International Journal of Multilingualism

ISSN: 1479-0718 (Print) 1747-7530 (Online) Journal homepage: www.tandfonline.com/journals/rmjm20

L2 conditionally facilitates L3 word recognition among Chinese-English-Spanish trilinguals

Chuqiao Song, Hao Chen, Fei Gao, Hainuo Qian, Lu Geng & Xiangzhou Ye

To cite this article: Chuqiao Song, Hao Chen, Fei Gao, Hainuo Qian, Lu Geng & Xiangzhou Ye (09 Dec 2025): L2 conditionally facilitates L3 word recognition among Chinese-English-Spanish trilinguals, International Journal of Multilingualism, DOI: 10.1080/14790718.2025.2600536

To link to this article: https://doi.org/10.1080/14790718.2025.2600536

Published online: 09 Dec 2025.

INTERNATIONAL JOURNAL OF MULTILINGUALISM
https://doi.org/10.1080/14790718.2025.2600536

L2 conditionally facilitates L3 word recognition among Chinese-English-Spanish trilinguals

Chuqiao Song[a], Hao Chen[b], Fei Gao[c], Hainuo Qian[d], Lu Geng[e] and Xiangzhou Ye[e]

[a]Basque Center on Cognition, Brain and Language, Gipuzkoa, Spain; [b]School of Languages, Shanghai University of International Business and Economics, Shanghai, People's Republic of China; [c]Institute of Modern Languages and Linguistics, Fudan University, Shanghai, People's Republic of China; [d]College of Foreign Language and Literature, Fudan University, Shanghai, People's Republic of China; [e]School of European Studies, Zhejiang Yuexiu University, Shaoxing, People's Republic of China

ABSTRACT

This study investigates the applicability of the Parasitic Model of vocabulary acquisition to Chinese-English-Spanish trilinguals by specifically examining how the second language (L2) primes the third language (L3) in a masked priming lexical decision task, offering new insights on the Parasitic Model of vocabulary acquisition. By using a masked priming lexical decision task, we investigated orthographic and semantic priming effects in sequential trilingual learners with intermediate L2 English and relatively lower L3 Spanish proficiency. Our results showed strong orthographic facilitation, particularly in cognate and orthographic neighbour conditions, highlighting the dominant role of form-based processing in early L3 acquisition. Conversely, semantic priming was minimal, suggesting underdeveloped semantic networks in L3. The findings underscore the applicability of the Parasitic Model to typologically distant languages and reveal that language similarity, particularly orthographic overlap between L2 and L3, drives cross-linguistic transfer even when L2 proficiency is limited. These results have practical implications for multilingual education, especially in contexts where learners are studying languages that are typologically similar, such as English and Spanish.

ARTICLE HISTORY
Received 7 December 2024
Accepted 30 November 2025

KEYWORDS
Semantic priming; orthographic priming; trilingual; cognate; Parasitic Model

1. Introduction

Bilingual and trilingual language processing pose unique cognitive challenges that complicate traditional L1-based theories of language acquisition and word recognition. These difficulties often stem from cross-linguistic influence involving both the first (L1) and second (L2) languages, alongside the increased cognitive demands required to manage multiple linguistic systems (De Bot & Jaensch, 2015). While bilingualism involves managing two linguistic systems, trilingualism introduces an additional layer of complexity, requiring individuals to control and navigate three languages simultaneously. Trilinguals must not only balance the activation and suppression of multiple languages but also

CONTACT Hao Chen shaert@qq.com School of Languages, Shanghai University of International Business and Economics, No.1900 Wenxiang Road, Songjiang District, Shanghai 201620, People's Republic of China

manage the potential cross-linguistic influence among them (Madrazo & Bernardo, 2018). This heightened cognitive demand significantly influences how trilinguals store, retrieve and process lexical items, making trilingual language processing an area of multilingual research. Studies have shown that trilinguals engage distinct cognitive mechanisms, such as enhanced inhibitory control, to handle this complexity (Abutalebi et al., 2013; Clyne, 1997; Lindqvist & Falk, 2014; Poarch & Van Hell, 2012). Understanding these mechanisms is crucial, as it sheds light on the broader processes involved in multilingual language management.

A key area where this added complexity becomes especially apparent is in word recognition, since varying levels of proficiency in L1 and L2 may lead to different degrees of cross-linguistic influence (Olson, 2017), and typological differences may lead to the use of different processing mechanisms (De Bot & Jaensch, 2015), particularly when three linguistic systems are involved. For instance, an L1 Chinese speaker with English as L2 and Spanish as L3 might rely more heavily on English cues during Spanish lexical retrieval. This aligns with Lindqvist and Bardel's (2013) finding that language proximity facilitates transfer, as shown in personal narrative tasks. These dynamics underscore the importance of investigating the multilingual mental lexicon to better understand the complexities of word recognition in trilinguals. However, the relatively limited literature on this subject leaves many unanswered questions, particularly regarding how typologically closer languages (whether L1 and L2, L1 and L3, or L2 and L3) interact within the mental lexicon and influence the word processing mechanism.

Given the heightened cognitive demands of trilingual language processing, an interesting aspect would be sequential trilingual learners. Sequential learners are individuals who acquire a single language from birth, followed by a L2 in early childhood, and additional languages (Ln) later in life (McCarthy et al., 2014). In China, where Chinese is the first language for most people and English is the common L2 for educational purposes, many choose to learn an L3 upon entering university, either as a break from English or as part of their professional studies. The prevalence of sequential trilinguals in China highlights the importance of studying this group and their unique language acquisition patterns.

Under these considerations, the present study of sequential trilinguals offers critical insights into the cognitive mechanisms underlying the management of multiple languages. Investigating how trilinguals process words across L2 and L3 can reveal not only the nature of cross-linguistic interactions but also the influence of language dominance, proficiency, and structural similarity on language processing. Understanding these factors is essential for advancing our knowledge of multilingualism and for developing models that accurately reflect the realities of trilingual language use.

2. Literature review

2.1. Non-selective access and cognate effects

A foundational framework for understanding bilingual lexical access is the Bilingual Interactive Activation Plus (BIA+) model (Dijkstra & Van Heuven, 2002), which proposes non-selective activation, i.e. the simultaneous co-activation of both languages during processing. This parallel activation facilitates word recognition and fluid language switching,

enabling bilinguals to navigate their linguistic environments effectively. Within this framework, cognates are the most prominent word type for investigating non-selective access in bilinguals. Cognate words share similar orthographic, phonological, and semantic properties across two or more languages due to their common etymological origins. In bilingual research, cognates have been recognised to facilitate word processing in light of faster retrieval and improved retention, known as cognate facilitation effect. This is attributed to the notion that cognates could trigger the simultaneous engagement of corresponding representations of both languages, thus reducing the cognitive effort required for word recognition (De Groot & Nas, 1991; Dijkstra & Van Heuven, 2018; Peeters et al., 2013; Poort & Rodd, 2017). Specifically, bilingual studies on alphabetic languages (e.g. English-German, English-Dutch) have shown that facilitation occurs due to cross-linguistic similarity in both form and meaning (Dijkstra et al., 2023; Schröter & Schroeder, 2016).

In particular, Dijkstra et al. (2023) explored the interaction between orthography and semantics in bilingual visual word recognition using two masked priming experiments with Dutch-English bilinguals. In these experiments, participants made lexical decisions on English targets following Dutch primes, categorised as neighbour cognates (cognates whose form is only slightly different), noncognate translations, orthographically related neighbours (words that share orthography but not meaning), or unrelated words. The study found a strong cognate facilitation effect, with a slightly smaller effect for noncognate translations, reinforcing existing evidence on the role of cognates in enhancing bilingual word recognition. These results suggested that shared orthographic and semantic features between languages significantly boost lexical processing efficiency.

The transition from bilingualism to trilingualism is not merely additive but rather transformative in nature. While bilinguals navigate between their L1 and L2, trilinguals must also incorporate an L3 (Rothman et al., 2019). While the BIA + model primarily focused on bilingual visual word recognition, cognates also play an equally critical role in trilingual language processing. Szubko-Sitarek (2011) showed that Polish-English-German trilinguals activated both L1 and L2 during L3 processing, providing early evidence of parallel activation across languages. In a visual lexical decision task with Dutch-English-German speakers, Lemhöfer and Dijkstra (2004) found faster recognition of L1-L3 double cognates and especially L1-L2-L3 triple cognates compared to non-cognates, demonstrating that all three languages can be co-activated, with cumulative overlap strengthening facilitation. Furthermore, Bartolotti and Marian (2017) proposed that cross-linguistic similarities function as anchors, allowing cognates to link L3 forms to both L1 and L2 representations. More recently, Foryś-Nogala et al. (2025) tested Polish-English-Italian trilinguals and found that L1-L2-L3 cognates were known and processed more successfully than L2-L3 cognates or non-cognates, with the strongest facilitation for low-frequency triple cognates. Interestingly, L2-L3 cognates did not differ from non-cognates, suggesting that facilitation depends on cumulative overlap across the entire multilingual lexicon rather than on single-source similarity. Collectively, these studies provide evidence for non-selective access in trilinguals, with cognates playing a central role in driving co-activation across all known languages. However, most research has focused on typologically similar languages, and studies on the nature and extent of parallel activation in trilinguals, particularly when the languages are typologically distant, remain relatively limited (see Chen, 2020; Zhu & Mok, 2020). While non-selective accounts such as the BIA + model capture

how multiple languages are simultaneously activated during processing, they offer less insight into how new lexical items in an additional language are integrated into the multilingual lexicon. To address this issue, the Parasitic Model (PM) (Hall & Ecke, 2003) can provide a complementary perspective, explaining how novel L2 or L3 words become anchored to pre-existing lexical representations through cross-linguistic similarity.

2.2. Parasitic model in trilinguals

The PM offers a possible explanation for better understanding the interaction of distinct linguistics systems in trilinguals (Hall & Ecke, 2003), and particularly, how multilingual learners integrate L2 and/or L3 vocabulary into their existing L1 lexicon. According to the PM, the acquisition of new lexical items in L2 or L3 is not an isolated process, yet deeply rooted in the learners' prior linguistic knowledge. These parasitic connections are typically established through similarities in orthography, phonology, or semantics between the new language and the known languages, thereby facilitating the learning and organisation of new vocabulary items and reducing the cognitive efforts required for lexical acquisition. More specifically, the PM outlines three stages of vocabulary acquisition. In the initial stage, learners link new L3 words to the 'host' words in L1 or L2 based on visual or auditory similarities. For example, an L1 English-L2 French learner might associate the Spanish word *activo* (L3) with *active* (L1) or *actif* (L2) due to orthographic and phonological resemblance. In the second stage, these links are enriched by transferring semantic and grammatical properties from the host language to the L3 word, enabling more effective contextual use. Finally, as learners' proficiency increases, parasitic links are revised or severed, allowing L3 words to develop independent representations linked to their semantic and syntactic properties. Repeated exposure automates these processes, thus enhancing L3 fluency and word retrieval.

Previous research has established the PM's feasibility in the context of typologically similar languages, such as French-English-Spanish trilinguals, where shared orthographic and phonological properties could facilitate efficient lexical transfer (Ecke & Hall, 2014). However, an important question arises when the languages involved in trilingual processing are not typologically similar. Specifically, when the native language is typologically distinct from the two non-native languages, as in the case of L1 Chinese learners of L2 English and L3 Spanish, the typological distance may influence the development of cross-linguistic awareness and transfer mechanisms between the two non-native alphabetic languages. Understanding how these learners navigate the orthographic similarities between L2 and L3 offers valuable insights into language processing across typologically diverse systems. Zhu and Mok (2020) touched upon this phenomenon among Cantonese (L1)-English (L2)-German (L3) trilinguals. Learners with high proficiency in L2 English and low-to-intermediate proficiency in L3 demonstrated faster and more accurate responses to German-English cognates, even with minimal L3 exposure. It thus indicated that L2 English acted as the dominant host language for L3 word recognition. Similarly, Chen (2020) found that L1 Tibetan learners of L3 English primarily connected L3 words to L2 Chinese when their L2 proficiency was high, while both L1 and L2 served as parasitic hosts at lower L2 proficiency levels. These findings support the notion that learners tend to rely on the more proficient or the typologically similar language, which becomes the primary strategy for L1 Chinese learners of L2 English. This aligns with the

PM's prediction that early-stage connections are vulnerable to cross-linguistic competition until more independent L3 representations are formed. Nevertheless, there is still limited research on whether the more proficient or the more similar language will be the source language (or 'parasitic host') for trilinguals, as is the case for L1 Chinese learners of L2 English and L3 Spanish or German. This is because the absence of an alphabetic foundation in L1 means that L2 English becomes the primary source of transfer in L3 acquisition, due to the shared alphabetic script and structural similarities between L2 and L3. Since these sequential trilinguals acquire their L2 at different stages and exhibit varying levels of L2 proficiency, this may influence both the extent of transfer and the strategies employed during L3 acquisition.

Investigating the PM in the context of L1 Chinese learners provides valuable insights into how and to what extent typological distance and language proficiency shape multilingual vocabulary acquisition. In particular, examining how L1 Chinese learners utilise L2 English as a host language for L3 Spanish or German allows us to test the PM's prediction that early-stage lexical connections are established through existing languages, and that these connections can produce both facilitation (when overlap supports transfer) and interference (when overlap triggers competition). To investigate such mechanisms, priming paradigms provide a powerful tool, as they can trace the influence of orthographic and semantic overlap on real-time word recognition. By assessing whether responses to L3 words are facilitated or inhibited by prior exposure to L1 or L2 equivalents, priming experiments directly reveal the parasitic links hypothesised by the PM.

2.3. Priming effects modulated by internal and external factors

Priming refers to the change in processing speed or accuracy for a target word when it is preceded by a related or unrelated stimulus, known as the prime (Forster and Davis 1984). Priming effects can be facilitatory, since related primes like cognates or translations speed up recognition; or inhibitory, since competing forms such as homographs slow it down (Forster et al., 2003). In L3 vocabulary acquisition, such effects show how new words are connected to earlier languages. For example, if an L3 Spanish word is recognised faster after its L2 English translation, this suggests that L3 access is supported by L2. Wang et al. (2023) used a masked translation priming paradigm with German-English-French trilinguals and found significant facilitation in cross-language priming, particularly in the L2-L1, L1-L3, and L2-L3 directions. These results demonstrate that translation priming can speed up recognition across languages, highlighting how lexical links between L1, L2, and L3 support priming-based facilitation in trilinguals.

Inhibition effects arise when competition between languages interferes with word recognition, and these have been more extensively documented in the bilingual literature. For instance, orthographic neighbours are words that share letter strings with the target and are initially co-activated during recognition (Mulder et al., 2018). Such neighbours compete for selection through lateral inhibition, where active word candidates suppress alternatives until one is selected (McClelland & Rumelhart, 1981). Dijkstra et al. (2010) presented orthographic primes for 60 ms in an L1 Dutch lexical decision task among Dutch-English bilinguals, in which within-language neighbour primes produced inhibition of 11 ms compared to controls. Additionally, cross-linguistic English-Dutch neighbour pairs induced even stronger inhibition (21 ms). Interestingly, while word

primes that overlapped with the target tended to yield inhibition, overlapping non-word primes produced facilitation, suggesting that inhibitory effects are tied to lexical competition between real words. While bilingual studies provide robust evidence that orthographic neighbours can slow recognition through lateral inhibition, this phenomenon remains under-explored in trilinguals. Specifically, it is not yet clear whether similar inhibitory dynamics extend to trilingual populations, where additional cross-linguistic interactions may alter the balance between facilitation and inhibition.

The priming effects are also modulated by individual factors. Proficiency is an important internal factor that affect priming effects. In a cross-linguistic repetition priming lexical decision task with Chinese (L1), English (L2), and Spanish (L3), Wang and Yang (2025) found that more proficient learners could access L3 semantics more directly, while less proficient learners relied on L1 and L2 translations. In addition, higher L2 proficiency enhances cognate effects, but lower L2 proficiency may hinder learning despite L2-L3 cross-linguistic similarity (Otwinowska, 2024). Supporting evidence comes from recent studies, which show that cross-linguistic links in trilinguals often rely on the dominant L1. For example, translation priming is typically mediated by L1, with limited direct L2-L3 priming (Aparicio & Lavaur, 2016), and L2 proficiency can modulate phonological priming (Lim & Ahn, 2024). Overall, no single language consistently drives cross-linguistic influence in L3 acquisition, though L1 generally exerts the strongest effect, with patterns further shaped by typological similarity. The influence of typological similarity is an important external factor in trilingual priming. When L2 and L3 are typologically similar, high proficiency in either language enhances both orthographic and semantic priming due to shared alphabetic scripts and morphological structures (Bartolotti & Marian, 2017). However, when the languages are more distant, such as English and Chinese, the absence of shared orthographic or phonological properties necessitates higher proficiency for effective priming. In such cases, only trilinguals with advanced proficiency in both L2 and L3 are likely to exhibit facilitative priming effects, as they can access well-integrated lexical representations across languages. Zhu and Mok (2020) has tapped into this topic by examining Cantonese–English-German trilinguals, showing that cross-linguistic similarity impacts L3 word recognition. However, their study did not systematically compare conditions across orthographic and semantic dimensions, making it difficult to evaluate how formal and meaning-based cues jointly shape lexical access.

The present study seeks to move beyond these limitations in two ways. First, by examining Chinese-English-Spanish trilinguals, it extends the investigation of priming effects to learners whose languages are typologically distant, a population that has rarely been tested with such precision (Zhu & Mok, 2020). Second, the study explicitly tests the predictions of the PM, which argues that new lexical items in an additional language are anchored onto existing representations in a typologically closer non-native language, by systematically manipulating orthographic and semantic relatedness in a masked priming lexical decision paradigm.

3. The present study

The present study was built upon Dijkstra et al.'s (2023) study of a masked priming paradigm, which demonstrated that the cognate facilitation effect in balanced Dutch-English bilinguals stems from cross-linguistic similarity in both form and meaning. We aim to

extend this research to trilinguals, in particular, Chinese (L1)-English (L2)-Spanish (L3) learners. By systematically manipulating orthographically related/unrelated and semantically related/unrelated prime-target pairs, we aimed to examine how L2 English primes, which vary in orthographic and semantic relatedness to L3 Spanish targets, influence L3 word recognition. Hence our study focused on the distinct and combined effects of form (orthography) and meaning (semantics) in cross-linguistic priming. Critically, the typological distance between Chinese, English, and Spanish raises questions about the mechanisms driving L3 processing: Does L2 English act as a cognitive bridge, facilitating L3 Spanish recognition via shared orthographic or semantic features? Or do trilinguals rely more on their dominant L1 Chinese, particularly when form-meaning mappings between L2 and L3 are weak? This design allows us to assess whether L3 processing is primarily shaped by orthographic overlap, semantic overlap, or L1 dominance.

We used the PM (Ecke, 2015) serves as a key framework, examining how early-stage trilingual learners rely on L2 to L3 connections, particularly through orthographic cues. As shown in Dijkstra et al. (2023) with balanced bilinguals, no significant difference was found between orthographic neighbours and unrelated word pairs, as inhibition effects may be reduced due to co-activation, where the prime simultaneously facilitates activation of the target. Extending this logic to our trilingual participants and based on the PM, we posit that low proficiency participants are more reliant on form-based cues, leading to weak or absent inhibition. The study will offer insights into the strategies trilinguals use, with implications for models of language processing and vocabulary acquisition. Based on the aforementioned discussion, the following research questions (RQs) are proposed:

RQ1: Do L2 orthography and semantics facilitate L3 word recognition when L1 is typologically distant from L2 and L3?

RQ2: How do reaction times differ across cognates, translations, neighbors, and unrelated controls in L3 word recognition?

RQ3: How does this mechanism contribute to understanding the stages of the PM?

We hypothesise that orthographic priming will dominate in early L3 acquisition, while semantic priming remains weak due to underdeveloped form-meaning links in L3. In line with this, we hypothesise that cognates will be processed the fastest of all conditions, as they benefit from both orthographic and semantic overlap. Translations, which share only semantic overlap, are expected to show weaker or possibly absent facilitation, since form-based connections are still the primary route for L3 access at this early stage. We further hypothesise that neighbours (orthographically related but semantically unrelated) will not induce significant inhibition or will have only weak inhibitory effects. As shown in Dijkstra et al. (2023) with balanced bilinguals, no significant difference was found between orthographic neighbours and unrelated word pairs, as inhibition effects may be reduced due to co-activation, where the prime simultaneously facilitates activation of the target. Extending this logic to our trilingual participants, who are working with two non-dominant languages and relatively low proficiency in L3, we expect facilitatory effects to outweigh inhibition. Based on the Parasitic Model, we posit that at this stage, with low proficiency, participants are more reliant on form-based cues, leading to weak or absent inhibition. Our findings will contribute to the understanding of multilingual processing by revealing how trilingual learners manage the cognitive demands of

juggling three languages. Meanwhile, the study will offer insights into the strategies trilinguals use, with implications for models of language processing and vocabulary acquisition.

4. Methods

4.1. Participants

We recruited 45 second-year Spanish-major students (age: 20.17 ± 0.68 years, 35 females) from a university in Zhejiang, China. All participants were native Chinese speakers and studied English since 6 years old. To further ensure comparability, we gathered the participants' College English Test-Band 4 (CET-4, a nationwide test) scores, and found no significant differences in their performance. They have been registered to study Spanish for an average of 1.98 years (SD = 1.37) through formal instructions, with identical lesson plans and progressions, ensuring consistency in their exposure to Spanish and have not stayed in an English- or Spanish-speaking country for more than six months. As a result, they have had comparable experience of exposure to these two languages. Participants were asked to rate their proficiency on four dimensions (listening, speaking, reading, and writing) in each language on a 10-point scale, with higher scores reflecting greater proficiency. As can be seen from Table 1, participants are more proficient in L2 English than L3 Spanish, constituting a homogenous sequential Chinese (L1, native)-English (L2, intermediate)-Spanish (L3, beginning to intermediate) trilingual sample. All research procedures and materials were approved by the Institutional Review Board of the local institute. All participants signed on the informed consent form before the experiment.

4.2. Materials

Materials were selected both to align methodologically with Dijkstra et al. (2023) and to ensure participants' familiarity with target stimuli. Drawing on a priming lexical decision tasks, four conditions of English-Spanish word pairs were utilised: cognates (semantically and orthographically related), orthographic neighbours (semantically unrelated and orthographically related), translations (semantically related and orthographically unrelated), and unrelated words (semantically and orthographically unrelated). Examples of the four conditions were provided in Table 2.

There were 30 word pairs in each condition. The 120 target Spanish words were sourced from the dataset compiled by Chen and Yang (2024) and aligned with the National Spanish Level 4 Exam in China (another nationwide test) (Chen & Liang, 2023). The words were 4–5 letters long and had a Zipf frequency value greater than 3.5 (mean = 4.38, SD = 0.51), as determined by the EsPal corpus (Duchon et al., 2013). Meanwhile, the English prime words were selected from SUBTLEX-US (Brysbaert and New 2009).

Table 1. Means (and standard deviations) of participants' proficiency ratings.

	listening	speaking	reading	writing
Chinese	8.60(1.38)	8.00(1.89)	8.37(1.46)	7.73(1.98)
English	6.24(1.77)	5.38(1.92)	5.86(1.78)	5.21(1.80)
Spanish	4.96(1.80)	4.31(2.10)	4.52(2.01)	3.72(2.16)

Table 2. Examples of the four experimental conditions.

	Semantically related		Semantically unrelated	
	English	Spanish	English	Spanish
Orthographically related	*abuse*	*abuso* ('abuse')	*blush*	*blusa* ('blouse')
Orthographically unrelated	*steel*	*acero* ('steel')	*strip*	*abeja* ('bee')

Identical cognates were excluded to minimise confounding effects, allowing the study to isolate orthographic and semantic priming influences (Comesaña et al. 2015). The grouping of the four conditions was verified by two experts in Spanish linguistics. They were familiarised with the syllabus and ensured that the relevant materials had been taught by the time participants took the test. Both English and Spanish words were comparable on frequency, familiarity (Zipf value), and word length across the four conditions (Table 3). For the orthographically related conditions (i.e. cognates and orthographic neighbours), we constrained the Levenshtein Distance (LD) between each word pair to one. For example, in the cognate condition, the English – Spanish pair 'abuse' and 'abuso' differs only by one letter ('e' → 'o'); similarly, in the neighbour condition, 'blush' and 'blusa' differ by a single letter ('h' → 'a'). Conversely, for orthographically unrelated conditions, we ensured that the Levenshtein Distance exceeded 3. A full list of all materials used in the experiment is provided in the Supplementary File (see Supplementary Materials).

To ensure participants' engagement in genuine lexical processing and to prevent strategic biases (e.g. defaulting to 'YES' responses), the task included an equal number of word and pseudoword trials (1:1 ratio). Specifically, 120 pseudowords (e.g. 'abuta', 'cuoto') were constructed using UniPseudo (New et al., 2024) to be orthographically legal and phonotactically legal in Spanish to make sure the reaction time reflects this genuine lexical retrieval and decision process within Spanish.

4.3. Procedure

The experiment was coded using PsychoPy 2 (Peirce et al., 2019) and conducted in a quiet classroom. All instructions were delivered in Chinese (L1) to ensure the participants' comprehension and all stimuli were displayed in white Arial font against a grey background. The experimental procedure is displayed in Figure 1: each trial began with a fixation cross (Open Sans, 0.15 letter height) at the centre of the screen for 500 ms, followed by a forward mask of six hash marks (######) for 500 ms. The lowercase English prime

Table 3. Lexical characteristics of prime and target words across the four conditions (standard deviations in parentheses).

Condition	Prime/Target	Log_{10} WF	Zipf Value	Length
Cognate	Prime	1.26 (0.60)	4.26 (0.59)	4.8 (0.86)
	Target	1.64 (0.52)	4.64 (0.52)	4.5 (0.51)
Neighbour	Prime	1.48 (0.84)	4.48 (0.84)	5.0 (0.76)
	Target	1.41 (0.49)	4.41 (0.49)	4.5 (0.51)
Translation	Prime	1.52 (0.52)	4.52 (0.52)	5.0 (0.69)
	Target	1.28 (0.44)	4.28 (0.44)	4.8 (0.43)
Unrelated	Prime	1.72 (0.71)	4.72 (0.71)	5.2 (0.83)
	Target	1.19 (0.48)	4.19 (0.48)	4.9 (0.43)

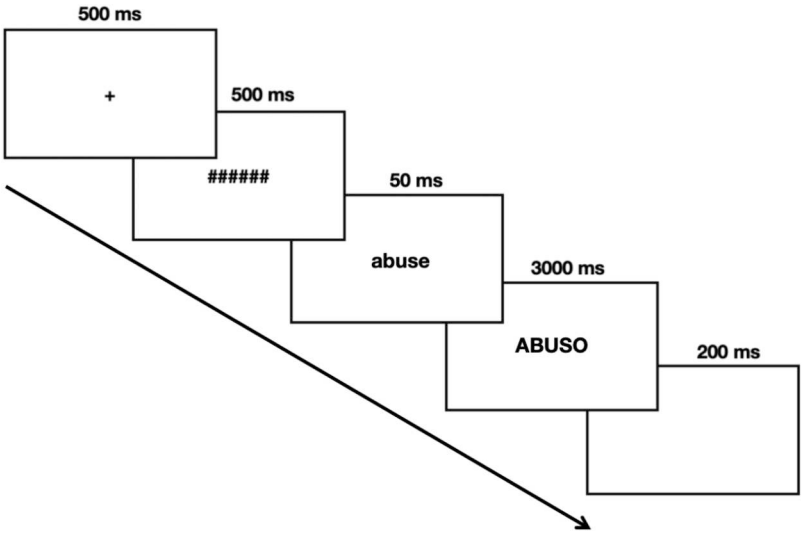

Figure 1. Trial procedure used in the masked priming lexical decision experiments.

appeared for 50 ms, immediately followed by the uppercase Spanish target. The prime is presented in lowercase letters and the target in uppercase, so as to ensure the observed effects are based on the activation of actual orthographic word forms, rather than simply the recognition of a perfect match in the characters. Targets remained visible until response, with a 3000 ms window to maintain task engagement and exclude delayed responses reflecting non-linguistic processes. After that, the screen stayed blank for 200 ms before the next trial started. The participants were instructed to determine, as quickly and accurately as possible, whether a string of letters was a real word in Spanish.

Before the formal test, there were 10 practice trials with correct/incorrect feedback. The participants were required to meet an 80% accuracy threshold to proceed to the main experiment. All trails were presented in in a randomised order. RT and accuracy rates were recorded by PsychoPy 2.

4.4. Data analysis

Data from four participants (all females) were removed from the formal analysis with an accuracy rate below 60%, resulting in a sample of 41. Data cleaning involved excluding RT below 200 ms and those exceeding 2.5 standard deviations from each participant's mean, as well as trials with accuracy below 60%. A Shapiro–Wilk test for normality indicated that the RT data were not normally distributed ($W = 0.95058$, $p < 0.001$). Consequently, a log transformation was applied to normalise the reaction time data distribution.

5. Results

5.1. RT results

RQ1 asked whether L2 orthography and semantics facilitate L3 word recognition when L1 is typologically distant from L2 and L3. A linear mixed-effects model was fitted using the

'lmer' function in R from the lme4 package, with RT as the dependent variable. The fixed effects included orthographic relatedness (ortho), semantic relatedness (sem), and their interaction (sem*ortho). Random intercepts were specified for both participants and target items to account for individual differences and item variability. The outcome of the linear mixed effects analysis on the RT data is provided in Table 4. The model indicated a significant main effect of orthographic relatedness on RT (Estimate = −0.047, SE = 0.013, t = −3.77, $p < .001$), suggesting faster word recognition for orthographically related word pairs (cognates and neighbours). In relation to RQ1, the results show that L2 orthography significantly facilitates L3 word recognition. To answer RQ2, concerning the reaction times patterns across the cognate, neighbour, translation and non-related conditions, pairwise comparisons of estimated marginal means were conducted using the emmeans package with Bonferroni correction for multiple comparisons. The results indicated that cognate condition (M = 941 ± 436 ms) was significantly faster ($p < 0.0001$) than the unrelated condition (M = 1079 ± 471 ms) by 138 ms, showcasing an overall cognate facilitation effect. In addition, the neighbour condition (M = 969 ± 444 ms) was also significantly faster ($p = 0.006$) than the unrelated condition by 110 ms.

In contrast, the effect of semantic relatedness was not significant (Estimate = −0.014, SE = 0.013, t = −1.100, $p = .270$), indicating that there is no significant difference between the semantically related word pairs (cognates and translations) and semantically unrelated word pairs (neighbours and unrelated) and no significant interaction was observed between semantic and orthographic relatedness (Estimate = −0.006, SE = 0.013, t = −0.50, $p = .62$). Therefore, L2 semantics alone does not facilitate L3 word recognition. Pairwise comparisons with Bonferroni correction showed that the translation condition (M = 1004 ± 424 ms) was 35 ms faster than the unrelated condition, although the difference was not significant (Figure 2).

5.2. Accuracy results

A generalised linear mixed-effects model (GLMM) was applied to the accuracy data using the 'glmer' function from the lme4 package, with accuracy as the dependent variable. The fixed effects included orthographic relatedness (ortho), semantic relatedness (sem), and their interaction (ortho*sem). Random intercepts were specified for both participants and target items to account for individual and item variability. The model was fitted using a binomial distribution with a logit link function. The results revealed a significant main effect of orthographic relatedness on accuracy (Estimate = 0.224, SE = 0.112, z = 2.000, $p = .045$), indicating higher accuracy rates for orthographically related word pairs than the orthographically unrelated word pairs. In contrast, semantic relatedness did not show a significant effect on accuracy (Estimate = −0.053, SE = 0.112, z = −0.470,

Table 4. Results of the Mixed Linear Model (sem: semantically related; ortho: orthographically related).

Model: RT ~ sem * ortho + (1| participant) + (1| target)				
	Estimate (SE)	df	t value	*p* value
(Intercept)	7.00272	48.87453	161.085	< 0.00001
sem	0.01519	70.75735	1.414	0.161727
ortho	0.03816	70.76541	3.553	0.000684
sem*ortho	0.00427	70.78724	0.397	0.692196

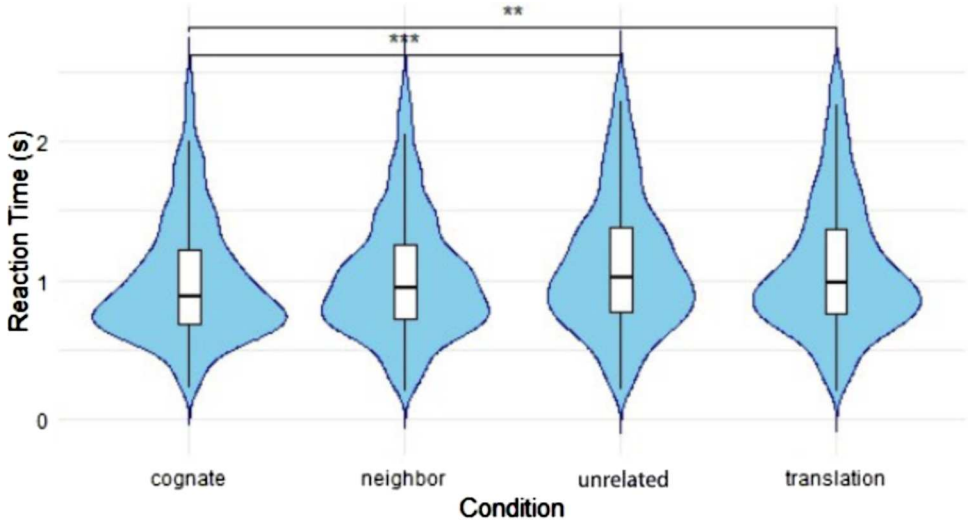

Figure 2. Comparison results across the four conditions. (** denotes $p < 0.01$, *** denotes $p < 0.001$).

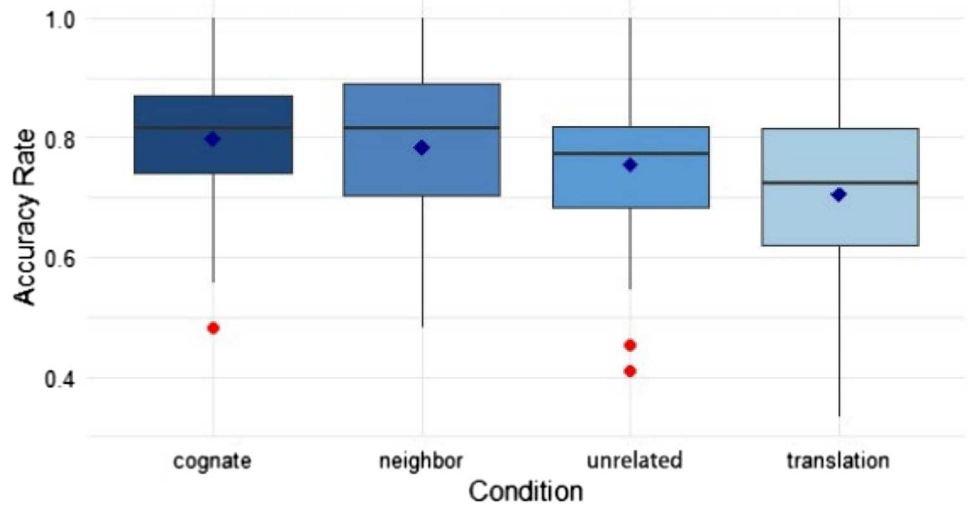

Figure 3. Accuracy rate comparison across the four conditions.

$p = .636$), and there was no significant interaction between orthographic and semantic relatedness (Estimate = 0.125, SE = 0.112, z = 1.12, $p = .264$). Taken together, this indicated that L2 orthography significantly increases the accuracy of responses to L3 words, while L2 semantics alone does not (Figure 3).

6. Discussion

The current study aimed to address the role of L2 orthography and semantics in L3 word recognition among L1 Chinese-L2 English-L3 Spanish trilinguals. Drawing on a masked

priming lexical decision task, our results revealed nuanced cross-linguistic influences, with L2 English serving as a scaffold for L3 Spanish, mainly through orthographic priming, while semantic priming effects were weak or absent. Our findings thus provided crucial support for the key aspects of the PM in trilingual processing.

To answer RQ1 concerning whether L2 orthography and semantics facilitate L3 word recognition, our findings suggest that L2 English facilitates L3 recognition through orthographic priming, specifically by speeding up the recognition of L3 words that are orthographically similar with their L2 counterparts. This finding is in line with the PM, which proposes that new L3 items initially attach to existing representations in prior languages. This is in line with our hypothesis with RQ1. A primary finding of the study was the robust facilitative effect of L2 English orthography on L3 Spanish word recognition, particularly when orthographic relatedness, such as cognates and related neighbours, was present. In these conditions, participants exhibited significantly faster reaction times, suggesting that L2 provides structural support for L3 processing by leveraging shared visual forms. However, shared orthography did not improve the accuracy. This suggests that while orthographic overlap aids early lexical access, it does not necessarily support accurate semantic retrieval. One explanation is that learners may rely on visual familiarity when encountering L3 words resembling L2 forms, leading to form-based guessing. Supporting this, Otwinowska et al. (2020) found that learners with greater cognate awareness often guessed meanings based on L1 – L2 form similarity. Similarly, Marecka et al. (2021) showed that false cognates, despite semantic mismatch, were learned more efficiently than non-cognates, likely due to the benefits of form overlap. These findings highlight the role of orthography in recognition, even when semantic access remains incomplete. While L2 facilitates L3 through orthographic pathways, semantic similarity alone has limited influence in the present study. The weak semantic priming observed suggested that automatic co-activation between L2 and L3 semantic networks had not yet fully developed. This aligned with the pattern in the early stage proposed by the PM, where learners initially relied on form-based cues and gradually shifted toward autonomous semantic representations as their proficiency as their L3 proficiency increased. These findings differ from those of Dijkstra et al. (2023), who reported strong orthographic and semantic priming effects in L1 – L2 bilinguals. In their study, both cognates and translation equivalents were recognised faster than unrelated words, pointing to robust semantic co-activation. In our study, by contrast, orthographic priming was evident, but semantic facilitation was limited. This may reflect the lower proficiency of our participants, who were Chinese L1 learners working between two non-native languages – English and Spanish – that share orthographic features but are typologically distant from their L1. Our results suggest that such cross-linguistic facilitation is more form-driven when proficiency is lower.

In line with previous bilingual studies, this study found that orthographic priming consistently led to faster reaction times and higher accuracy in trilinguals. This suggested that orthographic processing, which was less cognitively demanding, played a more prominent role in L3 word recognition, likely due to the increased cognitive complexity of managing three linguistic systems (Chen & Ng, 1989; Dijkstra et al., 2023; Lee et al., 2018). Orthographic priming produced larger facilitation effects with shorter Stimulus Onset Asynchrony (SOA) than translation priming, highlighting its efficiency. In contrast, no semantic priming was observed, particularly with a SOA of 50 ms between L2 English

primes and L3 Spanish targets. This likely reflects the participants' relatively low proficiency in the two non-native languages, as the Revised Hierarchical Model (RHM) (Kroll et al., 2010) predicts weakly connected shared conceptual node at lower proficiency levels. This finding contrasted with Aparicio and Lavaur (2016), where significant translation priming was observed at the same SOA of the current study. Prior research also suggests that short SOAs may be insufficient for semantic activation in non-native languages (Gollan et al., 1997; Jiang, 1999; Lee et al., 2018). For example, Lee et al. found that only a 150 ms SOA produced semantic effects in low-to-intermediate bilinguals. Kouider and Dupoux (2004) further argued that semantic priming depends on partial awareness of the prime, which may require longer exposure in less proficient languages. Together, these findings suggest that both proficiency and SOA interact to constrain semantic facilitation, and that longer SOAs or more advanced learners may be necessary to observe these effects.

In RQ2, we asked about how the reaction times differ across cognates, translations, neighbours, and unrelated controls in L3 word recognition. We compared reaction times across the four conditions and found that cognates elicited the fastest responses, followed closely by neighbours. Translations were slower than both cognates and neighbours, while unrelated controls produced the slowest responses overall. The advantage for cognates likely reflects the combined influence of orthographic and semantic overlap, which may strengthen cross-linguistic connections between L2 English and L3 Spanish, facilitating more efficient word recognition. Notably, orthographic neighbours – sharing form but not meaning – performed nearly as well as cognates, despite the lateral inhibition hypothesised by Dijkstra et al. (2023). Meade et al. (2018) similarly demonstrated in a typing task that L1 orthographic neighbours positively interacted with L2 word learning at early learning stages. The absence of inhibitory effects suggests that early-stage L3 learners prioritised form-based processing, allowing facilitation to override potential competition. While semantic cues played a more limited role, the translation condition was still 75 ms faster than the unrelated one, hinting at the participants' tendency to prioritise form-based cues. The lack of direct orthographic overlap between Chinese characters and Spanish words reduces the likelihood that L1 can effectively support L3 word recognition through form-meaning mappings. As a result, trilinguals may preferentially utilise L2 English semantic networks as a 'host' or scaffold to bootstrap L3 Spanish comprehension, particularly in early stages of acquisition when L3 lexical representations remain fragile.

In terms of RQ3 where we asked about how the current study contribute to the understanding of stages of the PM, our findings provide insight into the early stages of the PM. The results showed that L2 English facilitated L3 Spanish word recognition primarily through orthographic overlap, supporting the PM's prediction that learners initially rely on form-based cues from a typologically closer language. For L1 Chinese learners, whose logographic system is distant from the alphabetic scripts of English and Spanish, L2 English acted as the primary 'host' language, scaffolding L3 processing via shared orthographic patterns rather than direct L1 transfer. This aligns with prior evidence that cross-script learners depend more on form-based than semantic cues at low proficiency (Zhang et al., 2019). The absence of robust semantic priming in our data further confirmed that semantic connections between L2 and L3 remain weak in early stages of acquisition, with learners prioritising orthographic over conceptual links. Similar

trends have been observed in trilingual studies, such as Chen (2020), who showed that L2 served as the main host when its proficiency was high, and Zhu and Mok (2020), who found that overlap between two non-native languages facilitated recognition even with limited L3 proficiency. These findings along with ours suggest that typological proximity, rather than L1 dominance, drives early parasitic connections in accordance with the PM (Ecke, 2015). Methodologically, our study advanced the field by systematically manipulating orthographic and semantic relatedness in a factorial masked priming design. This allowed us to directly compare cognates, neighbours, translations, and unrelated controls, providing clearer insight into how form and meaning jointly influence L3 word recognition. Our results also mirror broader evidence from trilinguals with complex language combinations (e.g. Chinese-English-Japanese; Kim et al., 2016) showing that language proximity exerts a stronger influence at low proficiency. In sum, the current study supports the PM by demonstrating that, when L3 proficiency is relatively low, form-based cues dominate. Future research should examine whether, as L3 proficiency grows, learners continue to rely on L2 as the primary host or shift toward direct L1-L3 connections.

These findings extend prior research on cumulative cross-linguistic influence by showing that facilitation can still occur when only two of the three known languages are involved. While studies such as Szubko-Sitarek (2011), Lemhöfer and Dijkstra (2004), and Foryś-Nogala et al. (2025) demonstrated strong facilitation for triple cognates in alphabetic-language trilinguals, our results show that L2 – L3 overlap alone can support L3 word recognition – even without L1 involvement. This pattern aligns with bilingual research, which has shown that cross-linguistic facilitation depends more on the quality of overlap between two languages than on the number of systems activated. In typologically diverse trilinguals, where L1 may not provide usable form-based cues, facilitation appears to emerge through selective reliance on the structurally closest language – in this case, L2 English. Thus, our study adds nuance to cumulative CLI accounts, highlighting the role of typological alignment and representational similarity in shaping multilingual lexical access. Future studies can include learner profiles as in the current study (trilinguals who use different writing systems across their three languages) and to examine whether phonological overlap can also trigger L1 activation in the absence of shared script.

7. Conclusions and future directions

The current study revealed significant cross-linguistic influences in Chinese-English-Spanish lexical processing, with L2 English serving as a scaffold for L3 Spanish, particularly through orthographic priming effects. The observed patterns of orthographic priming suggested that when L3 proficiency is low, these learners are still in the early stages of the PM, relying heavily on form-based connections while gradually building more autonomous L3 representations. The absence of strong semantic priming effects indicates that L3 semantic networks are not yet fully established, which has implications for multilingual education and curriculum design.

Specifically, these findings have practical implications for multilingual education in China, where many L1 Chinese learners with intermediate English are studying typologically similar L3 languages, such as Spanish or French. The strong orthographic facilitation observed suggests that educators can leverage orthographic overlap between L2 and L3

to support vocabulary acquisition. By focusing initially on form-based strategies, learners can build a foundation for recognising L3 words more efficiently. However, to foster long-term language proficiency, instructional strategies should also incorporate semantic integration. Approaches such as context-based learning and semantic mapping can help learners gradually transition from orthographic reliance to deeper semantic processing.

One limitation of our study is that we only included participants with a rather fixed level of proficiency (i.e. intermediate in L2 and low to intermediate in L3). Future studies should explore how parasitic connections between L2 and L3 evolve as proficiency increases, particularly in Chinese contexts. Longitudinal studies could investigate how learners move from orthographic to semantic reliance as L3 proficiency increases, offering insights into the role of language typology and cognitive factors in shaping cross-linguistic transfer. In addition, future research should explore how increased L3 proficiency influences the balance between orthographic and semantic priming, and whether the facilitation effects observed here persist at more advanced stages of the PM. Additionally, extending this research to other typologically distant languages will help clarify whether these findings are specific to L1 Chinese learners or generalisable to other multilingual populations. By integrating these insights, we can develop a more comprehensive model of multilingual word recognition that accounts for the distinct cognitive strategies employed by trilinguals.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Data availability statement

Data is available upon request.

References

Abutalebi, J., Della Rosa, P. A., Ding, G., Weekes, B., Costa, A., & Green, D. W. (2013). Language proficiency modulates the engagement of cognitive control areas in multilinguals. *Cortex*, *49*(3), 905–911. https://doi.org/10.1016/j.cortex.2012.08.018

Aparicio, X., & Lavaur, J. M. (2016). Masked translation priming effects in visual word recognition by trilinguals. *Journal of Psycholinguistic Research*, *45*(6), 1369–1388. https://doi.org/10.1007/s10936-015-9409-8

Bartolotti, J., & Marian, V. (2017). Bilinguals' existing languages benefit vocabulary learning in a third language. *Language Learning*, *67*(1), 110–140. https://doi.org/10.1111/lang.12200

Brysbaert, M., & New, B. (2009). Moving beyond Kučera and Francis: A critical evaluation of current word frequency norms and the introduction of a new and improved word frequency measure for American English. *Behavior Research Methods*, *41*(4), 977–990. https://doi.org/10.3758/BRM.41.4.977

Chen, H., & Liang, Q. (2023). 西班牙语三语习得者的语素意识研究 [A study on morphological awareness of Spanish trilingual learners]. *Linguistic Research*, *01*, 155–167.

Chen, H., & Yang, M. (2024). Comparative analysis of cognates in two datasets in Spanish teaching in China. *Cuadernos de Lingüística Hispánica*, *43*(2024), e17531. https://doi.org/10.19053/uptc.0121053X.n43.2024.17531

Chen, H. C., & Ng, M. L. (1989). Semantic facilitation and translation priming effects in Chinese-English bilinguals. *Memory & Cognition*, *17*(4), 454–462. https://doi.org/10.3758/BF03202618

Chen, J. (2020). How do L3 words find conceptual parasitic hosts in typologically distant L1 or L2? Evidence from a cross-linguistic priming effect. *International Journal of Bilingual Education and Bilingualism*, *23*(10), 1238–1253. https://doi.org/10.1080/13670050.2018.1439879

Clyne, M. (1997). Some of the things trilinguals do. *International Journal of Bilingualism*, *1*(2), 95–116. https://doi.org/10.1177/136700699700100201

Comesaña, M., Ferré, P., Romero, J., Guasch, M., Soares, A. P., & García-Chico, T. (2015). Facilitative effect of cognate words vanishes when reducing the orthographic overlap: The role of stimuli list composition. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *41*(3), 614–635. https://doi.org/10.1037/xlm0000065

De Bot, K., & Jaensch, C. (2015). What is special about L3 processing? *Bilingualism: Language and Cognition*, *18*(2), 130–144. https://doi.org/10.1017/S1366728913000448

De Groot, A. M., & Nas, G. L. (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

Dijkstra, A. F. J., & Van Heuven, W. J. (2018). *Visual word recognition in multilinguals*. Oxford University Press.

Dijkstra, T., Hilberink-Schulpen, B., & Van Heuven, W. J. (2010). Repetition and masked form priming within and between languages using word and nonword neighbors. *Bilingualism: Language and Cognition*, *13*(3), 341–357. https://doi.org/10.1017/S1366728909990575

Dijkstra, T., Peeters, D., Hieselaar, W., & van Geffen, A. (2023). Orthographic and semantic priming effects in neighbour cognates: Experiments and simulations. *Bilingualism: Language and cognition*, *26*(2), 371–383. https://doi.org/10.1017/S1366728922000591

Dijkstra, T., & Van Heuven, W. J. (2002). The architecture of the bilingual word recognition system: From identification to decision. *Bilingualism: Language and cognition*, *5*(3), 175–197. https://doi.org/10.1017/S1366728902003012

Duchon, A., Perea, M., Sebastián-Gallés, N., Martí, A., & Carreiras, M. (2013). Espal: One-stop shopping for Spanish word properties. *Behavior Research Methods*, *45*(4), 1246–1258. https://doi.org/10.3758/s13428-013-0326-1

Ecke, P. (2015). Parasitic vocabulary acquisition, cross-linguistic influence, and lexical retrieval in multilinguals. *Bilingualism: language and cognition*, *18*(2), 145–162. https://doi.org/10.1017/S1366728913000722

Ecke, P., & Hall, C. J. (2014). The parasitic model of L2 and L3 vocabulary acquisition: Evidence from naturalistic and experimental studies. *Fórum Linguístico*, *11*(3), 360–372. https://doi.org/10.5007/1984-8412.2014v11n3p360

Forster, K. I., & Davis, C. (1984). Repetition priming and frequency attenuation in lexical access. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *10*(4), 680–698. https://doi.org/10.1037/0278-7393.10.4.680

Forster, K. I., Mohan, K., Hector, J., Kinoshita, S., & Lupker, S. J. (2003). The mechanics of masked priming. In S. Kinoshita & S. J. Lupker (Eds.), *Masked priming: The state of the art* (pp. 3–37). Psychology Press.

Foryś-Nogala, M., Silva, B., Ambroziak, A., Broniś, O., Janczarska, A., Jastrzębski, B., & Otwinowska, A. (2025). Cumulative L1–L2–L3 lexical similarity versus L2–L3 lexical similarity: What impacts learners' L3 word knowledge and L3 word processing more? *Bilingualism: Language and Cognition*, 1–14. https://doi.org/10.1017/S1366728925000410

Gollan, T. H., Forster, K. I., & Frost, R. (1997). Translation priming with different scripts: Masked priming with cognates and noncognates in Hebrew–English bilinguals. *Journal of Experimental Psychology: Learning, memory, and cognition*, *23*(5), 1122. https://doi.org/10.1037/0278-7393.23.5.1122

Hall, C. J., & Ecke, P. (2003). Parasitism as a default mechanism in L3 vocabulary acquisition. In J. Cenoz, B. Hefeisen, & U. Jessner (Eds.), *The multilingual lexicon* (pp. 71–85). Kluwer Academic Publishers.

Jiang, N. (1999). Testing processing explanations for the asymmetry in masked cross-language priming. *Bilingualism: Language and Cognition*, *2*(1), 59–75. https://doi.org/10.1017/S1366728999000152

Kim, S. Y., Qi, T., Feng, X., Ding, G., Liu, L., & Cao, F. (2016). How does language distance between L1 and L2 affect the L2 brain network? An fMRI study of Korean–Chinese–English trilinguals. *NeuroImage*, *129*, 25–39. https://doi.org/10.1016/j.neuroimage.2015.11.068

Kouider, S., & Dupoux, E. (2004). Partial awareness creates the "illusion" of subliminal semantic priming. *Psychological Science*, *15*(2), 75–81. https://doi.org/10.1111/j.0963-7214.2004.01502001.x

Kroll, J. F., Van Hell, J. G., Tokowicz, N., & Green, D. W. (2010). The revised hierarchical model: A critical review and assessment. *Bilingualism: Language and Cognition*, *13*(3), 373–381. https://doi.org/10.1017/S136672891000009X

Lee, Y., Jang, E., & Choi, W. (2018). L2-L1 translation priming effects in a lexical decision task: Evidence from low proficient Korean-English bilinguals. *Frontiers in Psychology*, *9*, 267. https://doi.org/10.3389/fpsyg.2018.00267

Lemhöfer, K., & Dijkstra, T. (2004). Recognizing cognates and interlingual homographs: Effects of code similarity in language-specific and generalized lexical decision. *Memory & Cognition*, *32*(4), 533–550. https://doi.org/10.3758/BF03195845

Lim, J. H., & Ahn, H. D. (2024). Trilingual word recognition: Phonological priming effects in trilingual with different-script languages. 영어학, *24*, 921–933.

Lindqvist, C., & Bardel, C. (2013). Exploring the impact of the proficiency and typology factors: Two cases of multilingual learners' L3 learning. In M. Pawlak & L. Aronin (Eds.), *Essential topics in applied linguistics and multilingualism: Studies in honor of David Singleton* (pp. 253–266). Springer International Publishing.

Lindqvist, C., & Falk, Y. (2014). When Germans begin to learn Swedish: Which is the transfer source for function words, content words and syntax? *Eurosla Yearbook*, *14*(1), 225–239. https://doi.org/10.1075/eurosla.14.09lin

Madrazo, A. R., & Bernardo, A. B. (2018). Measuring two types of inhibitory control in bilinguals and trilinguals: Is there a trilingual advantage? *Psychological Studies*, *63*(1), 52–60. https://doi.org/10.1007/s12646-018-0439-9

Marecka, M., Szewczyk, J., Otwinowska, A., Durlik, J., Foryś-Nogala, M., Kutyłowska, K., & Wodniecka, Z. (2021). False friends or real friends? False cognates show advantage in word form learning. *Cognition*, *206*, 104477. https://doi.org/10.1016/j.cognition.2020.104477

McCarthy, K. M., Mahon, M., Rosen, S., & Evans, B. G. (2014). Speech perception and production by sequential bilingual children: A longitudinal study of voice onset time acquisition. *Child Development*, *85*(5), 1965–1980. https://doi.org/10.1111/cdev.12275

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

Meade, G., Midgley, K. J., Dijkstra, T., & Holcomb, P. J. (2018). Cross-language neighborhood effects in learners indicative of an integrated lexicon. *Journal of Cognitive Neuroscience*, *30*(1), 70–85. https://doi.org/10.1162/jocn_a_01184

Mulder, K., Van Heuven, W. J., & Dijkstra, T. (2018). Revisiting the neighborhood: How L2 proficiency and neighborhood manipulation affect bilingual processing. *Frontiers in Psychology*, *9*, 1860. https://doi.org/10.3389/fpsyg.2018.01860

New, B., Bourgin, J., Barra, J., & Pallier, C. (2024). Unipseudo: A universal pseudoword generator. *Quarterly Journal of Experimental Psychology*, *77*(2), 278–286. https://doi.org/10.1177/17470218231164373

Olson, D. J. (2017). Bilingual language switching costs in auditory comprehension. *Language, Cognition and Neuroscience*, *32*(4), 494–513. https://doi.org/10.1080/23273798.2016.1250927

Otwinowska, A. (2024). Cross-linguistic influence and language co-activation in acquiring L3 words: What empirical evidence do we have so far? *Second Language Research*, *40*(3), 765–783. https://doi.org/10.1177/02676583231176371

Otwinowska, A., Foryś-Nogala, M., Kobosko, W., & Szewczyk, J. (2020). Learning orthographic cognates and non-cognates in the classroom: Does awareness of cross-linguistic similarity matter? *Language Learning*, *70*(3), 685–731. https://doi.org/10.1111/lang.12390

Peeters, D., Dijkstra, T., & Grainger, J. (2013). The representation and processing of identical cognates by late bilinguals: RT and ERP effects. *Journal of Memory and Language*, *68*(4), 315–332. https://doi.org/10.1016/j.jml.2012.12.003

Peirce, J., Gray, J. R., Simpson, S., MacAskill, M., Höchenberger, R., Sogo, H., … Lindeløv, J. K. (2019). Psychopy2: Experiments in behavior made easy. *Behavior Research Methods*, *51*(1), 195–203. https://doi.org/10.3758/s13428-018-01193-y

Poarch, G. J., & Van Hell, J. G. (2012). Executive functions and inhibitory control in multilingual children: Evidence from second-language learners, bilinguals, and trilinguals. *Journal of Experimental Child Psychology*, *113*(4), 535–551. https://doi.org/10.1016/j.jecp.2012.06.013

Poort, E. D., & Rodd, J. M. (2017). The cognate facilitation effect in bilingual lexical decision is influenced by stimulus list composition. *Acta Psychologica*, *180*, 52–63. https://doi.org/10.1016/j.actpsy.2017.08.008

Rothman, J., Alonso, J. G., & Puig-Mayenco, E. (2019). *Third language acquisition and linguistic transfer (Vol. 163)*. Cambridge University Press.

Schröter, P., & Schroeder, S. (2016). Orthographic processing in balanced bilingual children: Cross-language evidence from cognates and false friends. *Journal of Experimental Child Psychology*, *141*, 239–246. https://doi.org/10.1016/j.jecp.2015.09.005

Szubko-Sitarek, W. (2011). Cognate facilitation effects in trilingual word recognition. *Studies in Second Language Learning and Teaching*, *1*(2), 189–208. https://doi.org/10.14746/ssllt.2011.1.2.2

Wang, T., & Yang, J. (2025). The semantic access mechanism of L3 Spanish words: Evidence from a cross-linguistic priming effect by Chinese native speakers. *Review of Cognitive Linguistics*. https://doi.org/10.1075/rcl.00175.wan

Wang, X., Steinman, C., & Taft, M. (2023). Priming asymmetry persists in German-English-French trilinguals: The sense model modified for the trilingual mental lexicon. *Language, Cognition and Neuroscience*, *38*(7), 983–1000. https://doi.org/10.1080/23273798.2023.2189274

Zhang, J., Wu, C., Zhou, T., & Meng, Y. (2019). Cognate facilitation priming effect is modulated by writing system: Evidence from Chinese-English bilinguals. *International Journal of Bilingualism*, *23*(2), 553–566. https://doi.org/10.1177/1367006917749062

Zhu, Y., & Mok, P. P. K. (2020). Visual recognition of cognates and interlingual homographs in two non-native languages: Evidence from Asian adult trilinguals. *Linguistic Approaches to Bilingualism*, *10*(4), 441–470. https://doi.org/10.1075/lab.17049.zhu