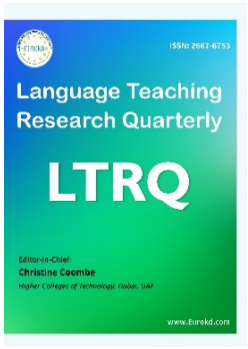

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Impact of Disciplinary Variations on Second Language Mental Lexicon

Yuxin Chen*, Yaqiong Wang

Department of International Chinese Language Education, Yunan University, Kunming, China

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Abstract

This study investigates how academic disciplines impact second language (L2) lexical competencies. Prior L2 research has often overlooked the broader effects of disciplinary backgrounds on lexical development. To address this gap, this study utilized lexical decision, memory, and semantic fluency tasks to examine lexicon recognition, memory, and storage processes among L2 Chinese learners from various academic fields. The study participants comprised 16 students from the Humanities and Social Sciences (HSS) disciplines and 11 from the Science and Engineering (S&E) disciplines, all having passed HSK level 4. The tasks were conducted using E-Prime 2.0. The findings revealed distinct cognitive strategies and thinking patterns among the participants from different disciplines . These strategies and patterns affected lexical task performance in terms of accuracy and response times. Although lexical memory exhibited no significant variation among the groups, discipline-specific tendencies were observed in the formation of semantic networks. Learners from S&E disciplines preferred mastering field-relevant Chinese terminology, whereas HSS learners tended to acquire words outside their specific disciplines. This observation highlights how learners' disciplinary backgrounds influence their vocabulary acquisition and the organization of semantic networks in L2.

Keywords: *Mental Lexicon, Disciplinary, Lexical Abilities, Lexical Decision, Semantic Networks*

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Introduction

Lexicon, integral to language mastery (Allen & Valette, 1972; Gui, 2000; Zimmerman, 1997), is closely linked to brain activity and cognition, and "mental lexicon" has emerged as a topic of extensive research. Factors affecting the mental lexicon include linguistic materials (Hino et al., 2010; Oganian et al., 2016; Vitevitch & Goldstein, 2014), individual characteristics

* Corresponding author.
E-mail address: 12022225027@mail.ynu.edu.cn https://doi.org/10.32038/ltrq.2024.45.01

(Cosgrove et al., 2021; Lichtman, 2016; Ma & Vanek, 2024), and environmental context, and other aspects (Laufer & Paribakht, 1998; Ma & Vanek, 2024). With regard to individual characteristics, aspects such as working memory (Baddeley, 2000; Ellis, 2012; Playfoot et al., 2018), age (Cremer et al., 2011; Ervin, 1961; Lichtman, 2016), and language proficiency (Gao et al., 2022; Zareva, 2007) have often been considered in experimental studies. In the neurological domain, it is established that the entire brain is involved in language processing, implying that complex linguistic functions are not localized to specific areas but span across a network (Petersen & Fiez, 1993; Price, 2012). Furthermore, specific academic disciplines are known to exert a profound influence on the brain structure (Erickson et al., 2011; Hyde et al., 2009; Korenar et al., 2023; Smith et al., 2023; Young et al., 2012). However, further study in this domain from a psycholinguistic perspective is essential. By the end of 2024, a considerable number of second language (L2) Chinese learners across various disciplinary backgrounds will have acquired the language, highlighting the need for comprehensive investigations. Therefore, this study explores, from a psycholinguistic standpoint, whether variations in brain neurology influenced by disciplinary backgrounds impact L2 learners' language performance and differentiate their mental lexicons.

During the preliminary testing phase, a brief assessment involved 20 Chinese native speakers from the Humanities and Social Sciences (HSS) and Natural Sciences and Engineering (S&E) disciplines, revealing distinct associative responses to the word "集合." Among native speakers from HSS background, the top three associative responses with "集合" were "操场, 做操, and 数学," whereas those from the S&E background native speakers predominantly associated the word with "包含, 子集, and 交集." HSS native speakers tended to use "集合" to describe the gathering of scattered people or things, while S&E native speakers leaned toward the mathematical definition of "集合" as a collection of items sharing common properties. Given the observed semantic disparities in associative responses to the term "集合" across different academic disciplines, this study explores the distinct processes involved in mental lexicon formation among L2 Chinese learners from HSS and S&E backgrounds. Moreover, it examines aspects such as lexical extraction, storage, and the organization of semantic networks within learners' minds. The investigation is structured around three central questions:

RQ_1: How does academic background influence the efficiency of L2 word identification?

RQ_2: Does disciplinary background impact the ability to remember and retrieve Chinese lexicon?

RQ_3: How does disciplinary background shape the structure and connectivity of linguistic representations in the L2 Chinese lexicon?

Literature Review

Definition of Mental Lexicon

The conceptualization of mental lexicon draws from Treisman's (1964)attenuation model, which suggests that a brain is lexicon composed of entries with distinct activation thresholds (Yang et al., 2001). Carroll (2000) viewed mental lexicon as a mental repository of words, encompassing semantic, phonological, and syntactic information. Zhang (2009) defined mental lexicon as the brain's repository for long-term and permanent storage of lexical knowledge.

The author emphasized the crucial role of mental lexicon in language comprehension and production. Aitchison (2012) metaphorically described mental lexicon as a network of interconnected stations. Friederici and Wartenburger (2010) emphasized the involvement of specific brain regions in lexical management. This intricate system facilitates the storage, comprehension, and usage of lexicons, thereby significantly influencing language acquisition (Carroll, 2000; Gui, 2000; Levow et al., 2005; Singleton, 1999; Zhang, 2009). Central to the mental lexicon is the bilingual mental lexicon, which explains how lexicons are stored for bilingual speakers and how the native lexicon influences the formation and retrieval of bilingual lexicon. This inquiry focuses on understanding how bilinguals manage two linguistic systems within their cognitive framework and the interactions between these systems (Yin, 2015).

Influences on Language Performance

Learners and discipline

The extraction and organization of the lexicon are influenced by individual differences. According to Perri et al. (2014), individuals' perception and decision-making strategies vary, affecting their accuracy and reaction times. Lockiewicz and Jaskulska (2015) highlighted a significant correlation between working memory capacity and the speed of accessing mental lexicon, which influences lexicon acquisition. Wulff et al. (2016) noted age-related differences in the mental lexicon, highlighting that older adults possess a broader potential lexicon but experience cognitive decline. Neurologically, Zull (2004) suggested that learning reshapes the brain's neural connections. Young et al. (2012) and Smith et al. (2023) demonstrated that domain-specific education impacts brain structure and functionality, affecting tasks such as emotional regulation in math-anxious children and conceptual reasoning in physics students. This interdisciplinary investigation emphasizes the dynamic interplay among cognitive, linguistic, and neurological processes in lexicon development. The intricate relation between discipline-specific studies and the development of the mental lexicon has often been overlooked in favor of focusing on cognitive and learning impacts within English majors. This trend is reflected in the works of Zhang (2010) and Wang and Sui (2015), who primarily compared English majors with native speakers (Li & Ni, 2023; Pranoto & Afrilita, 2019). Feng and Liu (2023a) investigated lexical–semantic networks among 49 engineering undergraduates. Yin (2013) included students from diverse fields such as Literature and Mathematics. However, the small sample size across disciplines limited the ability to identify distinct patterns, as these studies did not primarily focus on disciplinary factors. This gap in psycholinguistic research underscores the need for more comprehensive studies on how academic majors influence mental lexicon development. Zhang (2011) offered evidence for the effect of disciplinary factors by examining logistics students' responses to specialized lexicon, indicating a closer alignment with native speakers. However, focusing solely on logistics lexicon highlights the need for further research to determine if learners from various disciplines exhibit distinct reactions to both domain-specific and everyday lexicon, suggesting a promising area for future investigation.

Word-internal characteristics

Coltheart et al. (2001) introduced the Dual Route Cascaded (DRC) Model, which describes two pathways for reading and lexical recognition: the lexical route allows for the direct recognition of familiar words through an activated brain network. The nonlexical or phonological route is used for decoding unfamiliar words or those with irregular spelling. Although this model has been developed for alphabetic writing systems so far, it offers insight into L2 Chinese learners' lexicon recognition. It tells us how the lexical features and familiarity are influencing the development of mental lexicon and their organization. Coltheart et al. (2001) demonstrated that the factors of lexicality effects, word frequency, and stroke count of Chinese characters play a major role in learner mental lexicons. This model provides a framework for the specification of how these components influence L2 Chinese learners in developing the mental lexicon. It basically highlights dual processing for lexical recognition, both for a familiar and an unfamiliar or irregularly spelled word.

The lexicality effect—that is, better recognition of the words over nonwords—was first described by Rubenstein (1970) and later confirmed by Whiting et al. (2015), Sebastian-Gallés et al. (2006), Brenders (2012), and Chen et al. (2018). This effect agrees with the claim of the DRC model that meaningful words, rich in meaning and embedded in the mental lexicon, guarantee fast acquisition and recognition. However, the word frequency effect supports the faster identification of a high-frequency word since it has wider use in the mental lexicon of Chinese learners (Fang & Zhang, 2021; Strijkers et al., 2013; Zhang & Wang, 2014). The stroke number effect is still heatedly debated and yet a threshold that requires further study to confirm if it has effects on the processes for character recognition among Chinese learners (Zhou & Jiang, 2023). Based on the DRC model, characters that are simple would easily match this entry in the mental lexicons through visual recognition. On the contrary, complex characters that require distinguishing by their structure through both lexical and non-lexical routes are more problematic in recognition.

Disciplinary differences in language acquisition

The effect of "disciplinary differences" has been widely examined within the context of academic English. For instance, in the 1980s, Becher conducted ethnographic research on scholars of different disciplines to show how disciplinary differences shape the nature of academic discourse. Hyland (2008) explored the disciplinary variation of lexical bundles and found sharp differences between humanities and science learners in their choice of words. That is to say, in the sciences, there is more emphasis on the conveyance of processes of research and experimental data, and lexical bundles serve to express objectivity and methodological transparency. In contrast, in a humanities type of discipline, language is more relied upon in structuring arguments and interpreting complex social and human phenomena; lexical bundles are playing a vital role in making arguments and taking readers along a winding path of reasoning.

As far as spoken discourse is concerned, Zappa-Hollman (2007) and Morita (2000) explored discipline-specific norms and characteristics of oral presentations in applied linguistics, neuroscience, history, and engineering. In relation to Chinese acquisition, scholars have worked to develop specialized Chinese word lists for various disciplines, including medicine, law, and economics (Wang & Wang, 2022; Liu & Li, 2022; Xu, 2023). This

highlights the differences in vocabulary exposure among second language (L2) learners from different academic fields. For Chinese L2 learners in the sciences and humanities, their exposure to vocabulary varies depending on their respective fields of study such as sciences and humanities.

Vocabulary exposure frequency refers to the number of times and the rate at which language users encounter specific words in their daily language input. A wealth of research indicates that exposure frequency has a significant impact on vocabulary acquisition. Nation (2001) pointed out that repeated exposure to vocabulary is crucial for memory retention, as frequent repetition strengthens memory traces. According to Ellis (2002), vocabulary exposure frequency plays a vital role in consolidating vocabulary knowledge, enabling learners to recognize and produce words more quickly and accurately. Ellis also emphasized the importance of distinguishing between token frequency (how often a word appears) and type frequency (the diversity of word forms) asserting that both types of frequency significantly influence vocabulary acquisition and the organization of semantic networks. This is particularly evident when learners in certain disciplines frequently encounter specific terms, which enable them to remember and integrate these high-frequency words easier to remember and integrate into their cognitive systems.

For example, “Learners in different academic fields are more likely to encounter specific terms, and these high-frequency words, due to their repeated occurrence in professional studies, are easier to remember, thereby influencing the storage of vocabulary and the organization of semantic networks.” Current research often focuses on the professional materials accessible to learners in different disciplines, yet there is a need for further exploration of how L2 learners store and process vocabulary in the brain. Understanding how learners organize and store vocabulary can help educators design more effective teaching methods. From the perspective of the mental lexicon, the findings of this study can provide robust theoretical support for language instruction across disciplines, thereby enhancing both teaching efficiency and learning outcomes.

Methodology

Participants

This study included the range of disciplines within S&E among intermediate-level foreign students. It involved 16 students from HSS, studying fields such as International Economics and Trade, Chinese International Education, and Journalism, among others. Additionally, 11 students from S&E disciplines, such as Civil Engineering, Computer Science and Technology, and Electrical Engineering and Automation, participated (14 males and 14 females) with a median age of 22 years (SD = 17.83). All participants had passed HSK Level 4, making them eligible to provide valuable insights into the influence of academic disciplines on language acquisition and the development of the mental lexicon. The experiment was conducted in a quiet, well-lit room, with all participants seated comfortably in front of a computer. Only right-handed participants were included in the study, as determined by a handedness questionnaire.

Materials and Procedures

The study comprised three experiments: Experiment 1 - Lexical Decision Task, Experiment 2 - Lexical Memory Task, and Experiment 3 - Semantic Fluency Tasks.

Initially, word association tasks, as explored by Zhang (2009), where participants respond with the first word triggered by a stimulus, provided foundational insights (Kolers, 1963; Meara, 1983; Zareva & Wolter, 2012). Semantic fluency tasks further evaluated lexical retrieval within thematic constraints (Feng & Liu, 2023b; Llach, 2023). The accuracy of semantic priming assignments uncovered enhancements in processing through the interplay of prime-target stimuli (De Groot & Nas, 1991; Dong et al., 2005), which plays a crucial role in resolving the complexity of lexical acquisition and network activation. The lexical decision task and lexical priming task both belong to experiments with strictly controlled reaction times, primarily used to differentiate between words and non-words in order to assess learners' lexical recognition ability, thereby enhancing the precision of the experiment and the reliability of the data. Additional tasks included lexical memory tasks, translation (Potter et al., 1984), and verb generation tasks (Klein et al., 1995). Psycholinguistic methodology was employed to investigate real versus false word recognition, lexical memory tasks, and semantic fluency tasks. The aim was to explore the semantic networks of mental lexicon among L2 Chinese learners across various academic disciplines. Through such tasks, the experiment has been rendered precise and allowed insight into psychological semantic networks. It was done to find the differences in how mental lexicon manifests itself outside itself across different disciplinary domains.

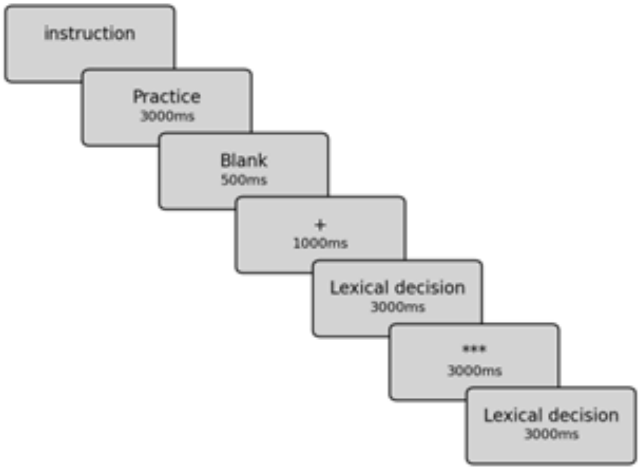
Experiment 1: Lexical Decision Task

This lexical decision task was developed using E-prime, with 44 real words whose stroke counts ranged from 10 to 24, split evenly into the high and medium-low-frequency categories based on both Chinese lexicon and proficiency criteria. There are also 45 nonwords, generated character-wise within the HSK levels 1–5, according to stroke count, for recognition tests. This structured design allows an examination into the interrelated complex relation between word frequency and lexical processing in L2 Chinese learners by emphasizing two important prime factors in accessing the lexical information, which are lexicality effect, frequency, and stroke number.

The experimental arrangement included instruction and trial phases that allowed the participants to familiarize and acclimate to the experimental conditions. Each word appeared for 3000 ms. The critical experimental phase was a sequence of the following: a blank screen (500 ms), a fixation point “+” (1000 ms); and a farther on-the-screen presentation of a vocabulary item for 3000 ms. Subjects responded by pressing the "f" key for "no" and the "j" key for "yes." Afterwards, the data from the experiment were analyzed with the help of SPSS software.

Figure 1

Flowchart of the Lexical Decision Task



Accuracy (ACC) and response time (RT) were compared in SPSS between L2 speakers from different academic disciplines using the Mann-Whitney U test, based on discipline, lexicality effect, and word frequency. The stroke effect is a categorical variable excluding non-responses, which was analyzed using the Kruskal-Wallis test. The real words were further divided into high- and medium-low-frequency categories, since nonwords do not naturally occur in real-life situations, in order to compare the effect of word frequency on lexical decision. This methodological approach highlights the subtle influence of frequency and lexical characteristics on linguistic processing across diverse disciplines.

Table 1 indicates significant differences in accuracy between Chinese learners from S&E and HSS, with S&E learners exhibiting higher correctness. RTs also differed between the groups, with S&E L2 learners between the groups. The analysis confirmed the lexicality effect, as real words had higher ACC and shorter RTs than nonwords. High-frequency words demonstrated higher ACC and faster recognition, consistent with the DRC model's predictions on the impact of lexical factors on recognition. The effects of stroke count on ACC and RT were not significant.

Table 1

Academic Discipline, Lexicality Effect, and Word Frequency Analysis

		ACC					RT				
		U	Z	MIDDLE	MEAN	*P*	U	Z	MIDDLE	MEAN	*P*
AD	S&E	3129.5	-2.2	0.73	0.68	0.03	3261	-1.81	1319	1338	0.07
	HSS	3129.5	-2.2	0.63	0.61	0.03	3261	-1.81	1263.5	1272	0.07
LE	RW	1501.5	-7.03	0.75	0.75	0	1555.5	-6.85	1172.5	1193	0
	NW	1501.5	-7.03	0.55	0.54	0	1555.5	-6.85	1396.5	1417	0
WF	HF	361	-4.79	0.82	0.83	0	924.5	-0.36	1118	1141	0.72
	LMF	361	-4.79	0.64	0.63	0	924.5	-0.36	1255	1275	0
Stroke				0.75	0.65	0.3			1173	1305	0.92

Note: AD = academic discipline, LE = lexicality effect, S&E = Natural Science and Engineering, HSS = Humanities and Social Sciences, WF = word frequency, RW = real words, NW = nonwords, HF = high frequency, LMF = low and medium frequency. $p < 0.05$ $p < 0.01$

Figure 2

Lexical Decision of L2 Chinese Learners in HSS and S&E ACC, RT Boxplots

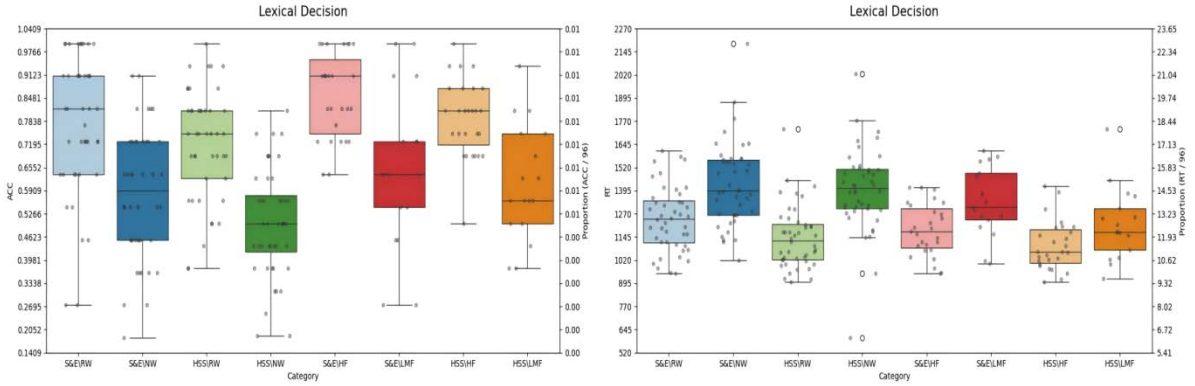


Table 2 indicates significant variances in RTs for true word recognition between S&E and HSS L2 Chinese learners, with S&E learners being slower. Although ACC rates between the groups did not significantly differ, S&E L2 Chinese learners exhibited slightly higher ACC. In false word recognition, S&E L2 Chinese learners exhibited notably higher ACC than their HSS counterparts, with differences in RTs between them being lower. High-frequency words were recognized more accurately by S&E L2 Chinese learners, albeit with slower RTs. For low- and medium-frequency words, ACC differences were negligible, though S&E bilinguals exhibited slower RTs.

Table 2

Lexicality Effect and Word Frequency Analysis

		ACC					RT				
		U	Z	MIDDLE	MEAN	*P*	U	Z	MIDDLE	MEAN	*P*
RW	S&E	750.5	-1.82	0.82	0.78	0.07	635	-2.78	1240.5	1243	0.005
	HSS	750.5	-1.82	0.75	0.72	0.07	635	-2.78	1126.5	1143	0.005
NW	S&E	720	-2.08	0.6	0.58	0.04	924.5	-0.36	1395.5	1243	0.72
	HSS	720	-2.08	0.5	0.5	0.04	924.5	-0.36	1409	1143	0.72
HF	S&E	238.5	-2.19	0.91	0.86	0.03	234.5	-2.25	1176	1098	0.002
	HSS	238.5	-2.19	0.81	0.79	0.03	234.5	-2.25	1064	1184	0.002
LMF	S&E	127	-0.6	0.64	0.65	0.57	88	-1.95	1307	1336	0.052
	HSS	127	-0.6	0.56	0.61	0.57	88	-1.95	1172	1214	0.052

Note: AD = academic discipline, LE = lexicality effect, S&E = Natural Science and Engineering, HSS = Humanities and Social Sciences, WF = word frequency, RW = real words, NW = nonwords, HF = high frequency, LMF = low and medium frequency. $p < 0.05$ $p < 0.01$

Experiment 2: Lexical Memory Task

The experiment utilized E-prime software and included 20 interference words. Of the 10 memory words selected from the "Mathematical Chinese Thematic Vocabulary List," 5 were categorized as high frequency and 5 as medium-low frequency based on the "Modern Chinese Frequency Dictionary." This categorization followed established linguistic research methodologies for studying the mental lexicon and its influence on memory processes in language learning.

The lexical memory task unfolded in three stages, starting with a practice phase to help learners familiarize themselves with the procedure. In the pre-experimental phase, each target word was displayed for 3000 ms to facilitate memorization. This phase was followed by a formal experimental phase, featuring a sequence of a blank screen (500 ms), a fixation point "+" (1000 ms), and the presentation of a word (3000 ms). The participants responded using the "f" key for "no" and the "j" key for "yes" in the test of their recall abilities, aiming to identify the 10 target words from the 30 words presented to them.

Figure 3

Flowchart of Lexical Memory Task

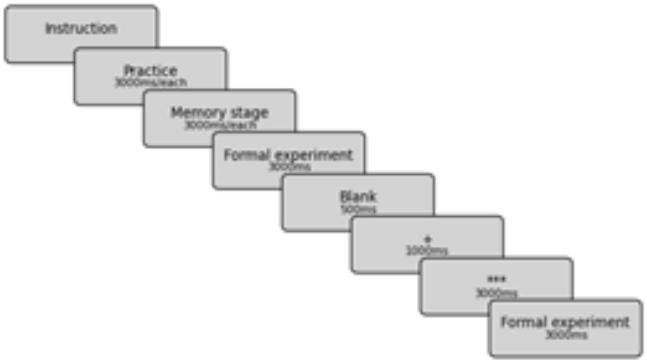


Table 3 indicates negligible differences in the ability of L2 Chinese learners from S&E and HSS disciplines to memorize lexicon. Similarly, the impact of word frequency on recall proficiency appeared minimal, implying that factors beyond discipline and frequency could play a critical role in lexical memory among these learners.

Table 3

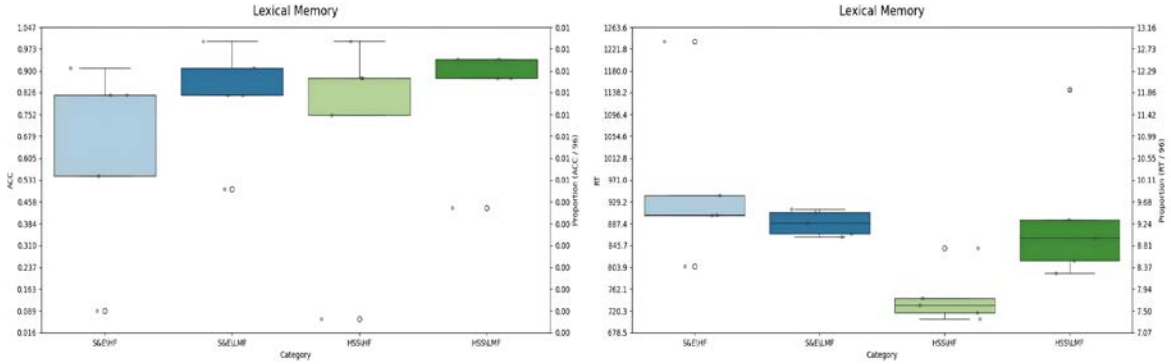
Lexicon Memorization Task Analysis

		ACC					RT				
		U	Z	MIDDLE	MEAN	P	U	Z	MIDDLE	MEAN	P
AD	S&E	369	-0.81	0.82	0.81	0.42	412.5	-0.12	954	992	0.9
	HSS	369	-0.81	0.88	0.79	0.42	412.5	-0.12	956	994	0.9
WF	HF	36	-1.07	0.82	0.68	0.29	36	-1.06	823.5	853	0.29
	LMF	36	-1.07	0.88	0.8	0.29	36	-1.06	878	895	0.29

Note: AD=academic discipline, LE=lexicality effect, S&E=Natural science and engineering, HSS=Humanities and Social Sciences, WF=word frequency, RW=real words, NW=non-words, HF=high frequency, LMF=low and medium-frequency. $p<0.05$ $p<0.01$

Figure 4

Lexical Memory of L2 Chinese Learners in HSS and S&E ACC, RT Boxplots



Experiment 3: Semantic Fluency Task

A semantic fluency task using the category “**学科**” (discipline) was employed to examine the influence of HSS and S&E majors on the semantic networks of L2 Chinese learners. The responses were recorded and analyzed using Ucinet software, which facilitated the visualization and comparison of semantic networks. Following the methodology of Feng and Liu (2023b), this study employed parameters such as network size, density, diameter, average distance, degree centralization, small-worldness, module degree, and module degree of random network to assess how disciplinary background impacts the organization of lexical–semantic networks.

Figures 5 and 6 depict the lexico-semantic networks for “**学科**” among S&E and HSS L2 students, respectively, indicating discipline-specific associations. Node size denotes word centrality within the network, indicating the frequency of associations. Line thickness signifies the strength of semantic connections. The figures reveal distinct lexico-semantic networks among international S&E and HSS students regarding “**学科**.” S&E students, particularly those pursuing Civil engineering, associated it with terms like “**土木工程**, **混凝土**, **建筑**, and **水泥**,” while Computer Science and Technology students associated it with “python, **开**发, **硬件**, and 软工程.” Similarly, Management Science and Engineering students linked it to “战略管理, **市**场营销, and **旅游管理**.” These associations demonstrate how disciplinary background affects the structure of mental lexicon, reflecting the unique perspectives of S&E and HSS students.

Figure 5

Semantic Network of "学科"(Discipline) for International Students of S&E

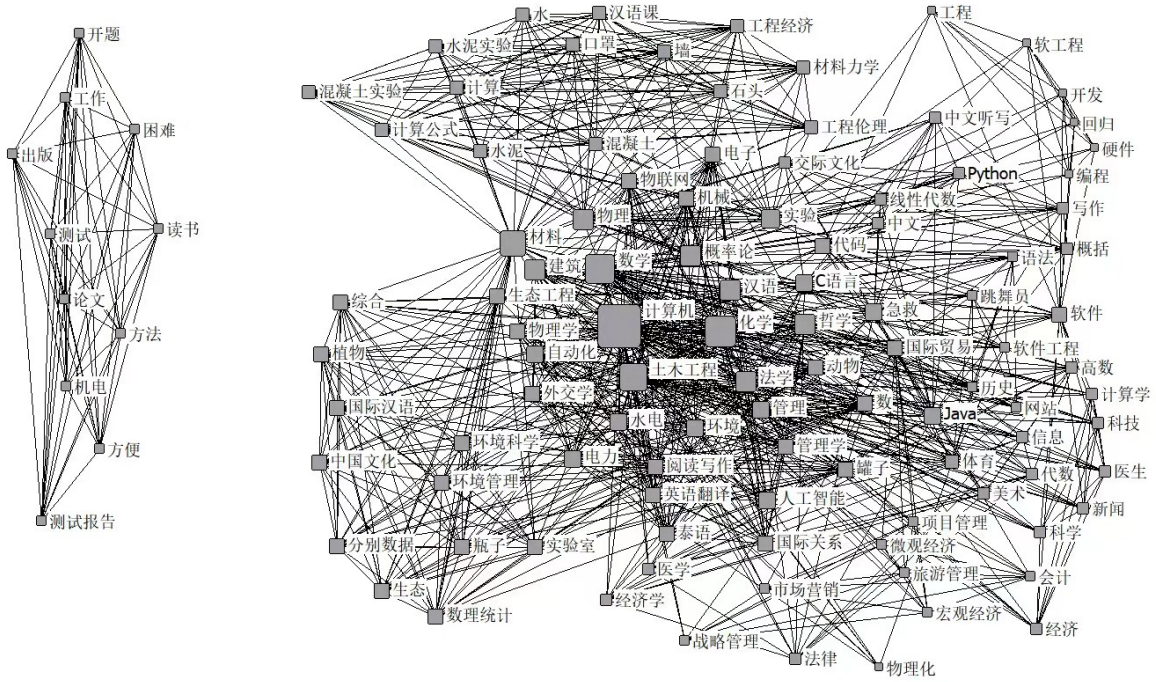


Figure 6

Semantic Network of "学科" (Discipline) for International Students of HSS

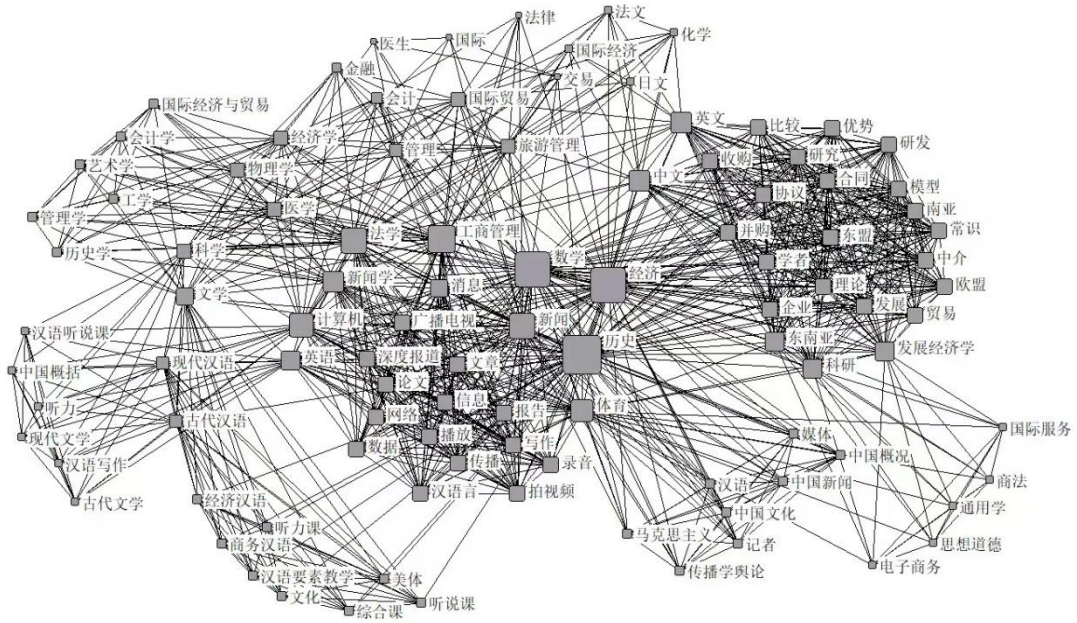


Table 4

Macro-Parameters of the Semantic Network of "学科" Lexicon of HSS and S&E L2 Learners

	S&E	HSS
Size	115	102
Density	0.314	0.442
Diameter	3	3
Average distance	37.6	48.392
Degree centralization	2.081	1.935
Small-worldness	43.83%	50.18%
Module degree	4.578	3.092
Module degree of random network	0.602	0.464

Notably, distinctive patterns emerged in the study of lexical–semantic networks among L2 Chinese learners from S&E and HSS backgrounds. First, the S&E group's response words exhibited a larger scale but lower density. This was evidenced by their network's lower average weighted degree (37.6) compared with the HSS group (48.392) and a network density value of 0.314, which was less than the HSS group's value of 0.442. Furthermore, the S&E group's average path length of 2.081 surpassed that of the HSS group (1.935), implying a broader diffusion of response words among S&E L2 Chinese learners. Both groups established small-world networks, with small-world indexes being greater than 1. Notably, the small-world index was stronger in the S&E group, implying that nodes in these networks were interrelated and formed tighter clusters, promoting effective information transfer and retrieval. Additionally, the core potential of the network of S&E L2 Chinese learners (43.83%) was lower than that of HSS learners (50.18%), suggesting less clustering around core words. Finally, the modularity of semantic network of S&E L2 Chinese learners surpassed that of the HSS learners. This finding underscores the disciplinary impacts on the properties of their lexical–semantic networks.

Network Centrality of "学科" (Discipline) Among S&E and HSS L2 Learners

Subsequent analysis of the lexical–semantic networks among S&E and HSS L2 Chinese learners focused on the top 20 central Chinese words. Table 5 indicates only a 15% overlap in the top 20 central words between the two groups' networks. A significant difference ($p = 0$) in the central words highlighted how their semantic networks are influenced by their respective disciplines. This distinction underscores the diverse effects of academic fields on learners' semantic networks, emphasizing the strong integration of disciplinary lexicon within each group's semantic network.

Table 5

Central Words in the Lexical–Semantic Networks of S&E vs. HSS L2 Chinese Learners

S&E L2 learners	Centrality	Normalized Centrality	HSS L2 learners	Centrality	Normalized Centrality
计算机	66	57.895	历史	71	70.297
化学	46	40.351	数学	65	64.356
数学	43	37.719	经济	64	63.366
土木工程	38	33.333	工商管理	47	46.535
材料	36	31.579	新闻	46	45.545
法学	28	24.561	法学	46	45.545
物理	28	24.561	计算机	41	40.594
建筑	28	24.561	体育	40	39.604
汉语	28	24.561	英文	34	33.663
哲学	28	24.561	中文	34	33.663
概率论	28	24.561	新闻学	34	33.663
实验	25	21.93	英语	33	32.673
管理	23	20.175	科研	32	31.683
C 语言	22	19.298	发展经济学	32	31.683
Java	22	19.298	东南亚	32	31.683
急救	22	19.298	消息	28	27.723
自动化	21	18.421	文学	28	27.723
人工智能	21	18.421	比较	26	25.743
环境	21	18.421	东盟	26	25.743

Discussion

This research utilized lexical decision tasks, lexical memory tests, and semantic fluency tasks to assess L2 Chinese learners' lexical performance. Based on the results, the study investigated the manifestation of mental lexicon in L2 Chinese learners from diverse disciplinary backgrounds. In the lexical decision task, S&E L2 Chinese learners demonstrated better ACC rates in recognizing words than their HSS counterparts, albeit with longer RTs. This phenomenon aligns with the connectionist model, which posits that lexical access involves selecting an appropriate word from a broad pool of candidates, a process that can prolong the response duration (McClelland & Rumelhart, 1981). Furthermore, the lexicality effect was significant, with real words outperforming nonwords in ACC and RT. S&E L2 learners exhibited higher overall ACC with real- and nonwords compared with HSS learners; however, they exhibited slower responses. This finding aligns with Collins and Loftus's (1975) spreading-activation theory, which suggests that upon encountering a lexical stimulus, individuals tend to activate related lexical candidates within the mental lexicon, selecting the one that best matches the stimulus. With their extensive lexicon associated with frequently used terms in their field, S&E learners require more time for selection. Evans and Stanovich (2013) introduced the dual process theory, which posits the presence of two cognitive modes in decision-making and memory: intuitive (System 1) and analytical (System 2) processing. S&E education emphasizes logical reasoning. Accordingly, the longer RTs observed in S&E learners directly reflect the analytical and methodical cognitive style emphasized in their academic

training, which prioritizes precision and logical reasoning. This contrasts with the intuitive cognitive style encouraged in HSS education, where learners focus on comprehension and synthesizing information from a broader range of sources. As a result, S&E learners exhibit slower but more accurate lexical decisions, as they meticulously evaluate multiple stimuli before responding. In contrast, HSS learners make quicker, but sometimes less precise, decisions due to their reliance on broader, intuitive processing strategies. This implies that cognitive strategies are shaped by academic training, which influences how learners from specific disciplines approach language tasks. Moreover, this study confirmed the word frequency effect, with the ACC and RTs for high-frequency words being higher and shorter, respectively, than those for low-frequency ones (Fang & Zhang, 2021; Strijkers et al., 2013; Zhang, 2011). S&E learners exhibited greater ACC across word frequencies than HSS learners but responded more slowly, highlighting differences in their mental lexicon networks and cognitive styles. Additionally, stroke count did not significantly affect L2 Chinese learners from diverse disciplines. Zhou and Jiang (2023) on the other hand, demonstrated that although L2 Chinese learners initially rely more on analytic-type processing, they develop their holistic processing capabilities with increased proficiency in Chinese. This process would then reduce or minimize the effect of stroke count. Actually, from the result, by the intermediate stage, both the S&E and the HSS learners tend to develop holistic processing abilities, showing a weakening of the effect of stroke count on lexical recognition at this stage.

The results of the lexical memory experiment did not show significant differences in memory capabilities between the two groups of L2 Chinese learners from S&E and HSS disciplines, therefore speaking to similar lexical memory skills that keep the structure of their mental lexicon network intact. The dual-process theory postulates that intuitive processing is used to enable fast recognition and memory, whereas analytical processing is implicated when one consciously recalls and selects. This means that the dual-processing approach yields similar memory results, which suggests that academic settings affect mostly the mechanisms of lexicon recognition and the network of the mental lexicon rather than memory.

Semantic fluency experiments revealed differences in the scale, density, and average path length of words used by learners. Feng and Liu (2023b) demonstrated that networks with lower density, longer average paths, and reduced centrality are more dispersed, lacking prominent core nodes and displaying balanced importance across the nodes. This finding indicates that S&E L2 Chinese learners develop more dispersed semantic networks with discipline-specific central lexicon. By contrast, HSS learners form tighter networks with more prominent central words, which reflects the influence of academic discipline on their semantic network structure. Newman (2006) proposed applying modularity to the lexical networks, emphasizing that more nodes within different communities and fewer linking words between them result in higher modularity. L2 Chinese learners with the HSS background have tightly knit mental lexical networks with clear central words. Conversely, the semantic networks of Chinese L2 learners from S&E background contain a larger number of modules with more apparent community structures. This suggests that despite belonging to the same S&E discipline, the lexicons produced by Chinese L2 learners pursuing different majors in S&E are more distinct, with the boundaries between majors being more prominent. By contrast, L2 Chinese learners from various HSS disciplines use more interconnected lexicon, with less apparent distinctions between majors. This indicates that S&E L2 Chinese learners acquire more domain-specific

Chinese words, whereas HSS learners acquire more general and interdisciplinary Chinese words. This conclusion is supported by MacLeod's (2018) findings, which indicated that the S&E disciplines often exhibit strong domain specificity, where differences in methodology, conceptual frameworks, and technical approaches create communication barriers between learners from different fields. In contrast, HSS learners tend to rely more on the integration of domain-specific knowledge and broader interdisciplinary approaches. Thus, the study corroborates that the lexical networks of S&E learners tend to be more dispersed and specialized, while those of HSS learners are more tightly interconnected and interdisciplinary in nature.

Furthermore, the semantic networks of S&E and HSS L2 Chinese learners exhibited small-world properties, with S&E learners displaying higher small-world indices. The higher small-world indices observed in S&E learners suggest that their lexical networks are efficiently organized, with a high local clustering (allowing for tight integration of related terms) and short global pathways (enabling faster retrieval of information) leading to a balanced state. This network structure supports quick access to domain-specific vocabulary, critical in fields that demand precision and technical knowledge. This reflects S&E students' enhanced local clustering and global reach in their semantic networks, promoting efficient information flow and complex network dynamics—indicative of an optimized lexical–semantic system, as discussed by Feng et al. (2023a). By contrast, HSS learners exhibited lower small-world indices, indicating less local clustering but high connectivity. Vitevitch et al. (2014) suggested that high small-world indices improve information dissemination and lexical processing, enabling S&E learners to more rapidly assimilate major-related vocabulary into their lexical network and enhancing their performance in lexical tasks. For S&E learners, high small-world indices facilitate more efficient processing of technical vocabulary, allowing for quicker integration and retrieval in specialized tasks. This is in contrast to HSS learners, who, though having lower small-world indices, benefit from broader and more interdisciplinary connectivity that supports their ability to navigate across diverse domains.

An overlap of only 15% in the top 20 response words between the semantic networks of HSS and S&E L2 Chinese learners critically highlights the significant role of disciplinary characteristics in shaping these networks. Furthermore, this low overlap suggests that the specialized focus within each discipline leads to highly differentiated lexical development. Specifically, the varied interpretations of "学科" (discipline) between these groups underscore that learners' semantic networks are influenced not only by language proficiency but also by the specific academic discourse to which they are regularly exposed. This aligns with De Deyne and Storms' (2008) observation that word frequency plays a central role in network centrality; in this case, the high frequency of domain-specific terminology likely reinforces stronger connections within each disciplinary lexicon. More importantly, it suggests that learners' mental lexicons evolve uniquely depending on the linguistic demands of their academic environment. The distinct semantic associations found in the networks of HSS and S&E learners could therefore be considered as a reflection of the disciplinary boundaries that shape their exposure and use of Chinese language. This meaning was further supported by the findings of Nelson et al. (2004), in which exposure density was found to be positively related to centrality within the lexical network. The better-connected networks here from particular domains in HSS and S&E learners show not just a divergence in vocabulary but point toward

wider linguistic and cognitive consequences of disciplinary immersion. Overall, these findings demonstrate how the different semantic realities for learners are constructed by discipline-specific linguistic environments.

Conclusion

Disciplinary contexts significantly influence the development of semantic networks and the organization of the mental lexicon in L2 Chinese learners. S&E learners exhibit higher ACC but longer RTs in identifying Chinese words, indicating an analytical approach. In contrast, HSS learners recognize words more quickly but with lower ACC, relying on intuitive processing. These differences highlight how their respective academic disciplines shape distinct cognitive styles and mental lexical networks. Comparative analyses revealed no significant differences in lexical memory between S&E and HSS L2 Chinese learners. However, their semantic networks differed considerably, reflecting the characteristics of their respective fields. This diversity underscores the unique lexical acquisition processes in S&E and HSS learners: while both may have similar lexical memory abilities, S&E learners tend to focus on major-related vocabulary, whereas HSS learners cover a broader range of words in their field.

The findings of the present study have practical significance in that, when designing courses, teachers should consider the disciplinary backgrounds of learners to improve teaching effectiveness. Furthermore, the findings provide policymakers with data and inspire the development and implementation of effective teaching strategies that can be adapted to learners from different disciplinary backgrounds, ultimately enhancing the quality of teaching Chinese as an L2. That is to say, it holds significant practical value for Chinese L2 acquisition. It not only offers insight into how disciplinary backgrounds influence vocabulary acquisition but also supports the effective development of teaching methods and strategies. In the next step, further research should explore how different teaching methods affect learners from various disciplinary backgrounds, in order to continually optimize the teaching of Chinese as an L2. In this regard, the present study acknowledges certain limitations concerning the selection of experimental words. Such selection may introduce familiarity bias among different disciplinary groups. Future research should also investigate the effects of word familiarity on lexical identification and memory across diverse academic backgrounds. Furthermore, this experiment did not employ professional equipment to explore differences in the neural activity of L2 learners from various disciplinary groups. It remains to be seen how such disciplinary differences further impact the cognitive processes in the brains of bilinguals.

ORCID

https://orcid.org/0009-0005-9880-8175

https://orcid.org/0009-0007-8194-7157

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References

Aitchison, J. (2012). *Words in the mind: An introduction to the mental lexicon*. John Wiley & Sons.

Allen, E. D., & Valette, R. M. (1972). *Modern language classroom techniques: A handbook*. Harcourt Brace Jovanovich.

Baddeley, A. (2000). The episodic buffer: A new component of working memory? *Trends in Cognitive Sciences, 4*(11), 417-423. https://doi.org/10.1016/S1364-6613(00)01538-2

Becher, T. (1987). Disciplinary discourse. *Studies in Higher Education, 12*(3), 261-274. https://doi.org/10.1080/03075078712331378052

Brenders, P. E. A. (2012). *Cross-language interactions in beginning second language learners* (Dissertation, Radboud University). Nijmegen. http://hdl.handle.net/2066/102405

Carroll, D. W. (2000). *Psychology of language*. Foreign Language Teaching and Research Press.

Chen, J., Zhang, C., Liu, X., & Cheng, R. (2018). The L2 proficiency effect on L3 semantic access by Tibetan-Chinese-English trilinguals [二语水平对藏-汉-英三语者英语词汇语义通达的影响]. *Foreign Language Teaching and Research, 50*(5), 727-737, 801. https://doi.org/cnki:sun:wjyy.0.2018-05-008.

Collins, A. M., & Loftus, E. F. (1975). A spreading-activation theory of semantic processing. *Psychological Review, 82*(6), 407-428. https://doi.org/10.1037/0033-295X.82.6.407

Coltheart, M., Rastle, K., Perry, C., Langdon, R., & Ziegler, J. (2001). DRC: A dual route cascaded model of visual word recognition and reading aloud. *Psychological Review, 108*(1), 204-256. https://doi.org/10.1037/0033-295X.108.1.204

Cosgrove, A. L., Kenett, Y. N., Beaty, R. E., & Diaz, M. T. (2021). Quantifying flexibility in thought: The resiliency of semantic networks differs across the lifespan. *Cognition, 211*, 104631. https://doi.org/10.1016/j.cognition.2021.104631

Cremer, M., Dingshoff, D., de Beer, M., & Schoonen, R. (2011). Do word associations assess word knowledge? A comparison of L1 and L2, child and adult word associations. *International Journal of Bilingualism, 15*(2), 187-204. https://doi.org/10.1177/1367006910381189

De Deyne, S., & Storms, G. (2008). Word associations: Network and semantic properties. *Behavior Research Methods, 40*(1), 213-231. https://doi.org/10.3758/BRM.40.1.213

De Groot, A. M. B., & Nas, G. L. J. (1991). Lexical representation of cognates and noncognates in compound bilinguals. *Journal of Memory and Language, 30*(1), 90-123. https://doi.org/10.1016/0749-596X(91)90012-9

Dong, Y., Gui, S., & MacWhinney, B. (2005). Shared and separate meanings in the bilingual mental lexicon. *Bilingualism: Language and Cognition, 8*(3), 221-238. https://doi.org/10.1017/S1366728905002270

Ellis, N. C. (2002). Frequency Effects in Language Processing: A review with implications for theories of implicit and explicit language acquisition. *Studies in Second Language Acquisition, 24*(2), 143-188. https://doi.org/10.1017/S0272263102002024

Ellis, N. C. (2012). Formulaic language and second language acquisition: Zipf and the phrasal teddy bear. *Annual Review of Applied Linguistics, 32*, 17-44. https://doi.org/10.1017/S0267190512000025

Erickson, K. I., Voss, M. W., Prakash, R. S., Basak, C., Szabo, A., Chaddock, L., . . . White, S. M. (2011). Exercise training increases size of hippocampus and improves memory. *Proceedings of the National Academy of Sciences, 108*(7), 3017-3022. https://doi.org/10.1073/pnas.1015950108

Ervin, S. M. (1961). Changes with age in the verbal determinants of word-association. *The American Journal of Psychology, 74*(3), 361-372. https://doi.org/10.2307/1419742

Evans, J. S. B. T., & Stanovich, K. E. (2013). Dual-process theories of higher cognition: Advancing the debate. *Perspectives on Psychological Science, 8*(3), 223-241. https://doi.org/10.1177/1745691612460685

Fang, N., & Zhang, P. (2021). L1 congruency, word frequency, collocational frequency, L2 proficiency, and their combined effects on Chinese–English bilinguals' L2 collocational processing. *International Journal of Bilingualism, 25*(5), 1429-1445. https://doi.org/10.1177/13670069211024747

Feng, X., & Liu, J. (2023a). A comparative study of L2 lexical-semantic network structure of Chinese middle and high school English learners [中国初、高中英语学习者二语词汇语义网络结构比较研究]. *Foreign Language Teaching and Research Press*, *55*(3), 397-409, 479-480. https://doi.org/10.19923/j.cnki.fltr.2023.03.013

Feng, X., & Liu, J. (2023b). The structure of L2 lexical-semantic networks as seen from a social network perspective. *International Review of Applied Linguistics in Language Teaching*, *61*(3), 967-994. https://doi.org/10.1515/iral-2020-0181

Friederici, A. D., & Wartenburger, I. (2010). Language and brain. *Wiley Interdisciplinary Reviews: Cognitive Science*, *1*(2), 150-159. https://doi.org/10.1002/wcs.9

Gao, F., Wang, J., Zhao, C. G., & Yuan, Z. (2022). Word or morpheme? Investigating the representation units of L1 and L2 Chinese compound words in mental lexicon using a repetition priming paradigm. *International Journal of Bilingual Education and Bilingualism*, *25*(7), 2382-2396. https://doi.org/10.1080/13670050.2021.1913984

Gui, S. (2000). Psycholinguistics: New edition [新编心理语言学]. *Shanghai Foreign Language Education Press*.

Hino, Y., Kusunose, Y., & Lupker, S. J. (2010). The relatedness-of-meaning effect for ambiguous words in lexical-decision tasks: When does relatedness matter? *Canadian Journal of Experimental Psychology*, *64*(3), 180. https://doi.org/10.1037/a0020475

Hyde, K. L., Lerch, J., Norton, A., Forgeard, M., Winner, E., Evans, A. C., & Schlaug, G. (2009). The effects of musical training on structural brain development: A longitudinal study. *Annals of the New York Academy of Sciences*, *1169*(1), 182-186. https://doi.org/10.1111/j.1749-6632.2009.04852.x

Hyland, K. (2008). As can be seen: Lexical bundles and disciplinary variation. *English for Specific Purposes*, *27*(1), 4-21. https://doi.org/10.1016/j.esp.2007.06.001

Klein, D., Milner, B., Zatorre, R. J., Meyer, E., & Evans, A. C. (1995). The neural substrates underlying word generation: A bilingual functional-imaging study. *Proceedings of the National Academy of Sciences*, *92*(7), 2899-2903. https://doi.org/10.1073/pnas.92.7.2899

Kolers, P. A. (1963). Interlingual word associations. *Journal of Verbal Learning and Verbal Behavior*, *2*(4), 291-300. https://doi.org/10.1016/S0022-5371(63)80097-3

Korenar, M., Treffers-Daller, J., & Pliatsikas, C. (2023). Dynamic effects of bilingualism on brain structure map onto general principles of experience-based neuroplasticity. *Scientific Reports*, *13*(1), 3428. https://doi.org/10.1038/s41598-023-30326-3

Laufer, B., & Paribakht, T. S. (1998). The relationship between passive and active vocabularies: Effects of languagelearning context. *Language Learning*, *48*(3), 365-391. https://doi.org/10.1111/0023-8333.00046

Levow, G. A., Oard, D. W., & Resnik, P. (2005). Dictionary-based techniques for cross-language information retrieval. *Information Processing & Management*, *41*(3), 523-547. https://doi.org/10.1016/j.ipm.2004.06.012

Li, L., & Ni, C. (2023). "Is 'hot dog' a 'hot' dog? --The effect of semantic transparency on the processing of bilingual compound words [“热狗”是“热”“狗”吗?——语义透明度对二语复合词加工的影响]. *Foreign Language Education*, *44*(3), 51-57. https://doi.org/10.16362/j.cnki.cn61-1023/h.2023.03.015

Lichtman, K. (2016). Age and learning environment: Are children implicit second language learners? *Journal of Child Language*, *43*(3), 707-730. https://doi.org/10.1017/S0305000915000598

Liu, H., & Li, X. (2022). A corpus-based approach to constructing a vocabulary of subject terms of TCM Chinese [基于语料库的中医汉语主题词表构建]. *Journal of Chinese Language and Culture*, Jinan University, Guangdong, China. https://doi.org/10.16131/j.cnki.cn44-1669/g4.2022.02.012

Llach, M. P. A. (2023). Mapping the mental lexicon of EFL learners: A network approach. *Revista de Lingüística y Lenguas Aplicadas*, *18*, 1-17. https://doi.org/10.4995/rlyla.2023.18769

Lockiewicz, M., & Jaskulska, M. (2015). Mental lexicon, working memory and L2 (English) vocabulary in Polish students with and without dyslexia. *Center for Educational Policy Studies Journal*, *5*(1), 71-89. https://doi.org/10.26529/cepsj.155

Ma, Y., & Vanek, N. (2024). First language lexical attrition in a first language setting: A multi-measure approach testing teachers of English. *Journal of Psycholinguistic Research*, *53*(2), 23. https://doi.org/10.1007/s10936-024-10068-7

MacLeod, M. (2018). What makes interdisciplinarity difficult? Some consequences of domain specificity in interdisciplinary practice. *Synthese*, *195*(3), 697-720. https://doi.org/10.1007/s11229-016-1236-4

Meara, P. (1983). Word associations in a foreign language. *Nottingham Linguistics Circular*, *11*(2), 29-38.

McClelland, J. L., & Rumelhart, D. E. (1981). An interactive activation model of context effects in letter perception: Part 1. An account of basic findings. *Psychological Review*, *88*(5), 375–407. https://doi.org/10.1037/0033-295X.88.5.375

Morita, N. (2000). Discourse socialization through oral classroom activities in a TESL graduate program. *TESOL Quarterly*, *34*, 279-310. https://doi.org/10.2307/3587952

Nation, I. S. P. (2001). *Learning vocabulary in another language*. Cambridge University Press. https://doi.org/10.1017/CBO9781139524759

Nelson, D. L., McEvoy, C. L., & Schreiber, T. A. (2004). The University of South Florida free association, rhyme, and word fragment norms. *Behavior Research Methods, Instruments, & Computers, 36*(3), 402-407. https://doi.org/10.3758/BF03195588

Newman, M. E. J. (2006). Modularity and community structure in networks. *Proceedings of the National Academy of Sciences, 103*(23), 8577-8582. https://doi.org/10.1073/pnas.0601602103

Oganian, Y., Froehlich, E., Schlickeiser, U., Hofmann, M. J., Heekeren, H. R., & Jacobs, A. M. (2016). Slower perception followed by faster lexical decision in longer words: A diffusion model analysis. *Frontiers in Psychology, 6*, 1958. https://doi.org/10.3389/fpsyg.2015.01958

Perri, R. L., Berchicci, M., Spinelli, D., & Di Russo, F. (2014). Individual differences in response speed and accuracy are associated to specific brain activities of two interacting systems. *Frontiers in Behavioral Neuroscience, 8*, 251. https://doi.org/10.3389/fnbeh.2014.00251

Petersen, S. E., & Fiez, J. A. (1993). The processing of single words studied with positron emission tomography. *Annual Review of Neuroscience, 16*(1), 509-530. https://doi.org/10.1146/annurev.ne.16.030193.002453

Playfoot, D., Balint, T., Pandya, V., Parkes, A., Peters, M., & Richards, S. (2018). Are word association responses really the first words that come to mind? *Applied Linguistics, 39*(5), 607-624. https://doi.org/10.1093/applin/amw015

Potter, M. C., So, K. F., Von Eckardt, B., & Feldman, L. B. (1984). Lexical and conceptual representation in beginning and proficient bilinguals. *Journal of Verbal Learning and Verbal Behavior, 23*(1), 23-38. https://doi.org/10.1016/S0022-5371(84)90489-4

Pranoto, B. E., & Afrilita, L. K. (2019). The organization of words in mental lexicon: evidence from word association test. *Teknosastik, 16*(1), 26-33. https://doi.org/10.33365/ts.v16i1.130

Price, C. J. (2012). A review and synthesis of the first 20 years of PET and fMRI studies of heard speech, spoken language and reading. *Neuroimage, 62*(2), 816-847. https://doi.org/10.1016/j.neuroimage.2012.04.062

Rubenstein, H., Garfield, L., & Millikan, J. A. (1970). Homographic entries in the internal lexicon. *Journal of Verbal Learning and Verbal Behavior, 9*(5), 487-494. https://doi.org/10.1016/S0022-5371(70)80091-3

Sebastian-Gallés, N., Rodríguez-Fornells, A., de Diego-Balaguer, R., & Díaz, B. (2006). First-and second-language phonological representations in the mental lexicon. *Journal of Cognitive Neuroscience, 18*(8), 1277-1291. https://doi.org/10.1162/jocn.2006.18.8.1277

Singleton, D. M. (1999). *Exploring the second language mental lexicon*. Cambridge University Press.

Smith, D. D., Meca, A., Bottenhorn, K. L., Bartley, J. E., Riedel, M. C., Salo, T., & Sutherland, M. T. (2023). Task-based attentional and default mode connectivity associated with science and math anxiety profiles among university physics students. *Trends in Neuroscience and Education, 32*, 100204. https://doi.org/10.1016/j.tine.2023.100204

Strijkers, K., Baus, C., Runnqvist, E., FitzPatrick, I., & Costa, A. (2013). The temporal dynamics of first versus second language production. *Brain and Language, 127*(1), 6-11. https://doi.org/10.1016/j.bandl.2013.07.008

Treisman, A. (1964). Monitoring and storage of irrelevant messages in selective attention. *Journal of Verbal Learning and Verbal Behavior, 3*(6), 449-459. https://doi.org/10.1016/S0022-5371(64)80015-3

Vitevitch, M. S., & Goldstein, R. (2014). Keywords in the mental lexicon. *Journal of Memory and Language, 73*, 131-147. https://doi.org/10.1016/j.jml.2014.03.001

Vitevitch, M. S., Goldstein, R., Siew, C. S. Q., & Castro, N. (2014). Using complex networks to understand the mental lexicon. *Yearbook of the Poznań Linguistic Meeting, 1*(1), 119-135. https://doi.org/10.1515/yplm-2015-0007

Wang, X., & Wang, J. (2022). A study on the academic Chinese word list for undergraduate majors in economics and trade [经贸类本科专业学术汉语词表研究]. *Language Teaching and Linguistic Studies, 55*(4), 97-109. https://doi.org/10.3969/j.issn.0257-9448.2022.04.003

Wang, Y., & Sui, M. (2015). A masked priming experimental study of recognition of lexical ambiguity of second language [遮蔽启动范式下第二语言词汇歧义识别研究]. *Foreign Language Research, (6)*, 116-122. https://doi.org/10.16263/j.cnki.23-1071/h.2015.06.023

Whiting, C., Shtyrov, Y., & Marslen-Wilson, W. (2015). Real-time functional architecture of visual word recognition. *Journal of Cognitive Neuroscience, 27*(2), 246-265. https://doi.org/10.1162/jocn_a_00699

Wulff, D. U., Hills, T. T., Lachman, M. E., & Mata, R. (2016, August 10 – 13). The aging lexicon: Differences in the semantic networks of younger and older adults. *38th Annual Meeting of the Cognitive Science Society* (CogSci 2016), Philadelphia, PA, United States.

Xu, Z. (2023). A research of academic Chinese vocabulary list based on corpus of legal papers [基于法律类论文语料库的学术汉语词表研究]. *Soochow University*. https://doi.org/10.27351/d.cnki.gszhu.2023.001986

Yang, Y., Cao, M., & Shen, X. (2001). An overview of the research abroad on mental lexicon [国外大脑词库研究概观]. *Contemporary Linguistics, 3*(2), 90-108, 157. https://doi.org/10.3969/j.issn.1007-8274.2001.02.002

Yin, F. (2013). *A WAT-Based mental lexicon study* (Doctoral dissertation, Jiangxi Normal University). Jiangxi.

Yin, Q. (2015). Bilingual thesaurus pattern changes and their implications for vocabulary instruction [双语词库模式变迁及其对词汇教学的启示]. *Journal of Xi'an International Studies University*, *23*(4), 82-85. https://doi.org/10.16362/j.cnki.cn61-1457/h.2015.04.020

Young, C. B., Wu, S. S., & Menon, V. (2012). The neurodevelopmental basis of math anxiety. *Psychological Science*, *23*(5), 492-501. https://doi.org/10.1177/0956797611429134

Zappa-Hollman, S. (2007). Becoming socialized into diverse academic communities through oral presentations. *Canadian Modern Language Review*, *63*, 455-485. https://doi.org/10.3138/cmlr.63.3.455

Zareva, A. (2007). Structure of the second language mental lexicon: how does it compare to native speakers' lexical organization? *Second Language Research*, *23*(2), 123-153. https://doi.org/10.1177/0267658307076543

Zareva, A., & Wolter, B. (2012). The 'promise'of three methods of word association analysis to L2 lexical research. *Second Language Research*, *28*(1), 41-67. https://doi.org/10.1177/0267658311423452

Zhang, J. (2011). *Research into the L2 mental lexicon based on word association test of logistics words* [Doctoral dissertation, Dalian University of Technology]. Dalian.

Zhang, P. (2009). Word associations and mental lexicon: A review of lexical network structure research [词汇联想与心理词库: 词汇深度知识研究现状]. *Foreign Language Learning Theory and Practice*, *3*, 71-82, 87.

Zhang, P. (2010). A comparative study of word association patterns in Chinese EFL learners mental lexicon [中国英语学习者心理词库联想模式对比研究]. *Foreign Language Teaching and Research*, *42*(1), 9-16, 80.

Zhang, Q., & Wang, C. (2014). Syllable frequency and word frequency effects in spoken and written word production in a non-alphabetic script. *Frontiers in Psychology*, *5*, 120. https://doi.org/10.3389/fpsyg.2014.00120

Zhou, Y., & Jiang, N. (2023). A study of L2 Chinese learners processing pattern in visual word recognition [汉语二语学习者双字词加工方式研究]. *Chinese Teaching in the World*, *37*(1), 111-126. https://doi.org/10.13724/j.cnki.ctiw.2023.01.008

Zimmerman, C. B. (1997). Historical trends in second language vocabulary instruction. In J. Coady & T. Huckin (Eds.), *Second language vocabulary acquisition* (pp. 5-19). Cambridge University Press. https://doi.org/10.1017/CBO9781139524643.003

Zull, J. E. (2004). The art of changing the brain. *Educational Leadership*, *62*(1), 68-72.

Appendices

Lexical decision					
Words				Nonwords	
High frequency		Low-and medium-frequency			
充分	结构	极大	离散	包由	科交
方向	表面	回归	端点	命入	率义
估计	试验	生成	概率	一换	表完
自动	集合	有序		存平	范析
平均	信息	积分		序化	试和
形式	现象	单位		条发	问换
统计	周期	极限		关件	数区
组合	基础	格式		机扩	本越
相关	检验	对策		传合	范络
空间	稳定	测度		区要	比墙
符号	答案	级数		世奇	悟现
语言	锻炼	模式		率义	约道
数据	模型	范畴		系间	
超越		解析		类号	

Lexical memory					
Memory words				Disruptive words	
High frequency		Low- and medium-frequency			
分析		生成		约束	传递
必要		收敛		分类	超越
动力		无限		形式	部分
表面		序列		重复	地图
逼近		传奇		理想	时间
				基本	递归
				试验	绝对
				数据	发散
				映射	传输
				无限	假借