Effectiveness of Morphological Intervention on Two Measures of Vocabulary Knowledge and Listening Comprehension

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Abstract

The morphological intervention has been long advocated to enhance students' vocabulary knowledge and language outcomes. Nevertheless, little is known about how the intervention affects listening comprehension through the mediation of vocabulary knowledge. To address this unanswered gap, this study used a quasi-experimental design to examine the direct effects of the morphological intervention on two measures of vocabulary knowledge (vocabulary depth and breadth) and listening comprehension and whether increased vocabulary depth and breadth mediate the effects of the intervention on listening comprehension. Two groups of Chinese university students (experimental n=32; control n=32) participated in this study. Results of MANOVA measurements indicated direct, significant effects of the intervention on vocabulary depth and breadth. Additionally, analysis from a PLS-SEM modeling found effects of morphological intervention on listening comprehension were totally indirect and the indirect effects were significantly mediated through both vocabulary depth and breadth. Notably, vocabulary depth showed a stronger mediating effect than vocabulary breadth. The findings of this research expanded the existing understanding of how morphological intervention improves EFL university students' vocabulary knowledge and listening comprehension.

Keywords: morphological intervention, vocabulary knowledge, listening comprehension

1 Introduction

Listening comprehension is a knotty and complicated construct. It is influenced by multiple factors at the levels of listening tasks, listening processes, interlocutors, and listening texts (Rubin,1994), as well as by individual differences regarding linguistic knowledge (Fung & Macaro, 2021; Ramli, 2019), metacognitive awareness (Mahdavi & Miri, 2019; Wang & Treffers-Daller, 2017), listening strategies (Yulisa, 2018), and working memories (Satori, 2021). Among these factors, individuals' vocabulary knowledge is recognized as the strongest contributor to Second language (L2) learners' listening comprehension (Ghorbani Nejad & Farvardin, 2022; Wallace, 2022). Existing studies have well-documented the critical role that vocabulary knowledge plays in listening comprehension (Lange & Matthews, 2020; Masrai, 2022).

The contribution of vocabulary knowledge to listening comprehension is typically consequential for Chinese university students who learn English as a foreign language (EFL) (Du & Man, 2022; Li & Zhang, 2019). Additionally, both vocabulary breadth and depth strongly predict Chinese EFL undergraduates' listening comprehension (Luo, Song, Wan, & Zhang, 2021; Wang, 2015). Nevertheless, studies show that Chinese undergraduates face obstacles in EFL listening development. They score much lower on listening tests than on reading and writing tests (Wang, 2002) and have difficulties understanding native English speakers (Goh, 2000; Ren, 2009). A main obstacle is inadequate vocabulary knowledge (Huang, 2005; Wang & Fan, 2015), which is highly related to listening comprehension difficulties (Goh, 2000; Juan & Abidin, 2013; Zhu, 2021). Therefore, there is an urgent need for intervention to improve vocabulary knowledge.

One promising strategy for promoting vocabulary knowledge growth is explicit morphological intervention that arouses attention to morphological awareness (Nation, 2001). Many studies have found evidence that morphological awareness intervention can effectively help EFL university learners boost vocabulary knowledge (Akbulut, 2017; Yuan & Tang, 2023). English is rich in multi-morphological words which comprise around 60% of unfamiliar words that students encounter in school (Nagy, Anderson, Schommer, Scott, & Stallman, 1989). With a good command of morphological awareness, learners can make correct analyses and inferences of unknown words (Anglin et al., 1993), and in return, their recognition of these morphemes (roots, reflections, and derivations) facilitates the expansion of breadth and depth of vocabulary knowledge (Carlisle, 2010; Qian, 2002).

Given the effects mentioned above of morphological intervention on vocabulary knowledge and the close correlations between vocabulary breadth, vocabulary depth, and listening comprehension, two research questions were addressed in this study:

1. To what extent does morphological intervention increase two measures of vocabulary knowledge (vocabulary breadth and depth), and listening comprehension?
2. Do two measures of vocabulary knowledge (vocabulary breadth and depth) collectively or individually mediate the effectiveness of the morphological intervention on listening comprehension?

2 Literature Review

2.1 Morphological Awareness, Vocabulary Knowledge, and Listening Comprehension

Morphological awareness is defined as the ability to recognize and deploy the morphemes and word-forming rules of a language (Kuo & Anderson, 2006). Morphemes refer to the least parts of a word with a meaning (Nagy, Carlisle, & Goodwin, 2014), such as impress (root), -ion (derivation), and -s (inflection) in the word impressions. In English, multimorphemic words are generally constructed with compounding (e.g., football = foot + ball), derivation, and inflection. Respectively, the awareness of these rules of word formation refers to compounding awareness, derivational awareness, and inflectional awareness. Inflection, as a grammatical process, involves the addition of an inflectional suffix after a root word, such as third-person singular, past tense, and progressives (Carlisle, 2003). Derivation involves generating a new word by attaching a derivational prefix or suffix to a root word (Carlisle, 2003). Compounding creates compound words by combining two root words (Kuo & Anderson, 2006). English learners mainly acquire inflectional awareness at early primary schools (Kuo & Anderson, 2006). In contrast, it takes a much longer time to obtain derivational and compounding awareness which involves deriving words with new meanings (Anglin, 1993; Singson, Mahony & Mann, 2000). Many secondary and tertiary students still struggle with their derivational knowledge (Mahony, 1994; Nagy, Berninger, & Abbott, 2006). Thus, this study focused on the intervention of derivational affixes.

Researchers proposed two dimensions of vocabulary knowledge, vocabulary breadth and depth (Nation, 2001; Read, 2004). Vocabulary breadth refers to the overall vocabulary size or estimated numbers that a learner acquires in the semantic aspect, while vocabulary depth involves how deeply a word is known by an individual in multifaceted aspects, such as pragmatic, collocational, syntactic, morphological, phonological, and orthographic characteristics (Nation, 2001). Extant studies have revealed that morphological awareness significantly contributes to both first language (L1) and L2 learners' vocabulary learning and development of vocabulary breadth and depth (Jiang & Kuo, 2019; Haomin & Bilü, 2017; Rabadi, 2019; Sparks & Deacon, 2015) which is likely contributory to listening comprehension. Sparks & Deacon's (2015) longitudinal study in English-speaking children of grades two and three indicated that morphological awareness predicted the temporal and long-term vocabulary breadth development. Haomin and Bilü (2017) examined whether both derivational and compounding awarenesses were predictions of vocabulary breadth and depth among Chinese EFL college students. The results displayed that only derivational awareness strongly predicted both breadth and depth of vocabulary knowledge. Rabadi (2019) disclosed that morphological awareness of Jordanian EFL university students was positively correlated with their vocabulary size, and students scored worse in derivational awareness than reflectional awareness. Despite the strong impact of morphological awareness on EFL vocabulary knowledge, Jiang and Kuo (2019) found even the more skilled EFL university learners had difficulty completely mastering morphological principles of derivational words. Thus, the intervention of morphological awareness, especially derivational awareness, is necessary to be implanted in EFL university students' vocabulary learning, which may contribute to both vocabulary breadth and depth based on the aforementioned studies.

It is well-known that vocabulary knowledge is positively correlated with listening comprehension and both breadth and depth of vocabulary knowledge strongly predict EFL students' listening comprehension (e.g., Li, 2019; Vafaee & Suzuki, 2020; Teng, 2014; Wang, 2015). For instance, both Teng (2014) and Wang (2015) revealed that depth and breadth of vocabulary knowledge significantly contributed to Chinese EFL adults' listening performance and vocabulary depth emerged as a stronger contributor. Other studies have found that Morphological awareness, as one component of vocabulary depth (Nation, 2001; Read, 2004), is a significant contributor to listening comprehension of young and adult English learners. Babayiğit (2014) and Valentini and Serratrice (2023) reported that L1 and L2 elementary learners' morphological awareness directly contributes to their listening abilities. Kim (2023) also reported a highly contributory effect (R=0.73) of morphological awareness on English-speaking primary students' listening comprehension. Fracasso (2016) has claimed that the derivational awareness of American ABE (Adult Basic Education) students is a unique contributor to their listening comprehension, spelling ability, and vocabulary knowledge. In the context of university EFL students, Hasan and Nomnian (2021), Wen (2014), and Xu, Dianmei, and Xiaojun (2022) all concluded in their studies that derivational awareness was positively related to listening comprehension.

Thus, based on the above-mentioned relationships among morphological awareness, vocabulary knowledge, and listening comprehension, this study hypothesized that explicit morphological intervention (derivational awareness intervention in this study) in vocabulary learning might, directly and indirectly, improve listening comprehension via the growth of morphological awareness and vocabulary knowledge.

2.2 Effects of Morphological Intervention on Vocabulary Knowledge and Listening Comprehension

Most studies on the instructional impacts of morphological awareness have focused on vocabulary-related skills. Bowers and Kirby (2010) found that Canadian fourth and fifth English-speaking grades improved their vocabulary ability to identify the base and meaning of morphologically complex words after the morphological instruction. Good, Lance, and Rainey (2015) conducted morphological instruction to examine third-grade L1 English children's vocabulary skills to identify multi-morphemic words and the experimental group made obvious progress in vocabulary learning after receiving the instruction.

Although morphological awareness, as mentioned above, can significantly contribute to both vocabulary breadth and depth, only a few studies centered on vocabulary breadth (Akbulut, 2017; Yuan, & Tang, 2023). In Akbulut's (2017) research, Turkish undergraduates who received a 12-week morphological analysis intervention of roots, prefixes, and suffixes, significantly outperformed the control group in vocabulary size and morphological awareness. Similarly, Yuan and Tang (2023) reported that explicit instruction in analyzing Latin roots, prefixes, and suffixes enhanced the Chinese EFL university students' receptive academic vocabulary size. Additionally, the instructional impacts on vocabulary depth remain to be unseen. Hence, it notes the necessity to explore an extensive study of morphological intervention on vocabulary breadth and depth.

Existing studies on the roles of morphological intervention in language skills mainly focused on reading comprehension and writing (Amirjalili & Jabbari, 2018; Allen & Lembke, 2022; Badawi, 2019; Crosson et al, 2021; Kim et al., 2021). For instance, Crosson et al (2021) reported that Latin roots intervention directly improved multilinguistic students' vocabulary breadth, and morphological awareness, and ultimately indirectly developed reading comprehension. By creating a mediation model, results from path analysis found that morphological analyzing abilities and vocabulary breadth existed as significant mediators on the effects of the intervention on reading comprehension.

In comparison, studies on the interventional effects on listening comprehension are relatively sparse. Karimi (2013) recruited 40 Irani pre-university EFL students for a morphological intervention regarding inflectional and derivational affixes. After five one-hour sessions, the experimental group scored significantly higher in the listening post-test than in the pre-test, while the control group did not show any listening enhancement. Similarly, Saeidi and Mirzapour's (2013) study on Irani University EFL students showed that the morphological intervention helped the experimental group improve their listening ability.

The above two studies both centered on the context of Arabic-speaking English learners. Nonetheless, there is a dearth of the intervention study on listening comprehension focused on Chinese-speaking EFL students. Chinese speakers shared a different L1 morphological system from Arabi-speaking students (Freynik, Gor, & O'Rourke, 2017). Chinese is rich in compounding and has barely any inflectional and derivation morphemes (Wang, Yang, & Cheng, 2009) which are abundant in English and Arabic (Freynik et al., 2017; Wang et al., 2009). Given the cross-linguistic variations, the findings of previous instructional effects on Iraqi English learners should not be directly generalized to Chinese-speaking EFL students from a diverse L1 morphological system. Plus, these two intervention studies only explored the direct effects of the intervention on listening comprehension. Nonetheless, the potential indirect effects of morphological awareness on listening comprehension remain unknown.

Furthermore, despite the aforementioned contributory effects of morphological awareness to both vocabulary knowledge and listening comprehension, few studies have attempted to use quasi-experimental analysis to simultaneously investigate the interventional effectiveness of morphological awareness on enhancing listening comprehension and vocabulary knowledge breadth and depth. Drawing on the above-reviewed research, an exploratorily conceptual model of this study (see Figure 1) was proposed with the following two hypotheses:

H1. Morphological intervention increases participants' two measures of vocabulary knowledge (vocabulary breadth and depth) and listening comprehension.

H2. Two measures of vocabulary knowledge (vocabulary breadth and depth) collectively and individually mediate the effectiveness of the morphological intervention on listening comprehension.

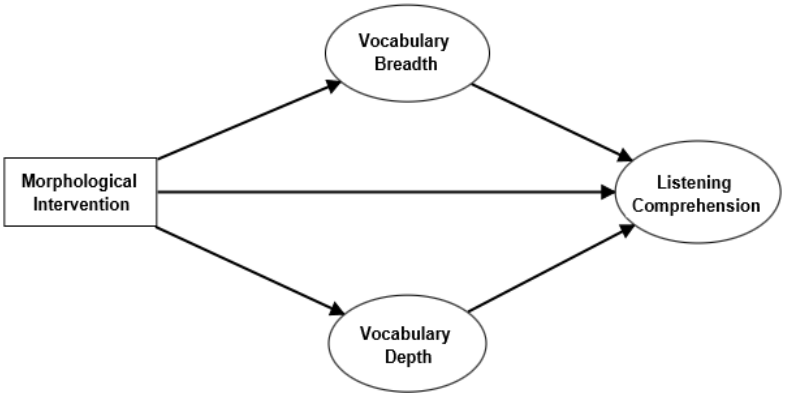

Figure 1. The conceptual model for effects of morphological intervention on vocabulary breadth and depth, and listening comprehension

3. Method

Based on the above research questions, this study used a quantitative research method and a quasi-experimental design to investigate the interventional effects of derivational awareness on morphological awareness, vocabulary breadth and depth, and listening comprehension. Research questions determine the selection of the research design (Cohen, Manion, & Morrison, 2007). Plus, the research design determines the selection of participants, and data collection and analysis (Cohen et al., 2007).

3.1 Sampling and Participants

Participants were 64 second-year business English major university students from two parallel classes in a university situated in central China. Convenience sampling was used to select the participants because of the institutional accessibility for the first author in this study (Etikan, Musa, & Alkassim, 2016). Additionally, funding and time restraints also explained the rationality of choosing this method of data collection (Campbell & Stanley, 2015). Convenience sampling can save funds and time significantly. The two intact classes were randomly allocated to the experimental (n=32) and control (n=32) groups. The experimental and control groups have homogenous characteristics in age (mean=19.53/19.37), gender (28/29 females, 3/4 males), years of formal EFL education (mean= 10.25/10.75), and average academic performance. The number of students who passed the College English Test Band 4 (CET-4) was the same in both groups with 29 in each group. The mean scores (503.92) of the two groups in CET-4 were significantly higher than the passing line (425). According to Peng and Liu (2021), Passing CET-4 means that students achieve the fifth CSE (China's Standards of English Language Ability) level which is equivalent to intermediate and above CEFR (the Common European Framework of References for Languages level), namely, level B1 or B2. Thus, most participants (90.62%)'s English level is intermediate or above.

3.2 Intervention

The intervention took place during the weekly 90-minute class of the participants' business English listening course which is the compulsory course in their first and second academic years. The first author with a 19-year teaching experience in business English listening course was the instructor of both experimental and control groups. The intervention took 14 weeks including two-week pretests, ten-week morphological instruction, and two-week posttests. Participants of both groups sat for all the pretests and posttests to assess their vocabulary breadth and depth, and listening comprehension before and after the intervention. The experimental group received ten 45-minute sessions of explicit derivational awareness instruction plus the conventional listening practice. Concurrently, the control group had normal business listening lessons with no morphological instruction. In addition to morphological intervention at class, the experimental students were assigned morphological segmenting and producing tasks after class which took them around 30 minutes each week.

Given the intermediate and above English levels of these participants, the derivational affixes for intervention are selected from Bauer and Nation's (1993) level three to six affixes (see Table 1; a total of 83 affixes). Bauer and Nation (1993) classified seven levels of affixes for English teaching and learning based on the difficulty levels from eight perspectives, including regularity of function, frequency, productivity, predictability, etc. Leontjev (2016) confirmed that the seven affix levels have the reliability of growing difficulty. This study excluded levels one, two, and seven, as the first two levels aim at English beginners, and level seven is more suitable for highly advanced learners (Nation and Bauer, 2023). The multimorphemic words utilized for analysis and practice in the intervention are chosen from words proposed by Nation and Bauer (2023).

Table 1. Derivational affixes used for intervention

Level	Derivational Affixes
3	Affixes with most frequency and regularity: *non-, -ish, un-, -less, -th, -able -y, -ness, -er, ly*.
4	Affixes that are frequent and orthographically regular: *in-, -ity, -al, -ize, -ment, -ous, -ist, -ess, -ism, -ful, -ation.*
5	Affixes that are regular but infrequent: *-ite, -ian,-ways, -most, -let, -i, -ery, -ent, -ence, -wise, -ward, -en, -dom, - ance, -ant, -an, , -atory, -ary -ally,-al,-age, un-, semi-, pro- -en, -eer,, post-, mid-, arch-, mis-, hyper-, neo-, ex-, inter-, -ly, -ling, -ette, -ese, fore-, en-, sub-, bi-, ante-, circum-, -hood, -ship, -ory, -esque, counter-, anti-*.
6	Affixes that are frequent but irregular: *pre-, re-, -ition, -ify, -able, -ic, -y, -ion, -ist, -ive, -th, -ee*.

Following the proposal of Aronoff and Fudeman (2011), the intervention was designed to build students' morphological awareness in two aspects: analyzing and synthesizing multi-morphological words. Analyzing refers to dividing a morphemic word into original morphemes and deciphering the meanings of each morpheme and the whole word, and synthesizing involves deriving new multi-morphological words by combining various morphemes based on correct word-formatting rules. The instruction procedure utilized the five steps of the CALLA model developed by Chamot and O'Malley (1994), which are preparing, presenting, practicing, evaluating, and expanding. First, the instructor prepared the interventional goal of each session by identifying students' extant knowledge of relevant affixes. Second, students were presented with affixes-to-be-learned and the corresponding word examples and word-forming rules. Third, under the guidance of the instructor, students practiced the affix knowledge with tasks of analyzing and synthesizing multimorphemic words containing the learned affixes individually or in groups. Fourth, Students self-evaluated and peer-evaluated their tasks of analyzing and synthesizing morphological words. Fifth, students expanded their learning of morphological knowledge with various assignments on morphology analysis and synthesis after class.

It can be noted above that one distinctive feature of the CALLA model is that the educational goal is achieved with abundant activities and practices (Chamot & Robbins, 2005). Gerakopoulou (2016) has maintained that multiple activities enhance students' prior knowledge and internalize their understanding of new knowledge. Activities, tasks, or projects in class provide language contexts and activate students' initiative engagement in L2 learning (Van Lier, 2004). Celce-Murcia (2007) has stated that L2 language teaching needs three essential steps, imparting language knowledge, arranging a large number of activities, and providing immediate feedback. Four types of tasks were deployed for practicing, two for morphological analysis and two for morphological synthesis. In the morphological analyzing

task one, students divided the given complex words into the smallest parts and offered meanings of these parts and these words. The second analytic task was comprised of sentences with each having one complex word missed. Students were supposed to write down the missing complex words according to what they heard, and then decomposed these words into morphemes and provided meanings of words and morphemes. Both synthetic tasks were set in sentence contexts. The first task involved creating a morphologically complex word based on a given root word in each given sentence. The second task required students to fill in the blanks of each given sentence with a semantically and grammatically correct multi-morphological word according to the relevant sentence they heard with a similar meaning. Thus, listening skills were integrated with these activities, as the ultimate goal of this intervention was to improve students' listening ability.

3.3 Instruments

All the following tests were undertaken by both experiment and control groups as pretests and posttests.

3.3.1 Test for Listening Comprehension

A recent set of the listening part of the Test for English Majors (TEM-4) was used for assessing the listening comprehension of the experimental and control groups. TEM-4 is a formal national test targeted at second and third-year university students of English majors in China. Most Chinese universities require English majors to pass TEM-4 to obtain a bachelor's degree. The test is designed to test comprehensive English language skills, speaking, listening, writing, and reading, together with linguistic knowledge, such as grammar, pronunciation, vocabulary, and orthography. The TEM-4 listening part consists of three 10-minute sections and each section has a different type of listening materials and questions. Section one is dictation which demands test-takers to dictate an 80-to-90-word passage with four times of listening. Section two is a gap-filling task that contains 10 gaps in an outline of a 500-word talk. Test takers listened to the talk once and wrote down no more than three words in each gap which should be correct in semantics and grammar. Section three has ten multiple-choice questions. Test takers had only one chance to listen to two 450-word conversations and ten relevant questions. Each conversation comprises five questions and test takers choose the correct choice that best fits the question.

The TEM-4 listening test was chosen in this study for mainly two reasons. First, the types of CET-4 listening questions are diversified, which may better justify the effects of morphological intervention on listening comprehension. For example, both dictation and gap-filling sections demand phonological, semantical, syntactic, and orthographic knowledge which is closely related to morphological awareness (Nagy et al., 2014; Casalis, Colé, & Sopo, 2004). Second, TEM-4 is the most suitable formal test for the participants who major in business English in the present research, as it aims to assess the language proficiency of English majors.

3.3.2 Test for Vocabulary Breadth

Participants' breadth of vocabulary knowledge was assessed with the Vocabulary Size Test (VST) (Nation & Beglar, 2007). VST tests students' vocabulary based on word frequency. It targets the first fourteen 1000 most frequent words, selecting 10 target words from each 1000-frequent-word level and making the item number reach 140. This study chose the first ten 1000 most frequent words with a total of 100 items, as most participants could not recognize words over the tenth frequency. VST is a multiple-choice test with four choices in each item and each item has a target word together with a sentence inserted with this word (see Figure 2). Test takers opted for the choice that best suited the meaning of the target word. The current study adopted the Chinese bilingual version of VST, as a bilingual test decreases participants' anxiety and fatigue during testing (Elgort, 2013). Furthermore, Zhao and Ji (2018) reported that the Chinese VST effectively differentiated EFL learners' English levels. Nguyen and Nation (2011) verified both monolingual and bilingual VST equally have high validity.

compound: They made a new **compound**.

a. thing made of two or more parts

b. agreement

c. guess based on past experience

d. group of people forming a business

Figure 2. An example of VST

3.3.3 Test for Vocabulary Depth

This study utilized Read's (1998) Word Associates Test (WAT) to examine participants' depth of vocabulary knowledge. WAT includes 40 items and each item comprises one target word and eight words evenly divided in two boxes side by side. WAT was designed to test learners' knowledge of words in semantics and collocation. Hence, in the right box of each item, there may be one to three words pragmatically or analytically associated with the target word (e.g., *sudden* and *quick*, *sudden* and *surprising*), and correspondingly three to one words that syntactically associated with the target word to form a collocation (e.g., *sudden change*, *sudden noise*) (see Figure 3). There are overall four correct words in two boxes, but the spreading of these correct answers is not evenly positioned. The rationale for the selection of this test is that WAT is a well-known vocabulary depth test adopted and adapted by a lot of researchers in the studies of listening comprehension (e.g., Migdadi, Yunus, & Daradkeh, 2019; Teng, 2016; Wen 2014)

Sudden

quick	beautiful	thirsty	surprising	doctor	change	school	noise

Figure 3. An example of WAT

3.4 Data Analysis

A multivariate analysis of Variance (MANOVA) was applied to guarantee the homogeneity of the control and experimental groups in the pretests. Then, MANOVA was conducted to statistically examine the effects of morphological awareness intervention on the depth and breadth of vocabulary knowledge and listening comprehension. The mediation model of the indirect effects will be analyzed by using a partial least squares structural equation modeling (PLS-SEM). PLS-SEM can handle data with small sampling and without normality (Hair & Alamer, 2022). PLS-SEM has been increasingly applied to explain predicting variables in L2 academic outcomes (Hair & Alamer, 2022) and to examine the mediating effects in education and L2 experimental research (Alamer, Al Khateeb, & Jeno, 2023; Janakiraman, Watson, Watson, & Newby, 2021). Considering the small sample and the mediation model in this experimental study, PLS-SEM was selected accordingly. The PLS-SEM modeling involves evaluating two models, the measurement and structural models.

4. Results

4.1 Data Screening and Descriptive Analysis

No missing data was found in any of the variables or any item of the mediation model. Univariate outliers did not exist in any case in this study, as the z score of each variable fell within ±3.29 (Tabachnick & Fidell, 2013). Data distribution was also considered. As seen in Table 2, data of all the variables shows the normal distribution, since the z-score (statistics/standard error) of skewness and kurtosis all were within the acceptable range (±1.96; Tabachnick & Fidell, 2013).

Table 2. Mean, Std. and distribution of dependent variables

	N	M	Std.	Skewness		Kurtosis	
				Statistics	Std.	Statistics	Std.
Control							
VD Pre	32	107.19	16.3	-0.611	0.414	0.076	0.809
VB Pre	32	53.75	10.06	0.261	0.414	-1.329	0.809
LC Pre	32	28.66	8.42	-0.356	0.414	-0.176	0.809
VD Post	32	113.81	8.15	0.036	0.414	-0.276	0.809
VB Post	32	60.25	9.09	0.482	0.414	0.604	0.809
LC Post	32	31.47	12.59	-0.49	0.414	-1.001	0.809
Experimental							
VD Pre	32	107.91	17.43	-0.268	0.414	-1.038	0.809
VB Pre	32	52.41	13.60	0.254	0.414	-1.110	0.809
LC Pre	32	27.25	6.77	-0.109	0.414	-1.259	0.809
VD Post	32	125.47	8.77	0.24	0.414	-0.723	0.809
VB Post	32	67.69	11.38	0.091	0.414	0.229	0.809
LC Post	32	40.06	11.6	-0.194	0.414	-1.313	0.809

Note: VD=vocabulary knowledge; VB=vocabulary breadth; LC=listening comprehension.

4.2 MANOVA Measurement

Between-group MANOVA was performed to guarantee the homogeneity of the experimental and control groups in combined three dependent variables, vocabulary depth, vocabulary breadth, and listening comprehension. The result revealed that no significant difference existed between the two groups in pretests (Wilks' λ=.977, F (3,60) =0.477, p>.05, $\eta 2$ = 0.23). Subsequent between-subject analysis for each dependent variable also presented non-significance (see Table 3).

The multivariate test result produced by MANOVA indicated significant differences (Wilks' Lambda =0.642, F (3, 60) =11.15, p < .001, $\eta 2$ = 0.358) in post-tests between the two groups when the three variables were combined. The mean differences of three dependent variables, as evident in Table 2, disclosed that both groups had similar performance in the pretest but different outcomes in the posttest. The control group (M= 113.81, Std.= 8.15) was outperformed by the experimental group (M= 125.47, Std.= 8.77) in the vocabulary depth posttest. In the vocabulary breadth posttest, the experimental group (M= 67.69, Std.= 11.38) did better than the control group (M= 60.25, Std.= 9.09). The experimental group (M= 40.06, Std.= 11.6) also performed better than the control group (M= 31.47, Std.= 12.59) in the listening posttest. Following-up inspection from the between-subject MANOVA (see table 3) revealed that the two groups all showed significant differences in vocabulary depth (F (1, 62) =30.31, p < .001, $\eta 2$ = 0.33), vocabulary breadth (F (1, 62) =8.34, p < .05, $\eta 2$ = 0.112), and listening comprehension (F (1, 62) =8.07, p < .05, $\eta 2$ = 0.12). Therefore, hypothesis one was supported.

Table 3. Statistics of between-subjects MANOVA

Dependent variables	SS	df	MS	F	p	η2
VD Pre	8.266	1	8.266	0.029	0.865	0.000
VB Pre	28.891	1	28.891	0.202	0.655	0.003
LC Pre	31.641	1	31.641	0.542	0.464	0.01
VD Post	2173.891	1	2173.891	30.309	< .001	0.33
VB Post	885.063	1	885.063	8.338	0.005	0.12
LC Post	1181.641	1	1181.641	8.069	0.006	0.12

4.3 Evaluating the Measurement Model

This study proposed a reflective measurement model with one observed variable (morphological intervention) and three latent variables. Figure 4 demonstrates the indicators of each latent variable. It is worth noting that each indicator of vocabulary breadth and depth contains ten items of VAT and VST. Thus, there are four indicators in vocabulary depth and five indicators in vocabulary breadth.

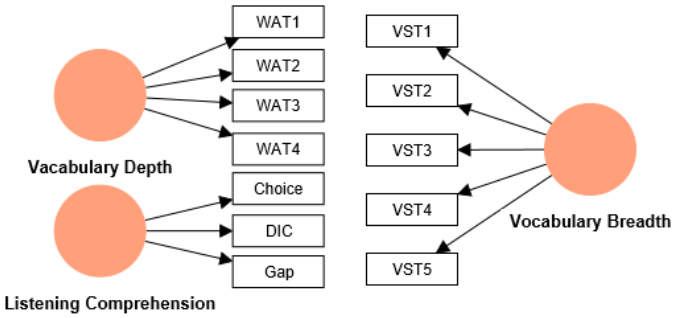

Figure 4. The measurement model for the three latent variables

Note. WAT1- WAT4=items 1-10, items 11-20, items 21-30, and items 31-40 respectively of the WAT; Choice=the multiple-choice section of TEM-4; DIC=the dictation section of TEM-4; Gap=the gap-filling section of TEM-4; VST1=word frequency levels 1 and 2; VST2=word frequency levels 3 and 4; VST3=word frequency levels 5 and 6; VST4=word frequency levels 7 and 8; VST5=word frequency levels 9 and 10.

The measurement model was evaluated with the reliability and validity of the three latent variables. The Cronbach's alpha and Composite reliability are measured to check the reliability, and the validity is assessed with convergent validity and divergent validity. The acceptable range of Cronbach's alpha and Composite reliability index is between 0.7-0.95. The average variance extracted (AVE) over 0.5 is believed to satisfy convergent validity (Hair et al., 2021). The heterotrait-monotrait (HTMT) index below .85 is advised to enjoy acceptable divergent validity (Hair et al., 2021). One can see in Tables 4 and 5 that values of Cronbach's alpha, Composite reliability, AVE, and HTMT all fall within the acceptable ranges, which indicates that the measurement model in this study meets satisfactory reliability and validity.

Table 4. Reliability indexes and convergent validity

	Cronbach's alpha	Composite reliability	AVE
LC Post	0.938	0.942	0.889
VD Post	0.745	0.799	0.566
VB Post	0.931	0.94	0.783

Table 5. HTMT indexes

	Intervention	LC Post	VD Post	VB Post
Intervention				
LC Post	0.352			
VD Post	0.65	0.788		
VB Post	0.357	0.536	0.46	

4.4 Evaluating the Structural Model

The structural model was evaluated in terms of quality with the coefficient of determination (R2), the predictive relevance Q2, and multicollinearity. R2 assesses the explaining power of the model and R2 values ranging from 0.11 to 0.30, 0.30 to 0.50, and above 0.50 indicate slight, medium, and strong explanatory power. As shown in Figure 5, the structure model accounts for a total of 50% variance in listening comprehension, showing a medium effect. Figure 5 suggests that this structural model has good predictive relevance, as Q2 over zero means satisfying the predictive correlation of the model (Hair et al., 2021). Multicollinearity was evaluated by the VIF index of the inner model. Hair et al. (2021) proposed collinearity problems existing between the independent and dependent variables when the inner VIF index turns out to be more than 5. Table 6 indicates no multicollinearity problem in this study, as the VIF index is between 1 to 1.634, much less than the minimum value 5.

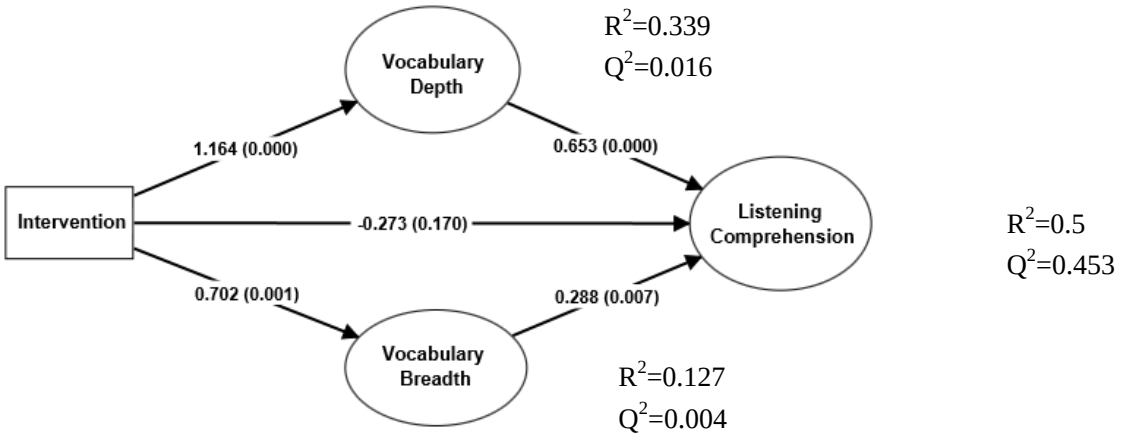

Figure 5. The intervention effects, R2 and Q2 of the structural model

Table 6. Collinearity statistics

	Intervention -> LC	Intervention -> VB	Intervention -> VD	VB -> LC	VD -> LC
VIF	1.547	1	1	1.232	1.634

4.5 Evaluating the Mediation

Bootstrapping was run to evaluate the mediating effects. As seen in Figure 5 and Table 7, the model indicated that the morphological intervention did not directly increase listening comprehension in the experimental group (β = -0.273, p=.170), but indirectly and significantly increased their listening comprehension collectively via the combination of vocabulary breadth and depth (β = .962, p<.01). Furthermore, both vocabulary breadth (β = .202, p=.043) and depth (β=0.76, p<.01) individually mediated the intervention effects of morphological awareness on listening comprehension, and vocabulary depth showed a stronger mediating effect. The total effects in the model were seen to be significant (β=.689, p=.001). Thus, hypothesis two was also supported.

Table 7. Total and specific indirect effects and total effects of the mediation model

	Coefficient	Std.	T values	P values	Confidence Intervals 2.50%	97.50%
Total indirect effects						
Intervention -> LC	0.962	0.177	5.451**	<.01	0.636	1.345
Specific indirect effects						
Intervention -> VB -> LC	0.202	0.1	2.027*	0.043	0.041	0.431
Intervention -> VD -> LC	0.76	0.164	4.633**	<.01	0.476	1.116
Total effects						
Intervention -> LC	0.689	0.211	3.266*	0.01	0.244	1.081

Note. * p < .05, ** p < .01.

5. Discussion

This study sought to investigate whether university EFL students' two measures of vocabulary knowledge and listening comprehension could be enhanced through morphological intervention. Additionally, it examined whether these two measures of vocabulary knowledge mediated the interventional impact on students' listening comprehension. Generally, the results of this study confirmed that students who were administered explicit morphological training experienced more robust growth in vocabulary breadth and depth and L2 listening comprehension. Contrary to the direct impacts on vocabulary breadth and depth, the direct interventional impact on listening comprehension showed no significance. Hence, receiving morphological intervention is insufficient for the immediate improvement of listening comprehension, at least directly assessed by the listening tasks in this study.

Results from MANOVA measurements indicated that students' vocabulary breadth increased significantly through morphological intervention. This result is in line with previous studies of Akbulut (2017) and Yuan and Tang (2023) who found that explicitly structural learning of roots, prefixes, and suffixes improved L2 university students' vocabulary size. This is not surprising given that students' knowledge of morphemes and word-forming regulations can enable them to infer the definition of unknown words to broaden their vocabulary size (Carlisle & Stone, 2003). This result is also in line with Sparks and Deacon's (2015) longitudinal study that primary children's growth of vocabulary breadth concurred with the growth of morphological awareness.

The second significant change found in the results was related to vocabulary depth. As indicated by the MANOVA analysis, the experimental group scored much better in vocabulary depth than the control group. To be specific, morphological intervention of derivational affixes facilitated students to increase their vocabulary depth in terms of synonymous, semantic, pragmatic, and collocational correlations of vocabulary knowledge assessed in WAT. Considering the syntactic, semantic, and orthographic features carried in

morphological awareness (Nagy et al., 2014), the expansion of vocabulary depth about collocational and semantic aspects through morphological intervention is plausible. The effect can be also explained that the improvement of morphological awareness through intervention subsequently deepened the quality of vocabulary knowledge. This is consistent with Haomin and Bilüs (2017) empirical study that derivational awareness is experienced as a strong predictor of both vocabulary breadth and depth.

Results from both MANOVA and Bootstrapping of PLS-SEM modeling revealed that morphological intervention significantly expanded listening scores, but the effects were totally indirect and collectively and individually mediated by vocabulary breadth and depth. The result is in alignment with previous studies that proposed EFL adult students could increase their listening by participating in morphological instruction (Karimi, 2013; Saeidi & Mirzapour, 2013). As morphemes in morphologically complex words hold semantic, phonological, and syntactic information (Nagy et al., 2014), learning morphological knowledge may help listeners process and recognize the aural text. Additionally, results of the PLS-SEM modeling indicated that vocabulary depth performed as a stronger mediator than vocabulary breadth. This may be partially due to the more robust impact of vocabulary depth on listening comprehension compared with vocabulary size (Teng, 2014; Wang, 2015).

It is noteworthy that morphological intervention did not directly but indirectly improve listening comprehension. The result is in alignment with Crosson et al (2021)'s findings in written language comprehension that teaching morphological analysis indirectly improved reading comprehension through morphological awareness and vocabulary knowledge. Given the robust effects of the morphological intervention on vocabulary breadth and depth (Haomin & Bilü, 2017) and the significantly contributory impacts of vocabulary breadth and depth to listening comprehension (Li, 2019; Vafaee & Suzuki, 2020), this result is plausible. The non-direct effect may derive from a limited time between intervention and post-test measurement. Though the experimental group witnessed more progress in listening compared with the control group, a short period may be insufficient to bring success in listening comprehension. Judging from the student's responsiveness to intervention, one-semester teaching may be insufficient to track ultimate listening success. Students may take more time to adapt the morphological analysis and synthesis in the process of text-based listening comprehension. Thus, a longer period may be ideal to inspect the trajectory of listening development actualized through morphological intervention.

6. Conclusion

Through quasi-experimental research, this study investigated the effectiveness of morphological intervention on L2 vocabulary knowledge and listening comprehension among Chinese university students. The findings of this research expanded the existing theoretical understanding of morphological awareness and vocabulary knowledge in EFL university students' listening comprehension. First, this research provided extended studies by integrating listening comprehension with vocabulary depth and breadth in the instructional impacts of morphological awareness. Second, findings of this research initially found that vocabulary depth and breadth mediate the instructional impact of morphological awareness in listening comprehension. Additionally, in terms of methodology, this study contributes to experimental studies on morphological intervention by pioneeringly using PLS-SEM modeling.

Some pedagogical implications have been offered in this study. It revealed the importance of morphological training of derivational affixes to expand vocabulary acquisition. This is specifically true for Chinese university students and other adult students in the L2 contexts. One of the implications is that morphological analysis and synthesis should be explicitly instructed and context-based. Additionally, despite the effects of morphological instruction on improving listening comprehension, this study also found this improvement effect is not direct after a one-semester interval. The main conclusion of this result is the necessity of long-term derivational awareness instruction. As morphological awareness can only facilitate the semantic processing level, it may require a long-term interval to guarantee the effectiveness of morphological intervention on listening development.

Some limitations in this study need to be addressed in future research. To begin with, the present research was limited to business English majors from the second academic year. It is noteworthy that females were overrepresented in the number of participants. This is interesting given that females tend to score higher than males in language proficiency tests (James, 2010). A wider range of ages with gender equality needs to be included in future studies. A second limitation is that the intervention effects were limited with immediate posttests in this study. An addition of delayed posttests would confirm and strengthen the research results. Future research could be designed with at least two-time posttests to estimate the successive effects of intervention. Additionally, future research may alter treatment intensity and duration to inspect the effect differences of each dependent variable. For example, as discussed above, students may need more time to apply their morphological awareness in listening processing. It is plausible that a more intense treatment with a longer duration would lead to participants' greater listening achievements.

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Authors contributions

Shuping Chen was responsible for study design, data collection, validation, data analysis, drafting, and revision. Dr. Nur Rasyidah Mohd Nordin was responsible for study design, validation, supervision, review, and editing.

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Data sharing statement

No additional data are available.

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