tense or voice should attract attention in the teaching and learning process to meet the needs of higher-level English academic writing.

At the phrasal level, 35 fine-grained metrics reached significance among the three groups ($p<0.05$). Primarily, the phrasal dependents contained in the learners' RA abstracts increased significantly as proficiency increased. The first 15 indicators in the table are all about dependent components. It can be seen that the increase in dependent components is reflected in several sentence structures, including agents, nominal subjects, passive nominal subjects, direct objects, objects of the prepositions. Biber et al. (2021) argued that the final stage in the development of second language writing is reflected in the extensive use of phrasal dependent structures as constituents of noun phrases. More dependents per language production unit can help EFL learners produce a richer and more nuanced description of actions and objects in the sentence, which satisfies the need for the reasoning requirements of academic papers.

It is worth noting that the two indicators on dependents per agent did not show significant differences between undergraduate and graduate students, but increased significantly between graduate and PhD students (agents_stdev, $M=0.242, 0.281, 0.592$; agents_NN_stdev, $M=0.223, 0.308, 0.620$). This may result from the lack of emphasis on the knowledge of agents in L2 teaching and learning process, or the difficulty of using them for learners with low proficiency, which resulted in a larger increase between the two groups of medium and high proficiency. Special attention should be paid on cultivating relevant knowledge about dependents in agents to improve RA writing in undergraduates' L2 and ERPP writing process.

Further, with the results of other fine-grained metrics, specific phrasal dependent types that contribute to phrasal syntactic complexity can be identified. Among the metrics with significant variability, there are six phrasal dependent types, namely possessives, conjunction "or", prepositions, verbal modifiers, adjective modifiers, and adverbial modifiers.

Firstly, the use of possessives showed significant differences between the three groups. All four indicators related to possessives significantly decreased between undergraduate and graduate students, which increased between graduate and PhD students (poss_pobj_deps_struct, $M=0.025, 0.016, 0.043$; poss_pobj_deps_NN_struct, $M=0.026, 0.016, 0.043$; poss_all_nominal_deps_NN_struct, $M=0.034, 0.020, 0.044$; poss_all_nominal_deps_struct, $M=0.032, 0.020, 0.042$). Kyle (2016) found a notable negative relationship between possessives in English L2 writing and length of English L2 learning. The possessives in writing decreased as English L2 proficiency increased among the undergraduate and graduate EFL learners in this study. However, the high use of possessives in PhD-level dissertations was anomalous, which warrants guidance on alternative solutions for the use of possessives in the L2 teaching process.

Secondly, the use of conjunction "or" gradually increased among the three groups. Moreover, the use of prepositions also increased significantly between the undergraduate and graduate students, with no significant difference between the graduate and PhD level students. The last significant feature is that as English L2 proficiency rises, learners used more modifiers in RA abstracts, as evidenced by the rising indicators of adjectival modifiers, adverbial modifiers and verbal modifiers. All of the six aspects above are important types that constitute phrasal dependents, whose variations are consistent with the increased reliance on phrasal modifiers characteristic of academic writing (Crossley, S.A. & McNamara, D.S., 2014). Complex noun features can also be found which are consistent to the findings of previous studies (Casal, J.E. & Lee, J.J., 2019; Parkinson, J. & Musgrave, J., 2014).

Overall, the above fine-grained clausal and phrasal indicators reflected significant differences in syntactic complexity in academic writing among cross-proficiency Chinese EFL learners and provided valuable information for their self-improvement as well as L2 and ERPP instruction.

4.2 Indices Effectively Predict Academic Writing Quality

The regression analysis (specific regression method: stepwise) was performed with all indicators that conformed to the normal distribution as the independent variables and group as the dependent variable. As shown in Table 3, the results indicated the validity of the three indicators (amod_dobj_deps_NN_struct; DC/C; nsubj_stdev) in determining the L2 academic writing quality. R-squared value of this model is 0.346, implying that these three metrics can explain 34.6% of the reasons for the variation of group. Moreover, the model passed the F-test ($F=8.898, p=0.000<0.05$), indicating the validity of this model. The model equation is as follows: $\text{group}=0.965+1.007 * \text{nsubj_stdev}+0.946 * \text{amod_dobj_deps_NN_struct}+4.766 * \text{DC/C}$. It can be concluded from the analysis that three metrics representing dependents per nominal subject (standard deviation), adjectival modifiers per direct object (no pronouns), and dependent clauses per clause will have a significant positive effect

on academic writing quality.

Table 3. Results of Stepwise Regression Analysis (n=90)

	Nonstandardized coefficient		Standardization coefficient	<i>t</i>	<i>p</i>	VIF
	<i>B</i>	SE	<i>Beta</i>			
Constant	0.965	0.450	—	2.145	0.035*	—
nsubj_stdev	1.007	0.281	0.342	3.583	0.001**	1.169
amod_dobj_deps_NN_struct	0.946	0.405	0.225	2.335	0.022*	1.194
DC/C	4.766	1.286	0.573	3.706	0.000**	3.074
<i>R</i> ²	0.346					
<i>Adjusted R</i> ²	0.307					
<i>F</i>	<i>F</i> (3,86)=8.898, <i>p</i> =0.000					
D-W	0.524					

Dependent Variable: group

* *p*<0.05 ** *p*<0.01

The regression equation shows that the syntactic complexity of RAs of Chinese EFL learners at the three stages is most affected by dependent clauses per clause (DC/C, *B*=4.766), followed by dependents per nominal subject (standard deviation) and adjectival modifiers per direct object (no pronouns) (nsubj_stdev, *B*=1.007; amod_dobj_deps_NN_struct, *B*=0.946). The more dependent clauses per clause, the more dependents per nominal subject, the more adjectival modifiers per direct object, the higher the quality of English academic writing. These three indicators can serve as effective references in determining the quality of the output texts during L2 academic writing learning. In addition, in the process of L2 teaching and ERPP teaching, emphasis should be placed on the cultivation of EFL learners' ability to use dependent clauses, dependents and adjective modifiers in their academic writing.

No valid clausal-level indicators were found, as previously noted by Biber (2016) that clause-based indicators of syntactic complexity are typical of spoken language, rather than the written form. The same conclusion was reached in Taguchi et al.'s study that composition quality is not highly correlated with clause-level syntactic complexity (Taguchi, N., Crawford, B. & Wetzel, D., 2013). Similar findings can also be seen from a research by Casal & Lee (2019) suggesting that indicates that phrasal metrics have a significant predictive power over college students' writing, while it was not evident for clausal indicators.

5. Conclusions

This study analyzed the syntactic complexity of L2 writing of EFL learners across proficiency levels. Differences in the syntactic complexity of thesis abstracts of Chinese EFL learners majored in Applied Linguistics at undergraduate, graduate and PhD level were explored, as well as significantly predictive indicators towards academic writing quality. Results of this study showed significant differences in the syntactic complexity of the thesis abstracts among EFL learners at the three different stages. At the global level, as English proficiency increases, learners tend to use longer sentences and T-units, more complex nominals, verb phrases per T-unit and dependent clauses per clause or per T-unit. At the clausal level, two indicators with significant differences were found (undefined dependents per clause & auxiliary verbs per clause). At the phrasal level, the more proficient learners tend to use more abundant dependents, which can help EFL learners to produce better descriptions to satisfy the need for the reasoning requirements of academic papers.

Moreover, through stepwise regression, results of this study also showed that among all the indicators considered, three indicators tend to be the most effective in determining the level of L2 academic writing, namely dependent clauses per clause, dependents per nominal subject (standard deviation), and adjectival modifiers per direct object (no pronouns) ranked from the highest to lowest correlation. Such findings are likely to provide pedagogical value for both teaching and assessment of English L2 writing and ERPP writing.

However, limitations still exist in the current study. Firstly, this study focuses only on the abstract part of theses related to English Applied Linguistics field. Future research could be extended to other disciplines or other part-genres of RAs. Secondly, the academic texts studied in this paper only covered RAs written by Chinese EFL learners majored in Applied Linguistics at undergraduate, graduate and PhD level. Future research can be extended to other academic writing groups, such as the comparison between students' academic writing and that

of the experts. Thirdly, this study roughly classifies theses written by undergraduate, graduate and PhD level EFL learners into three levels of English academic writing quality, from low to high. Future research can conduct more refined scoring approaches to explore the predictive power of different syntactic complexity indicators for academic writing quality. Besides, this paper only summarized the characteristics of syntactic complexity without analyzing the connection between syntactic complexity indicators and the rhetorical functions. Subsequent studies can consider the functional turn in syntactic complexity research.

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