

Exploring learners' understanding of technical vocabulary in Traditional Chinese Medicine

Cailing Lu

Zhejiang University of Technology, Hangzhou, China

<https://orcid.org/0000-0002-9911-2824>

lucailing68@126.com

Frank Boers

University of Western Ontario, London, Canada

<https://orcid.org/0000-0001-7552-4931>

fboers@uwo.ca

Averil Coxhead

Victoria University of Wellington, New Zealand

<https://orcid.org/0000-0003-3392-6961>

averil.coxhead@vuw.ac.nz

Abstract

This study explores English for specific purposes learners' understanding of technical words in a previously-developed technical word list in Traditional Chinese Medicine (TCM). The principal aim was to estimate what kind of technical terms pose problems to TCM learners and might therefore merit special attention in instruction. Of particular interest was the question whether there is a divergence in the understanding of technical vocabulary in TCM between Chinese and Western background learners. To achieve these aims, a combination of word association tasks and retrospective interviews was implemented with 11 Chinese and 10 Western background TCM learners. The data showed that both Chinese and Western learners encountered certain difficulties in understanding technical vocabulary in their study. However, their sources of difficulty were different. Comparisons of typical word associations between Chinese

and Western learners indicated that there was a degree of divergence in the way these two participant groups understood TCM terms.

Keywords: technical vocabulary; word list; word associations

1. Introduction

Traditional Chinese Medicine (TCM) is situated in China, where 24 TCM universities and most other medical institutions provide degrees in the subject (Ministry of Education of the People's Republic of China, 2020). Students are required to study specialized English as part of their degrees to prepare for communicating in English in global settings. TCM is also taught in English-speaking countries such as New Zealand and Australia because of a growing interest in Chinese medicine. In China and elsewhere, students come from Chinese and non-Chinese speaking backgrounds and need to be able to carry out a wide range of academic tasks in English. Learners of TCM need a large vocabulary in English to read academic texts (Lu & Coxhead, 2020), and technical vocabulary makes up a substantial proportion of the lexis in written academic texts (Chung & Nation, 2003; Coxhead, 2018). Previous research has shown that learners of English for specific purposes (ESP) have difficulty in understanding, learning, and utilizing technical vocabulary in their studies (Ardasheva & Tretter, 2015; Evans & Morrison, 2011; Ha & Hyland, 2017), even if English is their first language. It is useful to explore what kinds of technical words are difficult to understand for the learners so that they can be prioritized in class and/or instructional materials. To help learners and teachers in TCM decide what specialized lexis requires attention, a technical word list of TCM was developed using a written corpus (Lu, 2018), including items such as *qi* and *heart*. To optimize the usefulness of such frequency-based wordlists, Martinez and Schmitt (2012) suggested that the potential difficulty of the lexical items for the learners should also be taken into consideration.

This study aims to investigate whether TCM learners from different language backgrounds understand technical words in the same way. It is possible that some TCM technical terms, either borrowed intact from Chinese or substituted by an English-word translation, activate a network of associations in Western-background TCM students that only partially overlaps with that of Chinese-background students. If so, this might be attributable to differences in metaphoric conceptions of the body and matters of health. This hypothesis is based on research in Cognitive Linguistics showing that language is largely metaphorical in nature and metaphor use varies across different languages and cultures (Boers, 2003; Kövecses, 2005).

2. Literature review

2.1. Technical vocabulary

Technical vocabulary (e.g., *morpheme* and *token* in applied linguistics), defined as words which are recognizably specific to a discipline (Nation, 2013, p. 303), can make up a fairly large proportion of a technical text. Chung and Nation (2003) found that 37.6% of the words in an Anatomy text and 16.3% in an Applied Linguistics text were technical. Coxhead and Demecheleer (2018) found over 30% of the vocabulary in Plumbing and Fabrication written texts was technical, and Quero (2015) found 37% of the words used in medical textbooks was technical. Technical vocabulary occurs through high (first 1,000-3,000), mid (4,000-8,000) to low (9,000 onwards) frequency bands in English (Nation, 2016).

High-frequency vocabulary is important in ESP, including TCM, for several reasons. Firstly, Lu and Coxhead (2020) found that high-frequency vocabulary accounted for over 75% of an English TCM corpus made up of practice and theory textbooks and journal articles, with much lower coverage by mid-frequency (nearly 8.5%) and low-frequency (4%) words. TCM loan words (e.g., *qi*, *xue*) and medical terms (e.g., *radix*, *rhizoma*) from English made up an additional 6% of that corpus. Secondly, high-frequency items tend to be polysemous and their technical meaning in a specialized field may not be transparent to learners even if they are familiar with the more common, non-technical uses (Fraser, 2009, p. 155). Fraser refers to these lexical items as *cryptotechnical*, citing examples from pharmacology (*expression* and *control*). An example of a high-frequency word in English which has a technical meaning and high frequency in TCM is *warm* in gall bladder *warms* the spleen (*warm* here is a verb, which means providing heat to aid digestion). Because high-frequency words look familiar, however, learners may assume they understand their contextual meaning, while this is not necessarily the case (e.g., Bensoussan & Laufer, 1984; Watson Todd, 2017). The challenge with technical vocabulary is thus not only a matter of learning new word forms and their meanings, but to a large extent also a matter of establishing new form-meaning pairings when the word forms are already familiar.

Because technical vocabulary is closely connected to content knowledge in a specific field (Woodward-Kron, 2008), it is useful to examine how well learners understand technical terms in their discipline, and whether this understanding varies depending on students' backgrounds. TCM seems a particularly fruitful context for examining the role of learner background, because, although it obviously has its origins in a specific culture, TCM is now commonly taught not only in Chinese settings but also in Western settings, and it is now commonly taught in English. Because TCM concepts are rooted in Chinese culture, this raises

the question whether L1 Chinese learners have an advantage over L1 English learners when it comes to grasping these concepts, even if they are rendered in English. The small-scale exploratory study we report below addresses this question.

2.2. Discipline-specific wordlists in TCM

By prioritizing lexical items with high frequency, learners can have the greatest possible communicative success with the inevitably limited set of words they learn (Durrant, 2013). Thus, an increasing number of frequency-based technical wordlists in different disciplines have been developed (Coxhead et al., 2016; Fraser, 2009; Hsu, 2013; Lei & Liu, 2016; Valipouri & Nassaji, 2013; Wang et al., 2008; Ward, 2009; Yang, 2015). Recently, several efforts have been made to develop wordlists specifically for TCM. Using Nation's (2012) British National Corpus/Corpus of Contemporary American English (BNC/COCA) frequency lists, Hsu (2018) identified the most frequent 605 BNC/COCA mid- and low-frequency word families in English-medium TCM textbooks. Based on relative keyness (in the TCM Corpora compared to a general written English corpus), frequency and meaningfulness, Lu (2018) developed a TCM technical wordlist with 2,747 items. A common issue with these discipline-specific wordlists is that they are probably too large to be covered in a course. Thus, this study explores a way of identifying words in such long lists which learners are likely to need special assistance with.

2.3. Metaphor in TCM

As well as learning about the form, meaning and use of a word in English (see Nation, 2013, p. 49), ESP learners need to develop ways of thinking and frames of reference in their specific discourse domain (Hirvela, 1997). Words such as *kidney* have a very different meaning and set of references in TCM compared to Western medicine. In TCM *kidney* is the organ which stores essence, governs birth, growth, reproduction and development, produces marrow, fills up the brain with essence, controls bones, houses will power and controls the gate of life (Maciocia, 2005, p. 153). The extension of the concrete meaning of the word to these abstract notions is called metaphorization by Cognitive Linguists (e.g., Yu, 2003). It is one of the major mechanisms that creates polysemy.

Partington (1998) states that discipline-specific lexis tends to be rich in metaphoric uses. For instance, when business people talk about *ring-fencing*, they mean *limiting budgetary liability* (Littlemore et al., 2010, p. 192). Low et al. (2008) found the metaphoric density in academic lectures to range from 10% to 13% of all lexical items. Such metaphors were found to be semantically opaque to international students in English-speaking countries (e.g., Littlemore, 2001;

Littlemore et al., 2010) because they may require a considerable amount of figurative thinking (Littlemore & Low, 2006) in order to derive the metaphorical meaning from the basic, literal meaning of the words. It is often assumed that the learners will be familiar with the basic, literal meaning. This cannot always be taken for granted, however. The extended, metaphorical use of a word can be more frequent than its literal use in the samples of language that a learner is exposed to. For example, a student of commerce and economics is more likely to meet the words *chronic*, *injection* and *recovery* in phrases such as *a chronic deficit*, *a financial injection* and *economic recovery* than with reference to real health matters (e.g., Boers, 2000). The original, literal meaning of a word or an expression may stem from a domain of life that is culture-specific, too, such as particular games and customs (Boers, 2003). Lack of familiarity with these will of course also hinder learners' appreciation of how the literal underpinning informs the metaphorical use of a given word or expression.

When it comes to TCM, it must be puzzling for newcomers to this discipline why certain words have developed their extended meanings. For example, in TCM theory, the *gallbladder* has three main functions: it stores and excretes bile that is secreted by the liver; it has the capacity to make decisions in mental processes and activities; and it gives people *courage* (Maciocia, 2005). The GALLBLADDER IS THE CONTAINER OF COURAGE¹ metaphor is a culture-specific metaphor shaped by TCM theory (Yu, 2003). This illustrates that some TCM technical words might be difficult to understand for Western-background learners, because, while the words look familiar, their technical meaning reflects culture-specific metaphors that are quite different from the metaphors which these learners have grown up with (possibly even including remnants of the Jamesian view that emotions reside in the heart and reason in the mind). In the exploratory study reported below, we examine if this is indeed the case. Specifically, this study addresses the following research questions:

1. To what extent do Chinese-background and Western-background TCM learners understand a selection of technical words in their discipline?
2. Do Western-background TCM learners understand technical words in TCM in the same way as Chinese-background TCM learners?
 - a) if not, what kind(s) of technical words manifest this divergence between the understanding of the two groups?
 - b) what factors might account for the divergence, if any, in the understanding of the technical words by the two groups?

¹ Note that it is customary in publications about conceptual metaphors to write these in small upper case.

3. Methodology

3.1. Participants

A total of 21 TCM Bachelor degree students participated in this study: 11 students from a Chinese TCM university and 10 TCM students from a New Zealand institution. Table 1 presents the demographic information of the 11 Chinese participants. All the 11 Chinese TCM participants had Chinese as their first language and had studied English for over eight years. They had high scores on the English College Entrance Examination. Their medium of instruction was mainly Chinese, but academic communication in English (e.g., reading English-medium journal articles) was required by the university. Six had been English major students for two years at university prior to undertaking TCM study,² meaning a second year TCM student would actually be in their fourth year of study at university level. Other students took one compulsory college English course each semester, such as academic English.

Table 1 Chinese participant (CP) demographic information

Participant	Gender	Sub-discipline	Year of studying TCM	English major prior to TCM
CP1	Female	Chinese Internal Medicine	5	Yes
CP2	Female	Chinese Internal Medicine	4	Yes
CP3	Female	Chinese Herbal Medicine	3	No
CP4	Male	Acupuncture and Moxibustion	2	Yes
CP5	Female	Chinese Internal Medicine	1	No
CP6	Female	Chinese Internal Medicine	2	No
CP7	Female	Chinese Herbal Medicine	3	No
CP8	Female	Acupuncture and Moxibustion	2	Yes
CP10	Female	Acupuncture and Moxibustion	2	Yes
CP11	Female	Acupuncture and Moxibustion	2	Yes
CP12	Female	Chinese Herbal Medicine	4	No

The Bachelor's degree of TCM in New Zealand is a four-year program and English is the medium of instruction. As shown in Table 2, these participants were students from year one to year four, including nine English speakers from New Zealand, North America and the UK, and one Taiwanese. None of the nine English native speakers had studied Chinese as a second/foreign language, although one of them had Chinese parents. The participant who self-identified as Taiwanese had been living in New Zealand for 20 years. The latter two participants will be

² Those participants studied in a 7-year program which combines English and Traditional Chinese Medicine majors. In the first two years, the students have to learn what English majors learn and in the last five years the students have to learn what TCM learners learn. It is hoped that those students can have high specialized language proficiency through studying those two majors sequentially as a way to prepare them for international academic communication in their field.

labeled “Western TCM learners with Chinese background” in this article. The other participants in New Zealand will for simplicity's sake be referred to as “Western TCM learners” and those based in China as “Chinese TCM learners.” This categorization is over-simplistic since all learners could have multicultural backgrounds to varying degrees.

Table 2 New Zealand participant (NP) demographic information

Participant	Gender	Sub-discipline	Year of studying TCM
NP1	Female	Acupuncture	4
NP2	Female	Chinese Internal Medicine	3
NP3	Male	Acupuncture	1
NP4	Female	Acupuncture	3
NP5	Female	Acupuncture	3
NP6	Male	Acupuncture	4
NP7	Female	Acupuncture	2
NP8	Male	Acupuncture	2
NP9	Female	Acupuncture	2
NP10	Female	Acupuncture	2

3.2. Word association task

3.2.1. Format of the word association task

The association task used in this study was based on the format of Read's (1998) Word Association Test. Read's task contains a target lexical item, four associates and four distractors. Including as many as eight options makes the task less susceptible to guessing (Schmitt et al., 2011) and is possibly especially suitable for high-frequency polysemous words (Schmitt, 2000). The format is commonly used in word association research (Qian, 1999; Qian & Schedl, 2004; Read, 1993, 1998; Schmitt et al., 2011). Appendix A presents the word association task used in the present study. The participants were asked to choose four words of the eight options which they thought were most closely associated to the cue words in the context of TCM. The word association task served as input for a subsequent retrospective interview procedure where the association responses served as prompts. The task was limited to just 20 items, because it was felt desirable to complete the interviews within one hour to avoid fatigue on the part of the participants.

3.2.2. Target cue words

Although we were especially interested in participants' understanding of technical terms with meanings that reflect (culture-grounded) metaphors (see above), it was important to present them with a wider range of terms to compare the two

groups' overall familiarity with their field's technical lexis. With a view to including diverse cue words in the associations test, frequency banding and likely semantic transparency/opacity were taken into account as complementary parameters, following a proposal by Martínez (2013, p. 190). While Martínez used frequency (an estimate of utility) and likely semantic opacity (an estimate of learning difficulty) as two complementary parameters to select multiword expressions, this study applied the same general parameters to single words. Figure 1 shows the continua of frequency and likely transparency. On the vertical continuum, technical words from the first to the third 1,000 word families of the BNC/COCA word lists are in the upper quadrant (e.g., *heart* and *doctor*) and items from the lower-frequency bands are in the lower quadrant (e.g., *pathology* and *yang*). The cut-off point at 3,000 BNC/COCA level for distinguishing high-frequency words from mid-frequency words was proposed by Schmitt and Schmitt (2014).

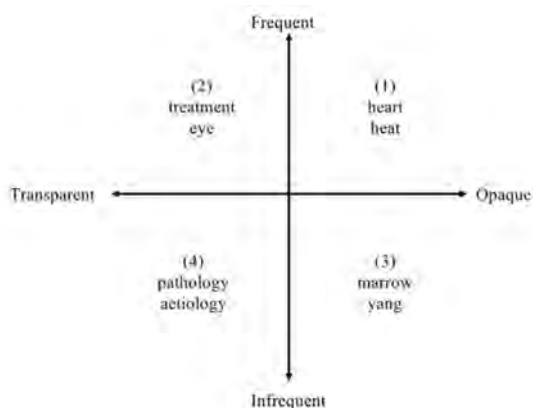


Figure 1 The Frequency-Transparency Framework for TCM technical words

On the horizontal continuum, opaque items are on the right and transparent items are on the left. The first indicator of likely opacity is whether the technical sense of a word differs from its general sense (Ha & Hyland, 2017). If a word is metaphorical or is used in a sense that differs from its use in general discourse, it was considered opaque. For example, the literal meaning of *heart* is “a hollow muscular organ of vertebrate animals that by its rhythmic contraction acts as a force pump maintaining the circulation of the blood” (heart, n.d.), whereas in TCM it refers to the organ that is situated in the chest whose main functions are to govern blood and to house the mind (Maciocia, 2005). The second indicator is whether a technical word is a loan word borrowed intact from Chinese (e.g., *qi*, *yang*). Interpreting loan words can be challenging even to people with knowledge of Chinese, because the four tones of Chinese are invisible in Romanized versions of loan words, and so they are potentially ambiguous.

Following these principles, the first author, with a Bachelor's degree in TCM, allocated the most frequent 200 technical words on the TCM technical word list (Lu, 2018) into the four quadrants. Appendix B presents the first 100 technical words in the aforementioned list. When there was uncertainty, an expert in TCM translation, who is also the second rater of the word association task, was consulted. Five technical nouns or verbs from each Frequency-Transparency category were then randomly selected for the word association task and used as the prompts in the retrospective interviews.

3.2.3. Associations and distractors

Word association tasks can indicate levels of mastery of cue words (Read, 2012). Using Fitzpatrick's (2006) categories and subcategories of association as presented in Appendix C, each item was developed to contain a mixture of association options. This version of word association task was adopted because it was essentially used as prompts to explore learners' deeper understanding of technical words. To make the task less susceptible to guessing, one to two distractors were provided for each item while the others were all possible associates. The respondents had to choose four associates out of eight options, six to seven of which were correct. The reason why more than four correct associates were provided was to capture the potential divergence among the learners as they made their selection of the four options they considered most closely associated with the given term. The respondents' selection of associates was a measure of how well the target cue words were known, where lack of knowledge was observed when one of the distractors was chosen by the participant. The self-reported reasons for selecting the associates in the subsequent interview reflected the kind of knowledge that drove the associations and checked on the verity of the selections in the task. The distractors were selected from the TCM technical word list and checked to ensure there was no direct semantic link with the cue word. Take *joint*, for example, in Figure 2. In TCM, *joints* are "more than just anatomical entities, they have an important function with regard to the circulation of Qi and Blood, with several implications in pathology" (Maciocia, 2005, p. 752). *Tendon* and *skeleton* are paradigmatic associations from the same word class as *joint*, while *qi* and *blood* are meaning-based associations which form the conceptual meanings of *joint*. *Pain (joint pain)* and *shoulder (shoulder joint)* are position-based associates. Only when the learners understand *joint* in TCM well can they associate *joint* with *qi* and *blood*. Choosing words other than *qi* and *blood* can also show that the learners understand the literal meaning of *joint*. In this example, *heart* and *hepatitis* are distractors and are on the TCM technical word list (see Appendix A for more examples).

This task contains 20 target words. Each target word (in bold) has eight (8) options. Please choose four words of the eight options which you think are most closely associated to the following words in the context of Traditional Chinese medicine (TCM). Put a tick (✓) in the box for each option you choose. Here is an example:

joint

- A. qi
- B. tendon
- C. skeleton
- D. blood
- E. pain
- F. heart
- G. shoulder
- H. hepatitis

Figure 2 *Joint* as an example in the word association task

3.3. Semi-structured interviews

Semi-structured retrospective interviews were used to explore the reasoning behind participants' answers (Cohen et al., 2007). Such open-ended format was chosen to ensure that the interviewees had the flexibility to elaborate on their answers within the given frame (Dörnyei, 2007). The interviewer probed how well the participants really understood the target words by asking them to explain their choices, thereby adding to the validity of the word association task results. The participants chose either Chinese or English to express their ideas. The interviews were recorded and transcribed.

3.4. Procedures

In each interview, a participant responded to one cue word on the task at a time, and was then asked to explain their response, before moving on to the next item on the test. The participants performed the word association task using paper and pencil, with no access to dictionaries or other reference texts and no time constraints. The first author sat face-to-face with each participant, and immediately after the participants had chosen associates for an item, she asked them to reflect on the reasons behind their responses to the association task, using questions such as, "why did you choose A?" and "why did you associate this word with B?"

3.5. Data analysis

Table 3 demonstrates the scoring criteria for the word association task. The participants' responses in the written word association task and the elaborations

given in the retrospective interview were assessed on a 5-point scale for each of the 20 items (maximum score = 100 points). For instance, in the case of *root*, one participant chose *cause*, *manifestation*, *herb* and *chronic* as the associations, and gave valid reasons for those associations in the interview. This participant was considered to have full knowledge of *root* and scored 5 points.

Table 3 Scoring criteria for the word association task (adapted from Schmitt et al., 2011)

Degree	Points	Criteria
Full knowledge	5	Selected at least three associations related to TCM and demonstrated full knowledge of the cue word in TCM context
	4	Selected at least three associations related to TCM and demonstrated some knowledge of the cue word in TCM context
	3	Selected at least two associations related to TCM and demonstrated a little bit of knowledge of the cue word in TCM context
Partial knowledge	2	Selected at least one association related to TCM and demonstrated no knowledge of the cue word in TCM context
	1	Selected association(s) unrelated to TCM but related to literal/general meaning and demonstrated no knowledge of the cue word in TCM context
No knowledge	0	Did not know the cue word at all or selected items that could not be justified

The responses of one participant's word association task were scored by the first author and then by a second rater. The level of agreement was 95% and agreement on the 5% other items was reached through discussion. The first author then scored all the tasks, and consulted the rater when needed. To answer research question 1, the mean score (*M*) and the corresponding standard deviation (*SD*) were calculated.³

To answer research question 2, the number of participants who chose each association were counted for each item. The four associations selected by the majority of participants in each group were then determined. Divergence was identified when at least one of the four typical associations was not the same for the two groups of participants. Interview data were then consulted to confirm divergence in the reasoning behind these associations of the two groups. The interview analysis followed the classic method for qualitative data analysis of Holliday (2010) and involved firstly coding all divergences and then determining themes. The divergences concerning the opaque items were examined first to ascertain if they were indeed related to cultural background. If not, then they were explored further to determine what other factors drove the divergences. The transparent items were analyzed to determine what factors led to the divergences, without expecting cultural background factors to emerge.

³ Given the small sample sizes, we consider this an exploratory study and will refrain from reporting inferential statistics (but see footnote 4).

4. Results

4.1. Outcome of the word association task

4.1.1. Performance of Chinese TCM learners in the word association task

As displayed in Table 4, the mean score for the Chinese TCM learners was 74.27 out of 100, suggesting that they had a good understanding of the majority of the technical words in the task. They did not demonstrate full knowledge of approximately 25% of the technical words in the task, and generally scored higher for the technical words from high-frequency vocabulary (a total mean of $19.91 + 23.64 = 43.55$) than lower-frequency bands (a total mean of $12.27 + 18.45 = 30.72$). The cue words *lumbar* and *diarrhoea* caused great difficulty for these learners, as did *wheezing* and *colorectal* in the task. These participants reported in the interviews that they had not chosen the latter words as associations in the task because they were not familiar with them.

The Chinese participants appeared to have better knowledge of transparent high-frequency technical words such as *cancer* ($M = 23.64$) than opaque technical words such as *mind* ($M = 19.91$). Interview data showed that four Chinese TCM learners had problems with the metaphorical meaning of technical words in English, especially those who had not taken English for TCM purposes courses. For example, they understood the meaning of *channel* as in TV *channel*, but not in connection with TCM. In this case, the learners failed to understand the specialized meaning of polysemous words even though they knew another, more common meaning. As to the technical words from low-frequency bands, the results in Table 4 indicate that Chinese TCM learners knew the opaque items such as *tang* ($M = 18.45$) better than the transparent items such as *lumbar* ($M = 12.27$). These results are not surprising because the Chinese learners had an advantage in understanding loan words which are from the opaque and infrequent category. Table 4 also shows a wide range of scores in the word association task, from students who displayed almost full knowledge of the target words (the highest score being 98 out of 100) to ones who appeared to understand only a small percentage (the lowest score being 40 out of 100).

Table 1 Descriptive statistics of Chinese learners' performance in the word association task ($N = 11$)

Category	Total	Minimum	Maximum	<i>M</i>	<i>SD</i>
Frequent and opaque technical words	25	16	25	19.91	3.48
Frequent and transparent technical words	25	16	25	23.64	2.94
Infrequent and transparent technical words	25	0	25	12.27	9.27
Infrequent and opaque technical words	25	7	25	18.45	7.09
All 4 categories	100	40	98	74.27	21.12

Note. *M* = mean; *SD* = standard deviation

4.1.2. Performance of Western TCM learners in the word association task

Table 5 displays the descriptive statistics of the word association responses from the Western TCM learners. The mean score was 94.20 out of 100, indicating that the Western TCM learners had a higher level of understanding of the technical words in the task, failing to understand, on average, only one out of twenty target words. They scored slightly lower on opaque technical words from both the high-frequency band, such as *mind* ($M = 22.90$), and the lower-frequency bands, such as *tang* ($M = 21.40$), than on the technical words expected to be transparent according to our framework, with mean scores of 24.50 (e.g., *cancer*) and 24.90 (e.g., *lumbar*) respectively.

Table 5 Western learners' performance in the word association task ($N = 10$)

Category	Total	Minimum	Maximum	<i>M</i>	<i>SD</i>
Frequent and opaque technical words	25	17	25	22.90	2.73
Frequent and transparent technical words	25	23	25	24.50	.85
Infrequent and transparent technical words	25	24	25	24.90	.32
Infrequent and opaque technical words	25	19	25	21.40	2.55
All 4 categories	100	86	99	94.20	4.13

Note. *M* = mean; *SD* = standard deviation

The results indicate that opaque loan words, both among the cue items of the task and among the association options, appeared to pose some difficulty for the Western learners. For example, these learners found it difficult to differentiate loan words which have similar forms (e.g., *zhong*, *zong* and *zheng*). Two of the Western participants mentioned explicitly in the interview that they found it especially challenging to learn loan words, and that some low-frequency technical words (e.g., *colorectal* and *borborygmus*) were also difficult (see Extract 1). Note that *colorectal* was not the cue word in the word association task, and so this difficulty was not reflected in the scores directly, but was revealed through the interview.

Extract 1: A Western learner talks about associations of the cue word *cancer*

NP6: (Looking at *colorectal*) What is this word? Colorectal? I don't know this word.

Interviewer: So, you've never seen this word?

NP6: No.

The two Western participants who had some Chinese heritage scored 99 out of 100 on the word association task. Perhaps these participants had the best of both worlds, in that they had exposure to low-frequency words in English and also understood the Chinese loan words.

4.2. Comparison of typical associations between Chinese and Western learners

In answer to subquestion b, typical associations were compared to other association options prompted by the target technical words in each participant group. Table 6 shows that a major divergence of understanding was manifested with two (out of 20) target technical words (*phlegm* and *tang*), with only two typical associations shared by the two participant groups. It is not surprising that both items are low-frequency and opaque.

Table 6 Summary of divergence between the two groups in each category of TCM specialized words

Degree of divergence	Major divergence	Minor divergence	No divergence
Frequent and opaque technical words	0	2	3
Frequent and transparent technical words	0	3	2
Infrequent and transparent technical words	0	4	1
Infrequent and opaque technical words	2	1	2
Total	2	10	8

Minor divergence was found in ten items (50%) where both participant groups shared at least three typical associations. It is interesting to note that minor divergence was identified from all four categories as indicated in Table 6. For the remaining eight cue words, Chinese and Western TCM learners shared the same typical associations, accounting for 40% of the lexical items in the task. The divergence identified could come from technical words in any category of the frequency-transparency framework, but lower-frequency items manifested more divergence than high-frequency items.

4.3. Factors contributing to divergence

Language knowledge and breadth of subject knowledge were identified in the qualitative analysis as the main contributors to divergence in the understanding of the technical words in the association task. In contrast, it was clear from the analysis that, against our expectations, cultural background did not stand out in the data.

4.3.1. Language knowledge

The language knowledge of the participants was identified in the interview data as the most important factor for the divergence. This factor was evident in the data in two ways. First, the Chinese TCM learners appeared to lack knowledge of technical words in English from the lower-frequency bands. That is, their knowledge of words that they would have had few chances to meet in their English language

learning experience seemed to be limited. For example, 10 out of 11 Chinese learners did not select *borborygmus* as an association for *diarrhoea* simply because they were not familiar with this technical low-frequency word (Extract 2) in English (but did know it in their L1). In Extract 2, typical associations from Chinese learners are underlined (spleen, stool, dampness, and dizziness) and associations from Western learners are in bold (spleen, borborygmus, stool, and dampness).

Extract 2: A Chinese learner talks about associations of the cue word *diarrhoea*

Diarrhoea

A. spleen B. heart C. *borborygmus* D. stool E. dampness F. ceaseless
G. dizziness H. chronic

Interviewer: So, can I please ask why you didn't choose C (*borborygmus*)?

CP10: I don't know this word.

Interviewer: So, if you had known this word means fuming (Chinese translation of *borborygmus*), would you have chosen it?

CP10: Fuming, ah, I would.

Interviewer: Why?

CP10: I would remove dizziness, because it has stronger association. This disease has a symptom as such.

Similar patterns could also be found when the participants met other technical words from the lower-frequency bands such as *lumbar* as a cue word and *mucus* as an association. Unfamiliarity with technical words from the lower-frequency vocabulary bands affected Chinese TCM learners' choices of associations.

The second major divergence arose when the Western TCM learners appeared to lack high levels of knowledge of the Chinese loan words such as *tang* (cue word) and *chengqi* (association option). Extract 3 from an interview with a Western TCM learner illustrates this point. Seven out of the ten Western learners showed a similar reaction when they saw *tang*.

Extract 3: A Western learner talks about associations to the cue word *tang*

NP8: (looking at *tang*) Sounds very hard?

Interviewer: Have you ever seen this word?

NP8: Oh, no, *tang*, is that *tong* means pain?

Interviewer: No, not this one.

NP8: No, I don't know.

Some Western learners decoded this word as an English word rather than a loan word, despite the TCM context of the word association task. Extract 4 is a case in point. *Tang* is a mid-frequency word in English in Nation's (2012) BNC/COCA lists and it is also a word form used in Chinese when Romanized.

Extract 4 thus demonstrates that such loan words were likely to create confusion for the learners if they were not explicitly explained.

Extract 4: A Western learner encoded *tang* as an English word

NP1: *Ok, tang, I'm not familiar with this word. Is this an English word or Chinese word?*

I: *Actually, it's pinyin [Romanized Chinese word].*

NP1: *I don't know what it is as a Chinese. So, I can't make associations. Whereas if I choose to look at it as an English word, then I might be able to make associations.*

I: *So, how would you choose as an English word?*

NP1: *As a taste like a flavor.*

4.3.2. Breadth of subject knowledge

The second factor for the divergence was the breadth of subject knowledge of the learners. Extract 5 shows an interview extract with one Western TCM learner who is talking about *herbs* in relation to *cold*, and Extract 6 concerns the same word with a Chinese TCM learner. Even though neither the Western learner in Extract 5 nor the Chinese learner in Extract 6 had specialized in herbal medicine, the Chinese learner made the association without hesitation.

Extract 5: A Western learner talking about herbs as association to *cold*

Cold

A. fever B. heat C. yin D. pathogenic E. wind F. herbs G. intestine H. limbs

Note. Western learners' (NP3) associations in bold and Chinese learners' (CP12) underlined.

Interviewer: *Not herbs?*

NP3: *I didn't pick herbs because I don't really know anything about herbs yet, and they feel more like a treatment than a problem, yeah.*

Extract 6: A Chinese learner talking about herbs as association to *cold*

Interviewer: *So why did you choose herbs?*

CP12: *I chose herbs because a lot of herbs are cold herbs, I mean, some herbs have a cold property.*

Foundation TCM courses, such as acupuncture and herbal medicine, are compulsory in China. This means TCM learners must take such courses to get their degree. However, Western TCM learners have specialized courses on acupuncture. This difference in educational systems might account for the Western learners having somewhat narrower associations than the Chinese learners.

4.4. Divergence in understanding of technical words with the same typical associations

Even if the two groups of respondents produced the same typical associations for many words, this does not necessarily mean that their mental representations of these words were identical. The way knowledge is represented in the mind is likely determined by how it was acquired. Extract 7 and Extract 8 illustrate, for example, how a Western TCM learner referred to the acupuncture knowledge from courses, whereas the Chinese learner used their underlying theoretical and philosophical knowledge of TCM.

Extract 7: A Western TCM learner talked about *lung* as association to *spleen*

NP1: *I chose lung because in TCM you got your 12 primary channels, but they are paired up so there is taiyin, so the lung and the spleen are the same channel, and they have a really strong relationship, and they work together quite simultaneously in the body to, basically in creating qi and to ensuring smooth digestion, they both work together particularly in transforming, transporting and moving fluids around the body.*

Extract 8: A Chinese TCM learner talked about *lung* as association to *spleen*

CP4: *Um, because, the spleen and the lung has mother-child relationship. Then digestion, spleen governs transformation and transportation. Then, stomach has an external-internal relationship (with the spleen). Then blood, it's the material basis for production of qi and blood.*

The Western background learners who had some knowledge of Chinese culture showed a better ability to decode loan words that are used in the sub-discipline outside their specialization. Extract 9 shows the decoding process of a Western learner who did not have any Chinese background in comparison with Extract 10, a Western learner with a Chinese background who used translation to help with decoding the technical vocabulary.

Extract 9: A Western learner without Chinese background talks about the cue word *tang*

NP9: *Um, tang, that's a tricky one, I don't really know.*

Interviewer: *You haven't seen this word before?*

NP9: *No, well, in like yintang, that kind of thing, but I couldn't tell you... Ok, I will pick none [as an answer] because I can't really, but yeah, I've heard yintang and that kind of thing, but I can't think of any of these that would fit why.*

Extract 10: A Western learner with Chinese background talks about the cue word *tang*

NP5: *Oh, it's a tricky one coz I actually don't know the meaning I think it's herbs like you know when you have a formula unless I'm completely wrong, yeah, but I actually don't know the meaning of that. Um, also don't even know the meaning of this one (chengqi), so therefore if I think it's closely associated*

with herbs and I translated it into decoction, yeah, I tick that. And then with herbs you can have specific flavours, I'll tick bitter, and them because usually you'll smell them you know, I'll tick that (pungent odour).

Interviewer: So how would you translate it if you don't know . . . ?

NP5: Can you pronounce it for me or you're not allowed to?

Interviewer: Tang (the interviewer pronounces it with the tone).

NP5: I think possibly this (decoction), but other than this I don't know.

These extracts illustrate that when both Western learners did not have much knowledge of Chinese, the one who had some Chinese background showed a better ability to decode the technical words that were not used very commonly in their sub-discipline but used very commonly in another important sub-discipline of TCM. The same trend applied to other Western learners except one who had previously studied herbal medicine.

5. Discussion

In response to research question 1, this exploratory study revealed that the participants displayed good knowledge of the selected technical terms overall, although there were exceptions among the Chinese learners, who showed limited understanding of the mid- and low-frequency terms unless these were Chinese loanwords (see below for further discussion). Largely because of this, the mean score of the Chinese group on the word association task was lower than that of the Western learners⁴ (for whom English was their first or dominant language). The min-max values and the standard deviations in Tables 4 and 5 above indicate a much greater dispersion of the scores in the former group as well. While all the Western learners obtained overall scores of at least 86 out of 100, this held true for only 5 of the Chinese learners. It therefore looks as though instructional intervention would be especially welcome for certain learners in the latter population.

In response to research question 2, this study showed that the divergence in the understanding of the technical words between the two groups of TCM learners was due in large part to different language backgrounds and the frequency of the vocabulary items. For Chinese learners, specialized words used almost exclusively in medical or TCM contexts (e.g., *lumbar*) posed greater difficulty than those used in wider contexts. Such specialized words are often from the mid- and low-frequency bands of English vocabulary or even outside Nation's (2012) frequency bands. These must be challenging to Chinese-background TCM

⁴ The results of a *t*-test for independent samples indicates that the difference in scores between the two participant groups was statistically significant ($t = 2.93$; $p = .009$), and Cohen's *d* calculation confirmed that the effect for participant group was large ($d = 1.31$). Given the small sample sizes, we should of course interpret these statistics with caution.

learners, because they have had few opportunities to encounter English words outside the general high-frequency vocabulary bands in their previous EFL learning experience. After they enter their discipline where they are exposed to such technical words, they need to learn the subject knowledge and these technical words in Chinese and English simultaneously. As one Chinese participant commented, "I don't have time to use these technical words in English after class because I have many courses to attend in one semester." Added to the challenge is the overwhelmingly large quantity of such technical words in their discipline. Where problems did occur with Western TCM learners, it concerned mostly Chinese loan words which these participants were not yet familiar with (e.g., *yang*). Further, they found it especially difficult to differentiate loan words which have similar forms (e.g., *zhong*, *zong* and *zheng*). We might expect loan words to cause difficulties for learners who are not first language speakers of Chinese. These learners have to build knowledge of both the technical concept and the vocabulary that goes with it.

In contrast, the findings revealed that TCM learners from both contexts did not encounter great difficulty with high-frequency words with specialized meaning. At first glance, this finding contradicts the argument of Watson Todd (2017) who, when developing an engineering word list, claimed that learners may need explicit help with high-frequency words that have taken on specialized meanings. However, Watson Todd's word list served the purpose of helping learners prepare for English-medium study in engineering, whereas the ESP learners in our study had already been studying their subject for at least one year. Further, by indicating that learners from different linguistic backgrounds encountered different challenges, this study calls for attention to learners' linguistic background in applying word lists in teaching. This study also highlights that insights from learners can be a valuable complement to the word lists developed solely based on corpora.

We hypothesized at the start that cultural background would be a cause for divergence in the understanding of technical words between Chinese and Western learners. However, no compelling corroboration for this hypothesis emerged from our data. In general, Western TCM learners demonstrated a good understanding of most technical words that contain cultural metaphors (e.g., *mind*, *phlegm*). This is perhaps not surprising for two reasons. First, these Western-background learners had studied TCM for a considerable length of time. They had gained a reasonable or even excellent grasp of the technical knowledge and the underlying cultural knowledge. Second, the Western learners received English-medium instruction about the subject, which probably involved considerable semantic elaboration to support the learning of discipline-specific meanings of these technical words. Given that the Western learners are native or native-like speakers of English, they were familiar with the general meaning of these technical words. Therefore, it may have been relatively easy for them to make appropriate transfer from general meaning of these technical

words to the metaphorical meaning. This finding is consistent with the view of Woodward-Kron (2008), who pointed out that learning disciplinary knowledge involves understanding, engaging with, and adopting technical terms of that discourse. Evidence of understanding Chinese metaphoric conceptions of body and health demonstrated that the Western-background learners in this study have really learned these technical words. Therefore, even though TCM has culturally-bound metaphoric conceptions of the body and matters of health that differ from its Western counterparts, the Western-background TCM learners demonstrated similar comprehension to the Chinese learners of the technical words which reflect such metaphoric meanings.

This study also showed that the participants from both groups who studied the subject for even one year demonstrated good understanding of technical words with cultural metaphor. This finding contrasts with that of Littlemore (2001) and Littlemore et al. (2010), who found that metaphors in academic lectures created considerable comprehension difficulties among international students. One possible reason for this conflicting finding might be the difference between the participants' L1 and the language used as the medium of instruction in their study. The participants in Littlemore (2001) and Littlemore et al. (2010) were international students and the medium of instruction in their study was English, which was not the participants' L1. However, in the present study, the medium of instruction for Chinese participants in their study was mostly Chinese, while the medium of instruction for the western participants was English. That means almost all participants received instruction in their L1 (the Taiwanese participant is a native-like speaker of English) in the current study. It is not surprising that participants could comprehend metaphors of their study in their L1.

In addition, findings from the retrospective interviews shed light on the pathways that led the participants to choose certain associations. Chinese and Western-background learners of TCM seemed to acquire technical words through different pathways, although the resulting knowledge looks the same. The Chinese learners had probably acquired much of the underlying TCM theory and philosophy knowledge incidentally in daily life and this knowledge then became enhanced and systematized in their field of study. The Western learners, by contrast, probably acquired TCM technical words and their cultural underpinnings simultaneously through deliberate instruction with the aid of textbooks and course materials. This supports a broad interpretation of the concept of transfer appropriate processing proposed by Morris et al. (1977), which suggests that the way of learning something will determine the nature of the resulting knowledge.

It is important to note that this study contains only 20 technical TCM items and involved only a small number of participants. These small sample sizes are clearly limitations in this study. As regards the research procedure that we explored here, our findings highlight the value of retrospective interviews immediately after

task completion. This process allowed us not only to detect lacunae in ESP learners' vocabulary knowledge, but also to pinpoint some of the reasons for those gaps. Taken together, this study has the potential to inform instructional interventions to help specific groups of learners to overcome their specific difficulties with technical words that they encounter in their study.

6. Pedagogical implications

There is a range of possible implications for ESP learners, teachers and course designers based on this research. First, if there are technical loan words from another language in a subject, such as *zhong*, *zong* and *zheng* in the present study, learners (such as the Western participants in this study) who do not have a working knowledge of that language should probably avoid trying to learn these words at the same time to avoid confusion between them. Teachers could ensure that extra time and practice is allowed for these items. It is equally important for the course designers to select teaching materials which pay special attention to such loan words, for example, by providing explanations in the margins. If such materials are not available, the course designers and teachers could design supplementary learning materials and activities to help the learners with those loan words.

Second, learners such as the Chinese EFL learners in the present study will need considerable support for highly specialized and low-frequency words (e.g., *pericardium*), which involve acquiring new word forms and new meanings at the same time. Deliberate learning and consolidation in memory, for example through using word cards, would be useful in this instance (Nation, 2013). Semantic elaboration tasks can also help learners work out the similarity between the 'basic' word meaning and its extended meaning as a specialized word (Boers, 2000; Nation, 2013). This kind of learning is part of language-focused learning, which is one of Nation's (2013) Four Strands. It is of course also important for the learners to encounter the specialized vocabulary of their discipline through reading textbooks (meaning-focused input strand), as well as giving presentations, retelling the main points of a carefully selected article abstract and discussion activities (meaning-focused output strand). For them to be able to use the technical vocabulary in real time communication, learners will also need to practice what they have learned through activities that foster fluency (the fluency strand in Nation's model). Nation (2007) suggested that the learners spend a similar amount of time on each strand for learning to happen effectively.

Last, for subjects such as TCM which have a strong metaphorical component, it is important to plan for and consider the frequency, connection to the subject and learning of metaphors. The more learners know about a subject, the more likely they will also develop their understanding of metaphors in that area. Tasks such as the one from this study could be used to tease out the knowledge

of metaphors with learners, and teachers could be drawing attention to figurative meanings in class in a systematic way by pointing them out in reading texts and ensuring there are plenty of opportunities for both discussing metaphor in class and using technical terms in speaking and writing.

7. Directions for future research

The finding about factors affecting learners' understanding of technical words is solely based on qualitative analysis of semi-structured interview data. The number of participants in each group was not sufficient for inferential statistics such as a regression analysis to identify the predictors of word knowledge in the present study. Larger scale approximate replications would be welcome. Further work could also include a group of Western TCM learners who have prior knowledge of Chinese, and include word frequency in Chinese as another criterion to select the target words. Another avenue would be to explore teachers' approaches to technical vocabulary in university classes (see Basturkmen & Shackleford, 2015). Extending this line of research to other academic disciplines where cultural knowledge might affect learners' comprehension of technical vocabulary would also be welcome.

8. Conclusion

This study started with the assumption that the Western and Chinese-background TCM learners might understand technical words reflecting culture-specific metaphors in different ways. However, the findings of the present research showed that this assumption did not hold. A divergence was identified in that Western learners struggled with Chinese loan words and Chinese learners struggled with low-frequency English words. The interview data revealed that language knowledge and breadth of subject knowledge of the participants were the main contributors to the divergence. Overall, this exploratory study provided us with useful insights into the kinds of technical words which merit pedagogical intervention. This can help to make more informed use of the inevitably long word lists that have been produced in recent years, including our own TCM word list as a case in point. This investigation may stimulate further research into specialized language learning and teaching in TCM as well as in other academic disciplines.

Acknowledgements

We wish to thank the two editors and two anonymous reviewers for their insightful comments.

References

- Ardasheva, Y., & Tretter, T. R. (2015). Developing science-specific, technical vocabulary of high school newcomer English learners. *International Journal of Bilingual Education and Bilingualism*, 20(3), 1-20.
- Basturkmen, H., & Shackelford, N. (2015). How content lecturers help students with language: An observational study of language-related episodes in interaction in first year accounting classrooms. *English for Specific Purposes*, 37, 87-97. <https://doi.org/10.1016/j.esp.2014.08.001>
- Bensoussan, M., & Laufer, B. (1984). Lexical guessing in context in EFL reading comprehension. *Journal of Research in Reading*, 7(1), 15-32.
- Boers, F. (2000). Enhancing metaphoric awareness in specialised reading. *English for Specific Purposes*, 19, 137-147.
- Boers, F. (2003). Applied linguistics perspectives on cross-cultural variation in conceptual metaphor. *Metaphor and Symbol*, 18(4), 231-238. https://doi.org/10.1207/S15327868MS1804_1
- Chung, T. M., & Nation, P. (2003). Technical vocabulary in specialised texts. *Reading in a Foreign Language*, 15(2), 103-116.
- Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education* (6th ed.). Routledge.
- Coxhead, A. (2018). *Vocabulary and English for specific purposes research*. Routledge.
- Coxhead, A., & Demecheleer, M. (2018). Investigating the technical vocabulary of Plumbing. *English for Specific Purposes*, 51, 84-97. <https://doi.org/10.1016/j.esp.2018.03.006>
- Coxhead, A., Demecheleer, M., & McLaughlin, E. (2016). The technical vocabulary of carpentry: Loads, lists and bearings. *TESOLANZ Journal*, 24, 38-71.
- Dörnyei, Z. (2007). *Research methods in applied linguistics: Quantitative, qualitative and mixed methodologies*. Oxford University Press.
- Durrant, P. (2013). Discipline and level specificity in university students' written vocabulary. *Applied Linguistics*, 35(3), 328-356. <https://doi.org/10.1093/applin/amt016>
- Evans, S., & Morrison, B. (2011). Meeting the challenges of English-medium higher education: The first-year experience in Hong Kong. *English for Specific Purposes*, 30(3), 198-208. <https://doi.org/10.1016/j.esp.2011.01.001>
- Fitzpatrick, T. (2006). Habits and rabbits: Word associations and the L2 lexicon. *EUROSLA Yearbook*, 6, 121-145.
- Fraser, S. (2009). Breaking down the divisions between general, academic and technical vocabulary: The establishment of a single, discipline-based word list for ESP learners. *Hiroshima Studies in Language and Language Education*, 12, 151-167.

- Ha, A. Y. H., & Hyland, K. (2017). What is technicality? A technicality analysis model for EAP vocabulary. *Journal of English for Academic Purposes*, 28, 35-49. <https://doi.org/10.1016/j.jeap.2017.06.003>
- heart. (n.d.). In *Merriam-Webster.com*. Retrieved August 27, 2017, from <https://www.merriam-webster.com/dictionary/heart>
- Hirvela, A. (1997). Disciplinary portfolios and EAP writing Instruction. *English for Specific Purposes*, 16(2), 83-100.
- Holliday, A. (2010). Analyzing qualitative data. In B. Paltridge & A. Phakiti (Eds.), *Continuum companion to research methods in applied linguistics* (pp. 98-110). Continuum.
- Hsu, W. H. (2013). Bridging the vocabulary gap for EFL medical undergraduates: The establishment of a medical word list. *Language Teaching Research*, 17(4), 454-484. <https://doi.org/10.1177/1362168813494121>
- Hsu, W. (2018). The most frequent BNC/COCA mid- and low-frequency word families in English-medium traditional Chinese medicine (TCM) textbooks. *English for Specific Purposes*, 51, 98-110. <https://doi.org/10.1016/j.esp.2018.04.001>
- Kövecses, Z. (2005). *Metaphor in culture: Universality and variation*. Cambridge University Press. <https://doi.org/10.1017/CBO9780511614408>
- Lei, L., & Liu, D. L. (2016). A new medical academic word list: A corpus-based study with enhanced methodology. *Journal of English for Academic Purposes*, 22, 42-53. <https://doi.org/10.1016/j.jeap.2016.01.008>
- Littlemore, J. (2001). The use of metaphor in university lectures and the problems that it causes for overseas students. *Teaching in Higher Education*, 6(3), 333-351.
- Littlemore, J., Chen, P., Tang, P. L., Koester, A., & Barnden, J. (2010). The use of metaphor and metonymy in academic and professional discourse and their challenges for learners and teachers of English. In S. D. Knop, F. Boers, & A. De Rycker (Eds.), *Fostering language teaching efficiency through cognitive linguistics* (pp. 189-211). Mouton de Gruyter.
- Littlemore, J., & Low, G. (2006). Metaphoric competence, second language learning, and communicative language ability. *Applied Linguistics*, 27(2), 268-294.
- Low, G., Littlemore, J., & Koester, A. (2008). Metaphor use in three UK university lectures. *Applied Linguistics*, 29(3), 428-455. <https://doi.org/10.1093/app lin/amn008>
- Lu, C. (2018). *Investigating knowledge and use of technical vocabulary in Traditional Chinese Medicine* [Unpublished doctoral thesis]. Victoria University of Wellington.
- Lu, C., & Coxhead, A. (2020). Vocabulary in Traditional Chinese Medicine: Insights from corpora. *ILT-International Journal of Applied Linguistics*, 171(1), 34-61.
- Maciocia, G. (2005). *The foundations of Chinese medicine: A comprehensive text for acupuncturists and herbalists* (2nd ed.). Elsevier Churchill Livingstone.
- Martínez, R. (2013). A framework for the inclusion of multi-word expressions in ELT. *ELT Journal*, 67(2), 184-198.

- Martinez, R., & Schmitt, N. (2012). A phrasal expressions list. *Applied Linguistics*, 33(3), 299-320. <https://doi.org/10.1093/applin/ams010>
- Ministry of Education of the People's Republic of China, (2020). *A reply letter to proposal No. 3418 (No. 358 for education) on the third session of the 13th National Committee of the Chinese People's Political Consultative Conference*. http://www.moe.gov.cn/jyb_xxgk/xxgk_jyta/jyta_gaojiaosi/202101/t20210125_511017.html.
- Morris, E., Bransford, J. D., & Franks, J. J. (1977). Levels of processing versus transfer appropriate processing. *Journal of Verbal Learning and Verbal behavior*, 16, 519-533.
- Nation, P. (2007). The four strands. *Innovation in Language Learning and Teaching*, 1(1), 1-12.
- Nation, P. (2012). *The BNC/COCA word family lists*. <http://www.victoria.ac.nz/lals/about/staff/paul-nation>
- Nation, P. (2013). *Learning vocabulary in another language* (2nd ed.). Cambridge University Press.
- Nation, P. (2016). *Making and using word lists for language learning and testing*. John Benjamins Publishing Company.
- Partington, A. (1998). *Patterns and meaning: Using corpora for English language research and teaching*. John Benjamins Publishing Company.
- Qian, D. D. (1999). Assessing the roles of depth and breadth of vocabulary knowledge in reading comprehension. *Canadian Modern Language Review*, 56, 282-308.
- Qian, D. D., & Schedl, M. (2004). Evaluating an in-depth vocabulary knowledge measure for assessing reading performance. *Language Testing*, 21, 28-52.
- Quero, B. (2015). *Estimating the vocabulary size of L1 Spanish ESP learners and the vocabulary load of medical textbooks* [A thesis submitted to Victoria University of Wellington in fulfilment of the requirements for the degree of Doctor of Philosophy in Applied Linguistics]. Victoria University.
- Read, J. (1993). The development of a new measure of L2 vocabulary knowledge. *Language Testing*, 10, 355-371.
- Read, J. (1998). Validating a test to measure depth of vocabulary knowledge. In A. Kunnan (Ed.), *Validation in language assessment* (pp. 41-60). Lawrence Erlbaum.
- Read, J. (2012). Piloting vocabulary tests. In G. Fulcher & F. Davidson (Eds.), *The Routledge handbook of language testing* (pp. 307-320). Routledge.
- Schmitt, N. (2000). *Vocabulary in language learning*. Cambridge University Press.
- Schmitt, N., Ng, J. W. C., & Garras, J. (2011). The word associates format: Validation evidence. *Language Testing*, 28(1), 105-126. <https://doi.org/10.1177/0265532210373605>

- Schmitt, N., & Schmitt, D. (2014). A reassessment of frequency and vocabulary size in L2 vocabulary teaching. *Language Teaching*, 47(04), 484-503.
- Valipouri, L., & Nassaji, H. (2013). A corpus-based study of academic vocabulary in chemistry research articles. *Journal of English for Academic Purposes*, 12(4), 248-263. <https://doi.org/10.1016/j.jeap.2013.07.001>
- Wang, J., Liang, S. L., & Ge, G. C. (2008). Establishment of a medical academic word list. *English for Specific Purposes*, 27(4), 442-458. <https://doi.org/10.1016/j.esp.2008.05.003>
- Ward, J. (2009). A basic engineering English word list for less proficient foundation engineering undergraduates. *English for Specific Purposes*, 28(3), 170-182.
- Watson Todd, R. (2017). An opaque engineering word list: Which words should a teacher focus on? *English for Specific Purposes*, 45, 31-39. <https://doi.org/10.1016/j.esp.2016.08.003>
- Woodward-Kron, R. (2008). More than just jargon – the nature and role of specialist language in learning disciplinary knowledge. *Journal of English for Academic Purposes*, 7(4), 234-249.
- Yang, M.-N. (2015). A nursing academic word list. *English for Specific Purposes*, 37, 27-38.
- Yu, N. (2003). Metaphor, body, and culture: The Chinese understanding of gallbladder and courage. *Metaphor and Symbol*, 18(1), 13-31.

APPENDIX A

Word association task

This task contains 20 target words. Each target word (in bold) has eight (8) options. Please choose four words of the eight options which you think are most closely associated to the following words in the context of Traditional Chinese Medicine (TCM). Put a tick (✓) in the box for each option you choose. Here is an example:

joint

- A. qi
- B. tendon
- C. skeleton
- D. blood
- E. pain
- F. heart
- G. shoulder
- H. hepatitis

You might answer the task like this:

joint

- A. qi ✓
- B. tendon
- C. skeleton ✓
- D. blood
- E. pain ✓
- F. heart
- G. shoulder
- H. hepatitis

Think aloud:⁵ As you make your choices, I would like you to talk about your choices and why you chose (or did not choose) each one.

- | | | |
|---|---|--|
| 1. mind | <input type="checkbox"/> H. feelings | <input type="checkbox"/> F. abdomen |
| <input type="checkbox"/> A. essence | | <input type="checkbox"/> G. cause |
| <input type="checkbox"/> B. qi | 2. root | <input type="checkbox"/> H. strengthen |
| <input type="checkbox"/> C. consciousness | <input type="checkbox"/> A. herb | |
| <input type="checkbox"/> D. heart | <input type="checkbox"/> B. chronic | 3. spleen |
| <input type="checkbox"/> E. insomnia | <input type="checkbox"/> C. acute | <input type="checkbox"/> A. lung |
| <input type="checkbox"/> F. calm | <input type="checkbox"/> D. manifestation | <input type="checkbox"/> B. digestion |
| <input type="checkbox"/> G. hiccup | <input type="checkbox"/> E. treat | <input type="checkbox"/> C. stomach |

⁵ We used this term in the instruction to encourage the participants to elaborate on why they selected or did not select certain associates as soon as they made the choice, but they actually told us their rationales after they finished each item, which is a retrospective technique.

- D. blood
- E. saliva
- F. tongue
- G. deficiency
- H. eyes

4. channel

- A. organ
- B. penicillin
- C. acupoint
- D. collaterals
- E. connecting
- F. liver
- G. oedema
- H. stomach

5. skin

- A. wheezing
- B. tinnitus
- C. tissue
- D. outer layer
- E. dry
- F. disease
- G. surface
- H. muscle

6. qi

- A. spleen
- B. yang
- C. vision
- D. blood
- E. defensive
- F. movement
- G. zong
- H. stagnant

7. throat

- A. mouth
- B. neck
- C. nasopharynx
- D. kidney channel
- E. dry
- F. menopause
- G. sore
- H. backache

8. acupuncture

- A. needle
- B. alternative therapy
- C. acupressure
- D. moxibustion
- E. treatment
- F. auricular
- G. points
- H. stimulation

9. blood

- A. fluid
- B. yin
- C. heart
- D. leukaemia
- E. gallbladder
- F. red
- G. cool
- H. liver

10. knee

- A. leg
- B. joint
- C. respiration
- D. bend
- E. injury
- F. ear
- G. soreness
- H. pain

11. disharmony

- A. argument
- B. disease
- C. imbalance
- D. wind
- E. vessel
- F. internal
- G. pattern
- H. liver

12. cancer

- A. tumour
- B. toothache
- C. malignant
- D. stroke
- E. lung

- F. colorectal
- G. gastric
- H. chemotherapy

13. protein

- A. nutrient
- B. egg
- C. glucose
- D. enzyme
- E. urine
- F. expression
- G. antibody
- H. therapy

14. urine

- A. waste
- B. stool
- C. kidney
- D. bladder
- E. yellow
- F. spasm
- G. cloudy
- H. turbid

15. cold

- A. fever
- B. heat
- C. yin
- D. pathogenic factor
- E. wind
- F. herbs
- G. intestine
- H. limbs

16. diarrhoea

- A. spleen
- B. heart
- C. borborygmus
- D. stool
- E. dampness
- F. ceaseless
- G. dizziness
- H. chronic

17. phlegm

- A. throat
- B. mucus

- C. damp
- D. cough
- E. wind
- F. turbid
- G. heat
- H. hepatitis

18. lumbar

- A. cervical
- B. vertebrae
- C. diabetes
- D. back

- E. soreness
- F. pain
- G. spine
- H. region

19. tonify

- A. deficiency
- B. harmony
- C. nourish
- D. expel
- E. bladder
- F. spleen

- G. qi
- H. kidney

20. tang

- A. pungent odour
- B. bitter
- C. decoction
- D. herbs
- E. organ
- F. water
- G. chest
- H. chengqi

Answer Key

1. ABCDEFH
2. ABDEGH
3. ABCDEFG
4. ACDEFH
5. CDEFGH
6. ABDEFGH
7. ABCDEG
8. ABCEFGH
9. ABCDFGH
10. ABDEGH
11. BCDFGH
12. ACEFGH
13. ABDEFG
14. ABCDEGH
15. ABCDEFH
16. ACDEFH
17. ABCDEFG
18. BDEFGH
19. ACDFGH
20. ABCDFH

APPENDIX B

The first 100 items of the TCM technical word list (adapted from Lu, 2018)

Note. The word types were arranged by their number of occurrences in the TCM Corpora. The concordance lines of word types falling into a single lemma (e.g., *point*, *points*) were checked to see if they had similar meanings and patterns of use in the TCM Corpora. If so, they were combined into a single entry in the word list as *point(s)*.

1. qi	26. pulse(s)	51. vessel(s)	76. pathogenic
2. blood	27. channel(s)	52. fluid(s)	77. pi
3. treatment	28. decoction(s)	53. fu	78. jiao
4. heat	29. low(er)	54. water	79. severe
5. yin	30. damp	55. herbal	80. excess
6. pain	31. lung(s)	56. trail(s)	81. tonify(ies/ing)
7. liver	32. formula(s/e)	57. mind	82. exterior
8. yang	33 effect(s)	58. red	83. mu
9. deficiency(ies)	34. disease(s)	59. function(s)	84. urine
10. acupuncture	35. zi	60. western	85. therapy/therapies
11. patient(s)	36. dampness	61. stasis	86. medical
12. radix	37. fire	62. fructus	87. ling
13. kidney(s)	38. herb(s)	63. dry	88. manifestation(s)
14. spleen	39. syndrome(s)	64. skin	89. flow
15. heart	40. tang	65. condition(s)	90. obstruction(s)
16. cold	41. pattern(s)	66. cause(s/d/ing)	91. coating
17. medicine(s)	42. control(led/s)	67. level(s)	92. health
18. point(s)	43. shen	68. treat(ed/ing/s)	93. painful
19. symptom(s)	44. zhi	69. cao	94. intestine(s)
20. phlegm	45. rhizoma	70. abdominal	95. prescription(s)
21. body	46. case(s)	71. organ(s)	96. system(s)
22. wind	47. chronic	72. bladder	97. internal
23. tongue	48. stagnation	73. cell(s)	98. deficient
24. stomach	49. chest	74. feeling	99. food(s)
25. clinical	50. clear(s/ing)	75. factor(s)	100. essence(s)

APPENDIX C

Categories of word association responses (adapted from Fitzpatrick, 2006, p. 131)

Category	Subcategory (x = cue word, y = response word)	Definition (x = cue word, y = response word)
Meaning-based association	Defining synonym	x means the same as y
	Specific synonym	x can mean y in some specific contexts
	Hierarchical/lexical set relationship	x and y are in the same lexical set or are coordinates or have a metonymous or superordinate relationship
	Quality association	y is a quality of x or x is a quality of y
	Context association	y gives a conceptual context for x
Position-based association	Conceptual association	x and y have some other contextual link
	Consecutive xy/yx collocation	x collocates with y, or y collocates with x
	Phrasal xy/yx collocation	y follows x in a phrase, or x follows y in a phrase