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Do bilinguals represent between-language relationships beyond the word level in their lexicon?

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Abstract

There is much evidence that the bilingual lexicon is well integrated at the level of individual words. In this article, we propose that it is also integrated at the multiword phrase (MWP) level. We first review the representation of single words within and across languages. Drawing upon this framework, we review current accounts of MWP representations and supporting empirical evidence. Based on the reported parallels between single words and MWPs in many aspects of representation and processing, we propose that MWPs, like single words, also have integrated representations across languages. We then sketch two accounts of how such MWPs might be represented across languages: the online activation model and the learning-based model. Both accounts show how MWPs can be linked across languages at a level corresponding to phrases by sharing meaning and syntax. Importantly, the online activation account regards the between-language MWP links as a channel for cross-language activation during MWP processing. In contrast, the learning-based model treats the links as a channel for reshaping of representation in one lexicon by the other lexicon during MWP learning. We briefly evaluate the two accounts and discuss how to test some of the assumptions of the models.

Keywords: multiword phrase, bilingual lexicon, between-language link, online activation, learning-based

1. Introduction

Over the last two decades, research interest in lexical representation and processing has expanded from a focus on single words to larger lexical units – that is, multiword phrases (MWPs) such as *a cup of tea*, *major problem, don't have to worry,* or *go to the doctor*. Previous studies have shown that MWPs and single words have substantial similarities in many aspects of representation and processing. They suggest that MWPs, like single words, can be stored (Bybee, 2007; Jackendoff, 2002) and can become building blocks of language use and learning (Arnon & Christiansen, 2017; Arnon, McCauley, & Christiansen, 2017).

At the same time, MWP research is also relevant to the fields of second language learning and bilingualism. Some recent studies have investigated whether L2 representation of MWPs is similar to L1 representation (Siyanova-Chanturia, Conklin, & Van Heuven, 2011; Sonbul, 2015). But less research has been devoted to how L2 speakers, as bilinguals, represent MWP across languages. For example, if the phrase *a cup of tea* is a MWP in their L1 and its translation is a MWP in their L2, do they represent a link between these MWPs? In this article, we discuss this issue and consider possible models for how MWPs might be related between L1 and L2.

To that end, we organize this paper as follows. After a brief summary of existing models of single word representation within and between languages, we review current accounts of MWP representation, which have drawn much on the framework of single word representation. We then propose that bilinguals may represent a between-language relationship for MWP, similar to the way they represent a between-language relationship for their single word counterparts. Finally, we offer two possible models that could account for this relationship and suggest ways to test them.

2. Models of single word representation within language

To see why cognitive approaches to MWP fall within the scope of lexical research, we need to understand the representational features of typical lexical items – that is, single words. It has long been assumed that single words are stored in the mental lexicon. Researchers have proposed theoretical models of how each word in the mental lexicon is organized and stratified. Here we summarize two issues that are of most interest for current purposes.

The first point is that theories assume the existence of representational levels for single words, and that those levels are at least partly independent of each other. Some models of word production distinguish conceptual, syntactic (i.e., lemma), and sound-based (i.e., lexeme) levels of single word representation (e.g., Levelt, Roelofs, & Meyer, 1999). Other accounts assume slightly different levels (e.g., Caramazza, 1997; Dell, 1986). Models of word recognition also assume different representational levels, for example, the feature, the letter, and the word level of representation (e.g., Interactive Activation Model, McClelland & Rumelhart, 1988) or the phonological and orthographical level (and sometimes also semantic level, e.g., Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001). All such models assume inter-level connections, thereby providing channels for activation to spread from one level of representation to another during language use (although whether the flow is staged or cascaded is debated). These models are useful for locating the level(s) at which particular phenomena occur, such as the word superiority effect (i.e., letters are recognized better in words than non-words; Reicher, 1969), tip-of-tongue states (e.g., Brown & McNeill, 1966), speech errors (e.g., word blending; Fromkin, 1971), and picture-word effects (e.g., presentation of semantically related words interferes with picture-naming latencies; Schriefers, Meyer, & Levelt, 1990).

An important factor associated with word representation is frequency. Many studies have found that the ease of word recognition and production are influenced by a word's frequency of occurrence in the language (see Brysbaert, Mandera, & Keuleers, 2018; Oldfield & Wingfield, 1965). Some classical theories believe that information about frequency is "tagged" to the word representation, with words being ordered or having different resting levels of activation according to their frequency (Forster, 1976; Morton, 1969; Norris, 1986), in ways that may arise from experience or practice (see Monsell, Doyle, & Haggard, 1989). Taken together, language users keep track of information capturing the probability of word occurrence and contributing to its representational strength in the lexicon, which manifests as different levels of resting activation. Although there is controversy about the locus of the frequency effect in word recognition (compare e.g., Allen, Smith, Lien, Grabbe, & Murphy, 2005; Paap, Johansen, Chun, &Vonnahme, 2000) and in word production (compare e.g., Jescheniak & Levelt, 1994; Knobel, Finkbeiner, & Caramazza, 2008), but it is generally assumed that frequency is associated with word representation and thereby affects word use. However, as we discuss below, frequency is not only an index of representation and processing for single words, but also an index of representation and processing for multiword phrases.

The second issue is the representational structure of morphologically complex words. The key concern is whether complex words are represented as constituent morphemes (full-decomposition) or have distinct whole-word representations (full-listing). The full-decomposition approach (Taft, 1988; Taft & Forster, 1976) assumes that the basic unit of representation is individual morphemes. This approach is supported by evidence for priming of constituent morphemes (e.g., *clean*) by exposure to words related by inflectional or derivational morphology or through compounding (Rastle, Davis, & New, 2004; Stanners, Neiser, Hernon, & Hall, 1979), suggesting that people segment the morphologically complex word into individual parts.

In contrast, the full-listing approach claims that the basic unit of representation is the whole word (Bybee, 1995). This approach is supported by evidence that the whole-word frequency instead of the constituent morpheme frequency determines production time (Janssen, Bi, & Caramazza, 2008). It is also consistent with the finding that words (e.g., *balayageand*) are primed equally by exposure to their roots (e.g., *balai*) or by derived words (e.g., *balayeur*; Giraudo & Grainger, 2001), suggesting that derived words are not representationally different from free roots. Note that under the full-decomposition approach, the priming effect induced by derived words would be predicted to be smaller than that induced by free roots, as the former would have required extra time for breaking into individual morphemes.

More recently, a mixed representational view has gained ground as many studies have found that both whole-word and constituent properties influence compound processing (e.g. Kuperman, Bertram, & Baayen, 2008). A specific account is Libben's Morphological Transcendence Hypothesis (Libben, 2014), which postulates an inclusive approach to compound representation that embraces three elements: decomposition of the compound (e.g., [blue], [berry]), structured whole-word listing (e.g., [[blue-][-berry]]), and an independent lexical representation of the positional bound constituents (e.g., [blue-], [-berry]). This view proposes that people lexically represent both whole words and their component parts (and so there is redundancy in the lexicon). As we shall see, this emphasis is also mirrored in recent approaches to multiword phrase representations.

3. Models of single word representation between languages

An important question is how bilinguals (i.e., people who speak more than one language) represent single words in their two languages, and in particular how these representations are related to each other. An underlying issue is whether different languages' lexical entries are integrated or separated within the bilingual lexicon, and how this organization might affect bilinguals' lexical processing. Currently, most theories assume that the bilingual lexicon is well integrated. This is the case both for separate theories of bilingual word recognition (Dijkstra & Van Heuven, 2002; Shook & Marian, 2013) and production/translation (e.g. Costa, 2005; Kroll & Stewart, 1994), and more recently for an integrated theory of word recognition and translation (Dijkstra, Wahl, Buytenhuijs, Van Halem, Al-Jibouri, De Korte, & Rekke, 2018). Nevertheless, the degree of integration may differ across levels of lexical representation. In particular, there is likely to be more overlap in the meaning (conceptual) representation than in the form representation for translational words (except for cognates; see below).

But bilinguals do not seem to keep word form representations in their two languages entirely apart. For example, in the visual world experiments, where bilinguals match a picture with a word they just heard, bilinguals look more to distractor pictures with word form (e.g., *marker*) that is related to the translation of the target picture name (*marku*, meaning "stamp" in Russian) than to other irrelevant pictures (Marian, Spivey, & Hirsch, 2003; Spivey & Marian, 1999). Additionally, their judgments of the semantic relatedness of words in one language are affected by their form relatedness in their other language (e.g., the relationship between the Chinese translation forms *huoche-huotui* modulates the N400 effect when Chinese-English bilinguals judge the unrelated English word pairs *train-ham*; Thierry & Wu, 2007). Other studies found that bilinguals' lexical decision for a word (e.g. *east*) was facilitated by a brief presentation of a semantically-unrelated word (e.g., *thin*g) whose translation was form-related to the translation of the target word (e.g., their respective Chinese translations *dong* and *dongxi* share the first morpheme; Zhang, Van Heuven, & Conklin, 2011). Together, these findings indicate that the forms are stored in a related manner to each other across languages. They suggest that representations in the bilingual lexicon are interconnected in a way that affects word use (though see discussion of Costa, Pannunzi, Deco, & Pickering, 2017, below).

A special case is cognates: translation pairs that share both meaning and form across languages (e.g., English and French cognate: *film*). Many studies have found an advantage for cognates relative to non-cognates in bilingual speakers' word processing – that is, faster response latencies for cognates versus non-cognates (Costa, Caramazza, & Sebastian-Galles, 2000; De Groot & Nas, 1991; Duyck, Van Assche, Drieghe, & Hartsuiker, 2007; Strijkers, Costa, &Thierry, 2010). This cognate facilitation has led to a debate about whether cognates have a single cross-linguistic representation or instead are represented twice, once for each language. Although researchers generally agree that cognates share a single conceptual (meaning) representation, they disagree on how cognates are represented at other level(s).

For example, the *one-morpheme* and *two-morpheme* controversy centers on whether cognates have a single cross-linguistic representation or two separate representations at the morphological level. The *one-morpheme representation view* (e.g., Lalor & Kirsner, 2000; Sánchez-Casas, Davis, & García-Albea, 1992) assumes that there is a single cognate morpheme shared between languages. Thus, word occurrences in either language would contribute to its (cross-linguistic) representational strength. Under this view, frequency effects during cognate processing would be cumulative (e.g., Davis, Sánchez-Casas, García-Albea, Guasch, Molero, & Ferré, 2010). In contrast, the *two-morpheme representation view* (e.g., Dijkstra, Grainger, & Van Heuven, 1999) assumes that cognates are represented separately in each language at the morphological level. Word occurrences in one language contribute to its representational strength only in that language. Consequently, frequency effects during cognate processing would be independent (non-cumulative).

Peeters, Dijkstra, and Grainger (2013) contrasted the two competing views of cognate representations by investigating French-English orthographically identical cognates. Both the French and English frequency of cognate words affected reaction times and N400 amplitudes when late French-English bilinguals made lexical decisions in English, their second language (L2). Most importantly, words with high English but low French frequency (HELF cognates) were processed faster than those with low English but high French frequency (LEHF), suggesting that the target language property (e.g., English frequency) played a larger role than the non-target language property (e.g., French frequency) in cognate processing. This finding argues against the *one-morpheme view* that explains cognate facilitation in terms of cumulative frequency and instead attributes greater importance to the frequency of the native language (L1), the non-target language.

The combined findings indicate that separate representations of translation words, with shared or non-shared forms, may exist at many levels in their own language, but are interconnected across languages either by a direct lexical link (see Dylman & Barry, 2018) or via shared conceptual or combinatorial nodes (see Schoonbaert, Hartsuiker, & Pickering, 2007, for discussion of lexical-syntactic representations in the bilingual lexicon). Together, these studies highlight between-language links at the word level in the bilingual mind.

4. Representations of multiword phrases within language

In contrast to traditional linguistic frameworks, in which lexical items are always words (or morphemes), more recent views see lexical items as being of heterogeneous sizes, and include MWPs. Traditionally, a lexicon primarily contains individual words or morphemes that cannot be further decomposed (e.g., word stems and affixes; Pinker, 1991). These atomic elements are combined into complex words, phrases or sentences by applying combinatorial rules, without being stored redundantly in the lexicon (non-compositional idioms excepted; Chomsky, 1965). However, Jackendoff (2002) put (compositional or non-compositional) multiword phrases at an equal status to single words in the lexicon. He further argued that MWPs are stored in the lexicon with their internal syntactic structure (e.g., VP, NP, PP) (see Figure 1 for the representation of "take to task" as an example), which explains why some of the stored elements also conform to syntactic rules that generate novel expressions online. This "extended" view of the lexicon was echoed and reinforced in recent work that identified various types of MWP (idioms, collocations, compounds, and syntactic constructions) that can be stored, thus fully extending the concept of lexical items to include linguistic items larger than words (Culicover, Jackendoff, & Audring, 2017).

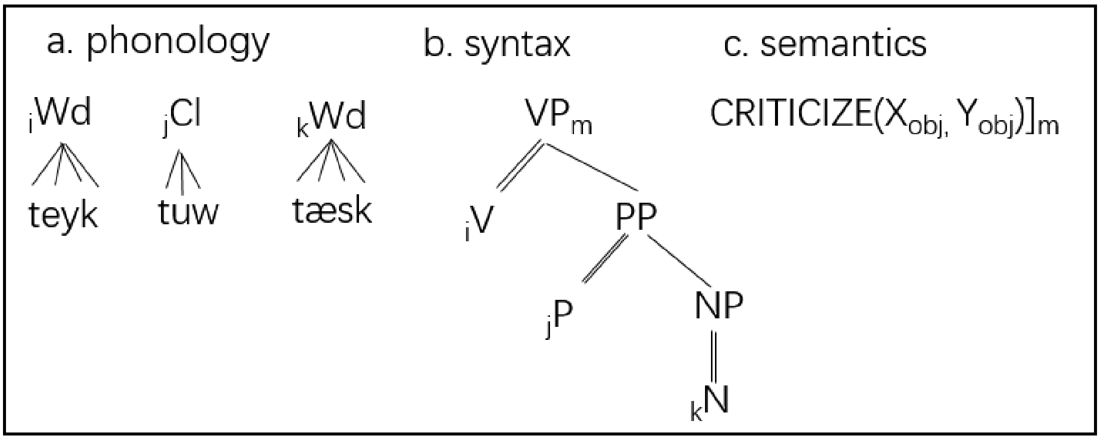

Figure 1. Linguistic representation of "take to task" under Jackendoff's (2002) account of the mental lexicon (adapted from Jackendoff, 2002: 170). A lexical item is viewed as a long term memory association of phonological, syntactic and semantic features. The figure shows that each component word of the phrase "take to task" may have distinct morphophonological representations (*Wd* and *Cl* are abbreviations for

word and *clitic*), but they are combined under a single VP structure (VP, PP and NP are abbreviations for verb phrase, prepositional phrase and noun phrase), and mapped as a whole to the meaning "CRITICIZE" (X and Y represent two conceptual constituents that belong to objects). The subscripts indicate coindexation.

Jackendoff's (2002) style of lexical representation has implications for the psychological modeling of MWP representation. Its subcomponents appear well-related to the representational levels in classic psychological models (e.g., Levelt et al., 1999). For instance, the phonological component of a lexical entry corresponds to the lexeme level; the syntactic component to the lemma level; the semantic component to the conceptual level. The three components are associated with each other through what Jackendoff called "interface rules," as he saw the function of lexical items as interfaces between phonology, syntax, and semantics. On this account, the MWPs are stored with their syntactic structure. It suggests that such elements (compositional or noncompositional) can be represented at the lemma level (see Sprenger, Levelt, & Kempen, 2006, for empirical evidence for a "superlemma").

Recent studies support the storage of MWPs by showing that access to the MWPs, like single words, is sensitive to frequency. As noted above, frequency is a factor that has been established to robustly influence lexical access. Hence if MWPs are indeed represented in the lexicon, they should also show frequency effects during processing. And indeed this is what Arnon and Snider (2010) found in a phrase-acceptability judgment task, where native speakers of English judged four-word sequences as making sense more quickly when they had higher frequencies (e.g., *don't have to worry*) than lower frequencies (e.g., *don't have to wait*). Importantly, this effect occurred even when the frequencies of the individual words were controlled. Other studies have also found similar MWP frequency effects among native speakers in sentence reading (Tremblay, Derwing, Libben, & Westbury, 2011) and in production (Bannard & Matthews, 2008; Janssen & Barber, 2012). These results therefore provide strong evidence that native speakers' lexical representations are not restricted to representations of individual words, but also include representations of frequently occurring sequences of words – that is, MWPs.

There is also evidence that non-native (L2) speakers have representations of MWPs. A few studies have shown that L2 speakers, similar to native (L1) speakers, track the surface frequency of MWPs in a language. For instance, Siyanova-Chanturia et al. (2011) found that L2 speakers of English, like their L1 counterparts, spent less time and made fewer eye fixations when reading more frequent binominal phrases (e.g., *bride and groom*) than their less frequent reversed forms (e.g., *groom and bride*) in sentences. Similarly, Sonbul (2015) showed that L2 English speakers, regardless of their proficiencies, had shorter first-pass reading latencies when reading more frequent two-word collocations (e.g., *fatal mistake*) than less frequent ones (e.g., *awful mistake*) in sentences, when frequencies of the constituent words were controlled. These results are consistent with findings from L1 speakers, thus suggesting that the extended view of lexical representation applies more broadly to L2 as well as to L1.

Although proposals for the lexical status of MWPs are gaining ground, researchers are cautious about whether MWPs are representationally independent from their constituent words. Arguably, if an MWP developed a representation detached from its constituents as free words, its constituent properties should no longer influence its access. However, this possibility is refuted by recent findings that both multiword frequency and individual word frequency affect MWP use in spontaneous speech. Specifically, both higher trigram and word frequency led to a shorter phonetic duration of the middle word, and the word frequency effect did not disappear even when trigrams had very high frequency (Arnon & Priva, 2014). The parallel use of the MWP and the constituent word knowledge suggests that both the MWP as a whole and its component words are stored and connected to each other in the lexicon. This proposal is analogous to proposals concerning the representation of morphologically complex words, in that both the whole-word representation and the individual morphemes coexist in the lexicon. Therefore, empirical evidence is also consistent with the lexical redundancy view of the lexicon (Jackendoff, 2002).

5. Representations of multiword phrases between languages

So far, we have seen a trend to consider MWPs as part of lexical research. This approach is not only theoretically reflected in the proposal that MWPs may develop lexical status in the lexicon as single words, but is also empirically supported by findings that access to MWPs is subject to phrase frequency in the same way as access to individual words is subject to word frequency. We also see a structural resemblance of MWP representations to those of morphologically complex words, as they both encode a part-and-whole relationship between the multiword and word levels. Together, these studies suggest that there are parallels between the representations of single words and MWPs.

So how are MWPs represented in bilinguals? As we have seen, there is evidence that speakers have MWP representations in not only their L1 but also their L2. But what is the relationship between these representations? In particular, do bilinguals maintain strictly separate representations for MWPs in each language, or do they instead develop between-language relationships for MWPs as they do for single words? In principle, bilinguals might maintain separate MWP representations. But given the evidence that bilingual representation of single words involves not only representations in each language, but also the integration of representations between languages, and the parallels between the representations of single words and MWPs in monolinguals, we might expect that bilinguals would develop MWP representations that were to at least some extent integrated across languages.

And in fact, we now have some evidence to support integrated bilingual MWP representations. Two ingenious studies in which participants judged whether presented sequences of words were acceptable/common phrases in the target language found that processing L2 MWPs is affected by their L1 translation properties (Wolter & Gyllstad, 2013; Yamashita & Jiang, 2010). The critical manipulation was whether an L2 MWP could be translated word-for-word into L1 while conveying the same meaning. For example, the key component *kill* in the English phrases *kill animals* and *kill time* translates into *korosu* (cause the death) in Japanese; this translation delivers the same meaning as *kill* in *kill animals*, but a different meaning from *kill* in *kill time*. To convey the same meaning as in *kill time*, Japanese uses a different component word: *tsubusu* (crush/break). Hence, *kill animals* could be translated word-for-word into Japanese (i.e., it is *translationally congruent*), but *kill time* could not (i.e., it is *translationally incongruent*).

Both studies, examining Japanese-English bilinguals and Swedish-English bilinguals respectively, show that bilingual participants judged translationally congruent MWPs (e.g., *kill animals*) more efficiently than incongruent MWPs (e.g., *kill time*). Not surprisingly, English speakers who did not speak the other relevant language (control group) were unaffected by the MWP's translation. However, we should interpret these results with caution because the relevant translation properties in the two studies were largely judged by the researchers and not by native participants. Furthermore, the selected MWPs were not controlled for semantic transparency or compositionality (i.e., to what degree the phrase meaning could be derived from the component meanings), a factor that may have potentially confounded the results.

Recently, Zeng, Branigan and Pickering (in preparation) adopted the same task to investigate whether having an L1 MWP that is translationally congruent (i.e., the L1 translation of the L2 MWP is also a multiword phrase composed of translation-equivalent lexical items, in the same order) affects the processing of an L2 MWP. For example, the English MWP *major problem* and its Chinese translation equivalent *zhuyao wenti* are congruent, in that the English component words *major* and *problem* translate into the Chinese component words *zhuyao* and *wenti* on a one-to-one basis in the same order. In contrast, the phrase *inner city* and its Chinese translation equivalent *shi zhongxin* are not congruent because the Chinese component words *shi* and *zhongxin* are not translation equivalents for *inner* (*neibu*) and *city* (*chengshi*), in the same order.

Zeng et al.'s study found that Chinese-English bilinguals of relatively advanced proficiency judged English phrases as being acceptable faster and more accurately when MWPs had congruent translations in Chinese (e.g., *major problem*) than they had incongruent translations (e.g., *inner city*). Most importantly, the congruency effect interacted with phrase frequency so that the judgement efficiency of English MWPs was more facilitated by phrase frequency if they had congruent than incongruent translations in Chinese. The above effects were observed when word frequencies was controlled. As phrase frequency is an index of MWP representation (beyond constituent word representation) in the lexicon, the interaction between translation congruency and phrase frequency indicates that the cross-language effect is not merely due to a word-by-word translation, but occurs at a level beyond the single word. In comparison, a control group of English monolinguals were unaffected by the cross-language manipulation. These patterns suggest that L2 MWPs and L1 MWPs are integrated or interconnected in some way, so that representational properties of MWPs in one language affect their processing in the other.

Together, these results provide evidence that bilinguals have MWP representations that – like their representations of single words – are integrated to at least some extent between languages. But how might such integration occur? In other words, how might bilinguals represent their L2 in relation to L1 at the MWP level and how might that representation affect L2 processing? Drawing on parallel research on bilingual single word representation and processing, we can identify two accounts for the relationship between L1 and L2 MWP representations. As we shall see below, the two accounts share basic assumptions about the between-language representation of MWPs, but they differ in their interpretation of what those representations mean for bilinguals' MWP processing.

5.1 Online processing model

The first account assumes that bilingual speakers activate their L1 when using L2 through a between-language link that connects L1 and L2 MWPs. We call this an online processing model, in the sense that observed behavioral effects arise as a consequence of online processing mechanisms. This account assumes an extended bilingual lexicon in which MWPs are represented alongside single words in both languages (as proposed for monolingual lexical representation by Jackendoff, 2002). In this model, bilinguals may have developed between-language links for some MWPs but not for others; these links serve as the channel that spreads activation to L1 MWPs when L2 MWPs are in use.

Specifically, under this account there exist "translation-congruent MWPs" that are linked between languages in this bilingual lexicon. We define translation-congruent MWPs as phrasal translational counterparts that have 1) the same meaning and 2) a one-to-one mapping across languages – that is, the phrasal counterparts have translation-equivalent component words in the same order, hence the same syntactic category and hierarchical structure. This definition is closely related to Yamashita & Jiang (2010)'s notion "word-for-word translation" (mentioned above). They define congruent/incongruent translations in terms of whether MWPs can be translated word-for-word while keep the same meaning. In other words, translation-congruent MWPs require the sequential translation of each word component to keep the same meaning across languages at the phrase level. Here, we further unpack this notion and propose that the translation-congruent MWPs share both meaning and syntax on a one-to-one basis. Again, take the English phrase *major problem* as an example, whose Chinese translation *zhuyao wenti* has – by definition – the same meaning. But in addition, the adjective component *major* and the nominal component *problem* map to their Chinese equivalents *zhuyao* and *wenti* respectively, which have the same syntactic categories in the same order. Therefore, *major problem* and *zhuyao wenti* are both adjective-noun phrases that map to each other on a one-to-one basis, hence translation-congruent phrases. In view of the constant mapping of L2 to L1 when bilingual speakers are learning their L2 (presumably as a way to access the concept/meaning; see Kroll & Stewart, 1994; Jiang, 2000), this meaning and structure similarity of congruent MWPs is likely to enhance learning of the interlanguage relationship, making translation-congruent L1 and L2 MWPs link to each other (see Figure 2). This link becomes strengthened under the constant between-language mapping and makes online activation quicker.

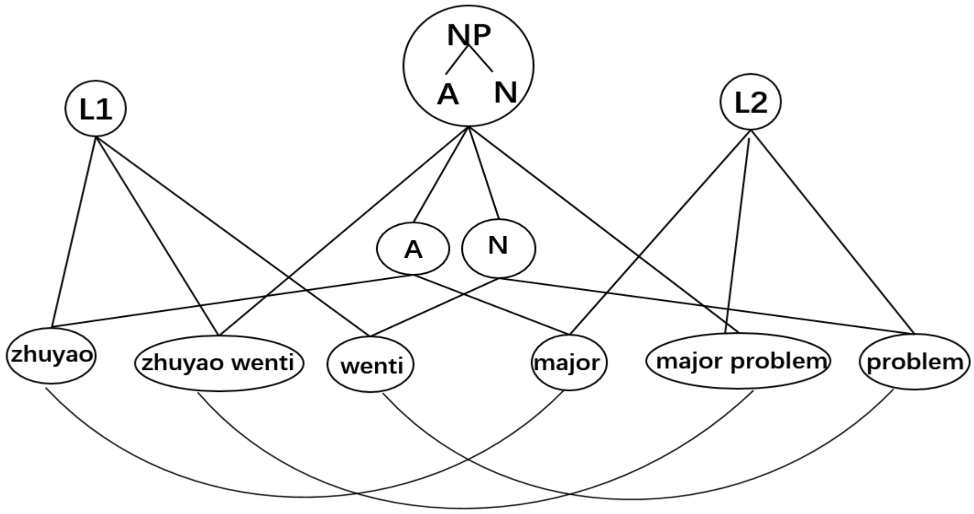

Figure 2. Hypothesized representation of translation-congruent MWPs at the lemma level[1] in the bilingual lexicon. There are both phrasal and word nodes representing the MWPs and their component words in each language respectively. They are linked to their respective language node (L1, L2) but to shared syntactic category nodes (e.g., A, N) or syntactic structure node (e.g., NP). The phrasal translations *major problem* (L2 English) and *zhuyao wenti* (L1 Chinese) are linked both at the phrasal and individual word levels as their component words are translation equivalents at the same phrasal position in each language.

A critical aspect of this model is that it involves a between-language link at the phrasal or MWP level, similar to what has been argued for the case of bilingual single words in the literature (Dijkstra & Van Heuven, 2002; Dijkstra et al., 2018; Kroll & Stewart, 1994). In this model, processing an L2 MWP activates its L1 MWP counterpart (i.e., the link is at the phrasal level). This account builds on claims that monolingual MWP processing involves both its whole and its parts (Sprenger et al., 2006; Arnon & Priva, 2014), and that processing L2 words activates their L1 translations (Thierry & Wu, 2007). Similarly, when processing an L2 MWP, bilingual speakers are also assumed to activate both the whole phrase and its individual words, but additionally, they coactivate their L1 counterparts at both levels through the

[1] According to Jackendoff (2002) and Culicover et al. (2017), MWPs are stored with their syntactic structure. Since syntactic properties are connected to the lemma stratum of lexical representation in some classic psycholinguistic models (e.g., Levelt et al., 1999), we hypothesize the phrasal and component word representation of MWP also to be connected with their syntactic information at the lemma level.

interlanguage links (i.e., phrasal link and word link). Some evidence consistent with this account is Zeng et al.'s (in prep.) finding that phrasal frequency of MWPs modulated the translation congruency effect (as mentioned above), a finding which indicates between-language crosstalk with respect to the whole phrase. In other words, the cross-language effect is not merely a result of word-by-word mapping between the languages, but involves the activation of a holistic phrasal representation of MWPs across languages.

In this account, L2 MWPs with a congruent translation benefit more during processing from phrase frequency than L2 MWPs with an incongruent translation because in the former case, the (congruent) holistic phrasal representation of the L1 MWP is co-activated and sends activation to the linked holistic phrasal representation of the L2 MWP. This co-activation boosts the L2 MWP's overall level of activation (probably by way of backpropagation). In contrast, L2 MWPs with an incongruent translation do not receive such a boost because their holistic phrasal representations lack, or have only a weak link to, the holistic phrasal representation of the L1 MWP (as discussed further below). Note that if the cross-language effect were explained solely by activation at the word level, this effect should be independent from the phrase frequency effect – but current evidence is not compatible with this explanation (Zeng et al., in prep.).

However, this L1-L2 phrasal link can be weak or absent in some other MWPs. Some MWPs may not have a meaning counterpart that is rendered in a similar way across languages and likely lack this between-language relationship. We term these

MWPs "translation-incongruent MWPs" – that is, MWPs without a translational counterpart that shares meaning and structure in the sense of a one-to-one mapping. For example, the meaning of the English phrase *inner city* cannot readily be rendered into a Chinese MWP composed of translation-equivalent words in the same order. Instead, its Chinese translation (i.e., *(cheng)shi zhongxin*) has different (or partially overlapping) word components in a different order (*chengshi* corresponds to *city*, but *zhongxin* does not correspond to *inner* but to another word *centre,* and *chengshi* precedes *zhongxin*) and different structure (i.e., noun + noun phrase instead of adjective + noun phrase) (see Figure 3).

We assume that this type of translational MWP is less likely to develop a cross-language relationship (or at least for it to be weak) in the bilingual mind. This is probably because bilinguals do not activate its phrasal translation during learning when they find that a word-for-word translation is not available, especially at the early stage of learning among sequential bilinguals (who have previously acquired word segmentation in L1 and tend to take single words as the basic unit of L2 learning). Therefore, we propose that the cross-language relationship at the phrase level is less straightforward, or may even be absent, when L1 and L2 MWPs lack component or structure overlap, compared to when they do so.

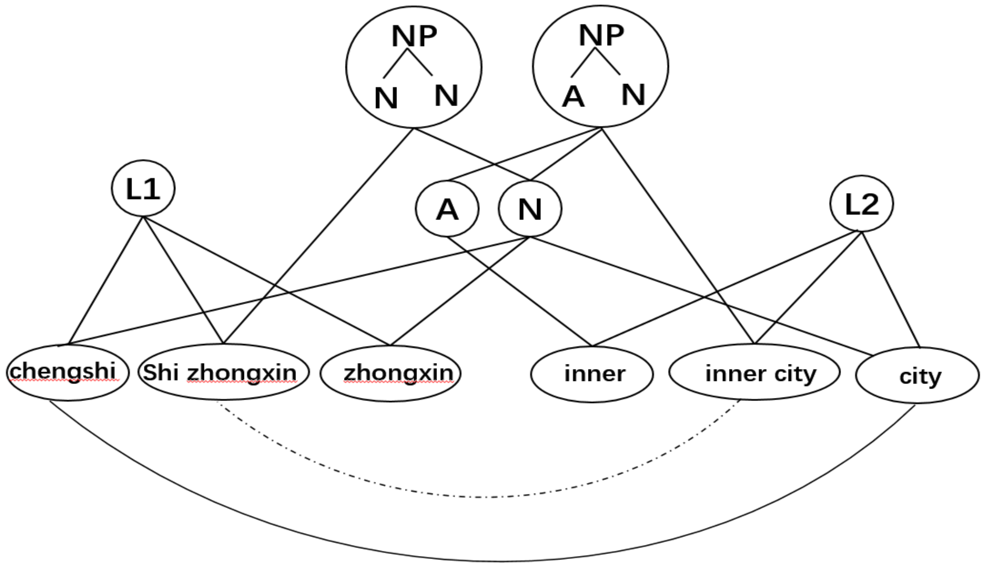

Figure 3. Hypothesized representation of translation-incongruent MWPs at the lemma level in the bilingual lexicon. The elements of figure 3 largely resemble figure 2. However, the translation-incongruent MWPs (*inner city* and *shi zhongxin*) are only weakly linked between L1 and L2 at this level for 1) they do not share (or only partly share) translation-equivalent component words and 2) they differ in syntactic structure (AN for the L2 phrase but NN for its L1 translation).

We have assumed that MWPs are linked across languages via holistic phrasal representations. Might the cross-language link between L1 MWP and L2 MWP also go via concept/semantic nodes? We acknowledge that incongruent MWPs can be linked across languages via common semantic/conceptual representations in virtue of meaning overlap, similarly to translation-congruent MWPs. In fact, Dijkstra et al.'s (2018) recent Multilink computational model of bilingual word recognition and translation assumes this to be the only way that lexical elements are linked (though we note that other accounts assume direct translational links, as in our account; see Dylman & Barry, 2018; Kroll, Van Hell, Tokowictz & Green, 2010). In this model, words from bilinguals' two languages are integrated at each psycholinguistic level (i.e., at the orthographical, phonological and conceptual levels). However, based on simulations suggesting faster L1-to-L2 than L2-to-L1 translation, Dijkstra et al.

proposed that distinct word forms are not directly connected, but are instead linked through shared or connected conceptual nodes. They argued that activating irrelevant words through a direct form-link would impede target word recognition, due to competition. Note however that this result does not directly contradict a direct between-language word link: Faster translation from L1-to-L2 than from L2-to-L1 could be explained either by a stronger L1-to-concept than L2-to-concept link (if only conceptual mediation is assumed), or by a stronger L1-to-L2 than L2-to-L1 word link (if direct word links are assumed alongside conceptual mediation).

Moreover, such links cannot explain why L2 congruent MWPs are processed more efficiently than incongruent MWPs (i.e., Yamashita & Jiang, 2010; Wolter & Gyllstad, 2013; Zeng et al., in prep.). Although there might be forward activation from L2 MWP to shared semantics, and then feedback from shared semantics to L1 MWP, this could not explain how activating an L1 MWP (via a conceptual node) composed of similar (i.e., translation-equivalent) or different (i.e., translation-nonequivalent) constituents in the same order would lead to different L2 processing patterns. Unlike "cognate word" processing, where activating an L1 word of similar form will boost recognition in L2 (due to phonological or orthographical overlap across languages), constituent word similarity of MWPs across languages does not lead to overlapped forms, thus cannot explain the cross-language effect. Therefore, something beyond conceptual mediation must be in play, and we suggest that this is a between-language link at the lemma level for translational congruent MWPs, which, however, is weaker or absent for translational incongruent MWPs.

In view of the above assumptions about translation-congruent and –incongruent MWP representations, the translation congruency effect of L2 MWP processing found in previous studies can be summarized as a processing advantage for translationally congruent MWPs over incongruent MWPs. Under the online processing account, this occurs as a result of parallel activation of the linked phrasal representations (and likely the constituent word representations as well) across languages. The presence and activation of a counterpart with similar meaning and structure in L1 gives congruent L2 MWPs a boost during processing compared with incongruent MWPs, which do not have an L1 counterpart with similar meaning or structure.

One question left open for further empirical investigation is to what extent bilinguals activate syntactic information during MWP processing and whether this activation modulates the magnitude of the translation congruency effect. Here we distinguish congruent and incongruent MWPs in terms of whether an MWP and its translation share translation-equivalent word elements on a one-to-one basis across languages. In other words, this distinction includes a degree of syntax (or structure).

Although congruent MWPs are by definition the same in syntactic structure, incongruent MWPs are more heterogeneous in that respect. For example, an MWP may correspond to a single word (different structural encoding), to a sentence (presence/absence of a counterpart in the lexicon), or to an MWP of different (e.g., PP translated to VP; AP translated to VP) or reversed (e.g. AN translated to NA) syntactic structure. We may ask to what extent the syntactic structure contributes to the observed processing advantage of translation-congruent vs. -incongruent MWPs.

Preliminary evidence for the involvement of syntactic information comes from Peycheva (2018) who found Bulgarian-English speakers process L2 MWPs faster when they have a single-word translation (e.g., *secondary school*-гимназия) than when they have a multiple-word incongruent translation (e.g., *living conditions*-условия на живот) in L1, but not different from translation-congruent MWPs. Note that MWPs with a single-word translation belong to translation-incongruent phrases under our classification. The findings imply that structural encoding (whether the same meaning is encoded as a word or a phrase) across the language may modulate the translation congruency effect, making incongruent MWPs "equally advantaged" as congruent MWPs. We might also predict that the translation congruency effect would be reduced but not eliminated for L1 and L2 MWPs that were different in word order but identical in word components (e.g., English adjective + noun phrase and French noun + adjective translation). In other words, the congruency vs. incongruency effect is a matter of degree, which can be modulated by variations in terms of constituent word components, word order, and meaning correspondence. Future studies may distinguish and test the processing of more refined incongruent MWP types (e.g., same structural encoding, but different constituent syntactic categories) and their possible processing differences with congruent MWPs.

5.2 Learning-based model

There is an alternative to the on-line activation account which is similar in all respects (i.e., the between-language representations of translation-congruent and -incongruent MWPs proposed above), except that the between-language relationships of MWP representations reflect a learning process instead of online cross-language activation. The learning-based model contends that representations of MWPs in the L2 lexicon are shaped by how their meaning counterparts are organized in the L1 lexicon during the process of L2 learning. Under this account, the observed L1-on-L2 effect during MWPs processing is ascribed to the result of L2 learning, instead of the online activation of the non-target language (i.e., L1).

This model draws on the proposal of Costa, Pannunzi, Deco, and Pickering (2017) for the bilingual representation of single words. In that proposal, Costa et al. (2017) provided an alternative account for the empirical findings of Thierry and Wu (2007) that: when judging the semantic relatedness of unrelated L2 word pairs (e.g., *train-ham*), Chinese-English bilinguals showed a smaller N400 effect when the words' L1 translations were form-related (e.g., *huoche-huotui*, sharing the first character *huo*) than they were not (and English monolinguals did not show this effect). Thierry and Wu (2007) ascribed this effect to the online activation of the words' L1 translations.

However, Costa et al. (2017) argued that the observed effect is not necessarily an online translation effect. They observed that seemingly unrelated words (*train-ham*) in L2 may end up being represented as related in the L2 by copying their relationship in L1 during L2 learning. They suggested that is achieved by a Hebbian style of learning mechanism in which representations that "fire together wire together". Specifically, they reasoned that bilinguals learning the word *train* would first activate its translation word *huoche*. The activation of *huoch*e then spreads to the form-related word *huotui*, which in turn activates its L2 translation *ham*. The similar activation point of time of the four words finally leads to the association between *train* and *ham*. In other words, the activation of the between-language word links (*train-huoche*, *ham-huotu*i) and the within-language word link in L1 (phonologically associated *huoche-huotui*) leads to the development of a within-language word link in L2 (*train-ham*). Therefore, what was explained as online cross-talk between languages (*train* activates *huoche*, and *ham* activates *huotui*; Thierry & Wu, 2007) can be explained alternatively by locating the effect within the target language (*train* activates *ham* through their own within-language link) (but see Oppenheim, Wu, & Thierry, 2018 and Costa, Pannunzi, Deco, & Pickering, 2019 for further discussion). Under this explanation, the between-language word links reflect only the coactivation of translation equivalents during L2 learning, and not when the L2 lexicon is well established.

Similarly, the learning-based model proposes that between-language links at the MWP level are the cause of the restructuring of L2 MWP representations, not the cause of cross-language activation during MWP processing. But how then do we interpret the processing advantage of translation-congruent MWPs over translation-incongruent MWPs under this account? One possibility is that when acquiring an MWP, L2 learners tend to translate it into L1, in the same way as they translate L2 single word into L1 by virtue of meaning association. Importantly, MWPs with a congruent translation (i.e., sharing translation-equivalent word components on a one-to-one basis) are likely to be acquired faster than those without. This learning boost is likely due to the possibility that every time L2 learners encounter the L2 MWP (e.g., *major problem*) and activate its meaning- and structure-overlapping L1 (e.g., *zhuyao wenti*, which maps to *major problem* on a word-by-word basis: *zhuyao-major*, *wenti-problem*), they become particularly aware of it. As a result, they learn translation-congruent MWPs better and process them faster (because they are more entrenched in L2 lexicon) than translation-incongruent MWPs. This also explains why (L2) phrase frequency effect is larger in the congruent condition (i.e., the interaction effect between phrase frequency and translation congruency) in Zeng et al.'s (in prep.) study, as congruent MWPs are more established in the L2 lexicon and so have a better chance to show the frequency effect. In sum, this account does not assume online activation of L1. Instead, the between-language link of MWP representations reflects how the L1 lexicon can impact on the representation of L2 lexicon during learning.

This model also allows some fluidity for MWP representations in the bilingual lexicon, given the changing proficiency of bilinguals' two languages. Although at the initial stage of L2 learning, the L2 lexicon is constantly shaped by the L1 lexicon, the ever increasing exposure to L2 and the improvement in L2 proficiency may also contribute to the reconstruction of the L2 lexicon. At some point, adequate L2 proficiency (Kroll & Stewart, 1994) and exposure (Bybee, 2007) may override the L1 influence, and reshape the L2 lexicon towards a more native-like lexicon resembling the monolinguals of that language. In our particular case for MWP representation, the initially lagging-behind representation of incongruent MWPs might gradually catch up with the representation of congruent MWPs in L2 as bilinguals' L2 proficiency improves. This pattern has already been evident in some studies which found a smaller translation congruency effect in more advanced bilinguals (Yamashita & Jiang, 2010; Zeng et al., in prep.).

5.3 Evaluating the two models

It should be noted that the online processing model and the learning-based model may be difficult to distinguish empirically. Costa et al. (2017, 2019) and Oppenheim et al. (2018) had some insightful debates on this issue based on their computational modeling results on single word processing. Despite their different simulation outcomes (due to slightly different simulation parameters), the learning-based model and the online processing model can both explain the L1-on-L2 effect of single word processing. Just as Costa et al. (2017) pointed out, "teasing apart the two interpretations may prove difficult, since it would be necessary to find the conditions that allow you to test the parallel activation of the two languages without being sensitive to the potential restructuring of the L2 as a consequence of the L1, and vice-versa" (pp. 1641-1642). Meanwhile, the learning-based model also highlights a missing part in the on-line activation model – that is, the changes in the respective lexica as a consequence of learning and interaction with the other language (Costa & Pickering, 2018). We argue that the same is true for the two models proposed here for the representation of bilingual MWPs.

Although the studies mentioned in the previous section form the starting point for our proposal that the bilingual lexicon can be integrated at the MWP level, we note that the L2 MWP materials used in those studies can be also connected through their L1 counterpart at the word level (e.g., *major problem-zhuyao wenti, major-zhuyao,* *problem-wenti*). In other words, the observed cross-language effect may be confounded with an L1 influence (learning influence or online activation) at both the word and phrase levels, making it hard to tease them apart.

A more direct way to test the presence of between-language MWP links would be an experimental manipulation that did not involve between-language links at the word level. An ideal choice would be using a type of translation-incongruent MWP that translates into a MWP with different component words. For example, the English MWP *best seller* translates into the Chinese MWP *changxiao shu*, whose component words *changxiao* (well-sold) and *shu* (books) are not translation equivalents for the words *best* or *seller*. Therefore, the translational MWPs are not linked at the individual word level.

With the word link controlled, we can test whether MWPs like *best seller* are directly linked to their translational counterparts like *changxiao shu* at the phrase level by observing whether presenting a translationally form-related or –unrelated word affects the processing of the MWP. For example, we may adopt the semantic relatedness judgement paradigm used in Thierry and Wu (2007) and ask bilinguals and monolinguals to judge whether the phrase *best seller* is semantically related to the word *sing.* Critically, *best seller* and *sing* are form-related in their Chinese translation (i.e., *changxiao shu* and *chang* share the character *chang*). If *best seller* does link to its Chinese translation *changxiao shu*, which is form-related to the Chinese word *chang*, the translation of English word *sing*, then judging the semantic relatedness of *best seller* and *sing* would give rise to a different pattern of effects than the control condition (e.g., judging the semantic relatedness of *best seller* and *swing*, which are not form-related in Chinese). Such a pattern of results would directly support between-language MWP links.

On a final note, what has been proposed in our two models is not only applicable to explaining L1-on-L2 effects, but is also in principle generalizable to L2-on-L1 effects during L1 MWP processing. There is accumulating evidence that an integrated bilingual lexicon leads to cross-language effects from L2 to L1 during word processing, especially among highly proficient bilinguals. The evidence includes translation priming effects during L1 word recognition (see Wen & Van Heuven, 2016 for a review), translation ambiguity effects (i.e., having a single vs. more than one translation across languages affects processing differently) in semantic judgement of L1 word pairs (e.g., Degani, Prior, & Tokowicz, 2011) and primed lexical decision (e.g., Jouravlev & Jared, 2019), and translation facilitation effect during L1 word production (e.g. Higby, Donnelly, Yoon, & Obler, 2019). These studies suggest that word translation properties, either in terms of presence/absence in L2, or in terms of one-to-one/one-to-many mapping across languages, affect bilinguals' perception or retrieval of the L1 words, no matter whether an L2 word is briefly presented (as in translation priming) or is completely absent (as in semantic judgement of word pairs) during the task.

Given the many parallels between words and MWP in representation and processing, our models also predict that L1 MWP representation and processing can be affected by their translational properties in L2. Presumably, bilinguals who are highly proficient in L2 or when their dominant language has shifted from L1 to L2 may coactivate their L2 MWP during L1 MWP processing, perhaps because of recency of L2 use (e.g., being immersed in an L2 environment or feeling more comfortable using L2 at the time of testing). Alternatively, knowing and using a counterpart that shares both meaning and structure in a second language may strengthen the representation of an MWP within the native language (e.g., due to an indirect frequency boost from L2 as suggested by Higby, et al., 2019), which would be compatible with the learning account. One way to test this prediction is to see whether bilinguals, compared with their monolingual counterparts, become more tolerant of an acceptable but not native-like MWP in their L1 if that MWP maps on a one-to-one basis to an L2 translation which is perfectly native in that language. Future studies may test this and other assumptions in the proposed models. We believe that testing these assumptions is beneficial to modeling bilingual representations beyond the single words and may help advance theories of the bilingual lexicon in general.

6. Conclusion

Previous lexical research has supported a well-integrated bilingual lexicon. In this bilingual lexicon, words are representationally linked between languages and the existence of these links may affect word processing. Based on evidence that MWPs can be stored and represented in the lexicon, and that translational properties (between-language relationship) affect MWP processing in a single language, we have proposed that language elements larger than single words, that is, multiword phrases (MWPs) may be also linked in the bilingual lexicon. We have provided two accounts for how the bilingual lexicon can be integrated at the MWP level, both of which assume between-language relationships for MWP representations, but differ in whether these links are involved in cross-language activation during MWP processing or instead reflect how L1 representations of MWP reshape L2 MWP representations during learning. These accounts, which are difficult to distinguish empirically, not only help explain recent experimental findings but also inform the future modeling of bilingual lexical representation and processing beyond single words.

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References

Allen, P. A., Smith, A. F., Lien, M. C., Grabbe, J., & Murphy, M. D. (2005). Evidence for an activation locus of the word-frequency effect in lexical decision. *Journal of Experimental Psychology: Human Perception and Performance, 31*(4), 713-721.

Arnon, I., & Christiansen, M. (2017). The role of multiword building blocks in explaining L1-L2 difference. *Topics in Cognitive Science*, *9(3)*, 621-636.

Arnon, I., & Priva, U. C. (2014). Time and again: The changing effect of word and multiword frequency on phonetic duration for highly frequent sequences. *Mental Lexicon, 9(3)*, 377-400.

Arnon, I., & Snider, N. (2010). More than words: Frequency effects for multi-word phrases. *Journal of Memory and Language, 62*(1), 67-82.

Arnon, I., McCauley, S. M., & Christiansen, M. (2017). Digging up the building blocks of language: Age of Acquisition effects for multiword phrases. *Journal of Memory and Language*, *92*, 265-280.

Bannard, C., & Matthews, D. (2008). Stored word sequences in language learning: The effect of familiarity on children's repetition of four-word combinations. *Psychological Science, 19*(3), 241-248.

Brown, R., & McNeill, D. (1966). The "tip of the tongue" phenomenon. *Journal of Verbal Learning and Verbal Behavior*, 5(4), 325-337.

Brysbaert, M., Mandera, P., & Keuleers, E. (2018). The word frequency effect in word processing: An updated review. *Current Directions in Psychological Science,* *27(1)*, 45-50.

Bybee, J. (1995). Regular morphology and the lexicon. *Language and Cognitive Processes, 10*(5), 425-455.

Bybee, J. (2007). *Frequency of Use and the Organization of Language*. Oxford, New York: Oxford University Press.

Chomsky, N. (1965). *Aspects of the Theory of Syntax*. Cambridge, Mass.: M.I.T. Press.

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.

Costa, A. (2005). Lexical access in bilingual production. In J. F. Kroll & A. M. B. De groot (Eds.), *Handbook of Bilingualism: Psycholinguistic Approaches* (pp. 308-325). Oxford, New York: Oxford University Press.

Costa, A., Caramazza, A., & Sebastiangalles, N. (2000). The cognate facilitation effect: Implications for models of lexical access. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 26*(5), 1283-1296.

Costa, A., Pannunzi, M., Deco, G., & Pickering, M. J. (2017). Do bilinguals automatically activate their native language when they are not using it? *Cognitive Science, 41*(6), 1629-1644.

Costa, A., & Pickering, M. J. (2018). The role of learning on bilinguals' lexical architecture: Beyond separated vs. integrated lexicons. *Bilingualism: Language and Cognition*, doi:10.1017/S1366728918000809.

Costa, A., Pannunzi, M., Deco, G., & Pickering, M. J. (2019). Does bilingualism alter lexical structure? Response to Oppenheim, Wu, and Thierry (2018). *Cognitive Science*, 43(2), e12707.

Culicover, P. W., Jackendoff, R., & Audring, J. (2017). Multiword Constructions in Grammar. *Topics in Cognitive Science,* 9(3), 552-568.

Davis, C., Sánchez-Casas, R., García-Albea, J. E., Guasch, M., Molero, M., & Ferré, P. (2010). Masked translation priming: Varying language experience and word type with Spanish–English bilinguals. *Bilingualism: Language and Cognition*, 13(02), 137–155.

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.

Degani, T., Prior, A., & Tokowicz, N. (2011). Bidirectional transfer: The effect of sharing a translation. *Journal of Cognitive Psychology, 23*(1), 18-28.

Dell, G. S. (1986). A spreading activation theory of retrieval in sentence production. *Psychological Review, 93(3),*3-321.

Dijkstra, T., & Van Heuven, W. J. B. (2002). The architecture of the bilingual word recognition system: From identification to decision. *Bilingualism: Language and Cognition, 5*(3), 175-197.

Dijkstra, T., Grainger, J., & Van Heuven, W. J. B. (1999). Recognition of cognates and interlingual homographs: The neglected role of phonology. *Journal of Memory and Language*, 41(4), 496–518.

Dijkstra, T., Wahl, A., Buytenhuijs, F., Van Halem, N., Al-Jibouri, Z., De Korte, M., &

Rekke, S. (2018). Multilink: A computational model for bilingual word recognition and word translation. *Bilingualism: Language and Cognition*. doi:10.1017/S1366728918000287.

Duyck, W., Van Assche, E., Drieghe, D., & Hartsuiker, R. J. (2007). Visual word recognition by bilinguals in a sentence context: Evidence for nonselective lexical access. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33(4),*3-679.

Dylman, A. S., & Barry, C. (2018). When having two names facilitates lexical selection: Similar results in the picture-word task from translation distractors in bilinguals and synonym distractors in monolinguals. *Cognition*, 171:151-171.

Forster, K. (1976). Accessing the mental lexicon. In R. J. Wales & E. Walker (Eds.), *New Approaches to Language Mechanisms* (pp. 257-287). Amsterdam: North Holland.

Fromkin, V. (1971). The nonanomalous nature of anomalous utterances. *Language*, 47(1), 27-52.

Giraudo, H., & Grainger, J. (2001). Priming complex words: Evidence for supralexical representation of morphology. *Psychonomic Bulletin and Review, 8(1)*, 127-131.

Higby, E., Donnelly, S., Yoon, J., & Obler, L. K. (2019). The effect of second-language vocabulary on word retrieval in the native language. *Bilingualism: Language and Cognition*. doi: 10.1017/S136672891900049X.

Jackendoff, R. (2002). *Foundations of Language: Brain, Meaning, Grammar, Evolution*. Oxford: Oxford University Press.

Janssen, N., & Barber, H. A. (2012). Phrase frequency effects in language production. *Plos One, 7*(3), e33202.

Janssen, N., Bi, Y., & Caramazza, A. (2008). A tale of two frequencies: Determining the speed of lexical access for mandarin Chinese and English compounds. *Language and Cognitive Processes, 23*(7/8), 1191-1223.

Jescheniak, J. D., & Levelt, W. J. M. (1994). Word frequency effects in speech production: Retrieval of syntactic information and of phonological form. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 20*(4), 824-843.

Jouravlev, O., & Jared, D. (2019). Native language processing is influenced by L2-to-L1 translation ambiguity. *Language, Cognition and Neuroscience*. doi:10.1080/23273798.2019.1652764.

Knobel, M., Finkbeiner, M., & Caramazza, A. (2008). The many places of frequency: Evidence for a novel locus of the lexical frequency effect in word production. *Cognitive Neuropsychology, 25*(2), 256-286.

Kroll, J. F., & Stewart, E. (1994). Category interference in translation and picture naming: connections between bilingual memory representations. *Journal of Memory and Language, 33(2)*, 149-174.

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.

Kuperman, V., Bertram, R., & Baayen, H. (2008). Morphological dynamics in compound processing. *Language and Cognitive Processes, 23*(7/8), 1089-1132.

Lalor, E., & Kirsner, K. (2000). Cross-lingual transfer effects between English and Italian cognates and noncognates. *International Journal of Bilingualism*, 4(3), 385–398.

Levelt, W. J. M., Roelofs, A., & Meyer, A. S. (1999). A theory of lexical access in speech production. *Behavioral and Brain Sciences, 22*, 1-75.

Libben, G. (2014). The nature of compounds: A psychocentric perspective. *Cognitive Neuropsychology, 31*(1-2), 8-25.

Marian, V., Spivey, M., & Hirsch, J. (2003). Shared and separate systems in bilingual language processing: Converging evidence from eyetracking and brain imaging. *Brain and language, 86*(1), 70-82.

McClelland, J. L., & Rumelhart, D. E. (1988). An Interactive Activation Model of context effects in letter perception, Part I: An account of basic findings. *Readings in Cognitive Science, 88*(88), 580-596.

Monsell, S., Doyle, M. C., & Haggard, P. N. (1989). Effects of frequency on visual word recognition tasks: Where are they? *Journal of Experimental Psychology: General, 118*(1), 43-71.

Morton, J. (1969). Interaction of information in word recognition. *Psychological Review, 76*(2), 165-178.

Norris, D. (1986). Word recognition: Context effects without priming. *Cognition, 22*(2), 93-136.

Oldfield, R., & Wingfield, A. (1965). Response latencies in naming objects. *Quarterly*

Journal of Experimental Psychology, 17A, 273– 281.

Oppenheim, G., Wu, Y. J., & Thierry, G. (2018). Found in translation: Late bilinguals do automatically activate their native language when they are not using it. *Cognitive Science, 42*(5), 1700-1713.

Paap, K. R., Johansen, L. S., Chun, E., & Vonnahme, P. (2000). Neighborhood frequency does affect performance in the Reicher task: Encoding or decision? *Journal of Experimental Psychology: Human Perception and Performance, 26*(6), 1691-1720.

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.

Peycheva, E. (2018). Effects of first language on phrase processing speed in second language. *Unpublished MSc dissertation*.

Pinker, S. (1991). Rules of Language. *Science, 253*(5019), 530-535.

Rastle, K., Davis, M. H., & New, B. (2004). The broth in my brother's brothel: Morpho-orthographic segmentation in visual word recognition. *Psychonomic Bulletin and Review, 11*(6), 1090-1098.

Reicher, G. M. (1969). Perceptual recognition as a function of meaningfulness of stimulus material. *Journal of Experimental Psychology*, 81, 275-280.

Sánchez-Casas, R. M., Davis, C. W., & García-Albea, J. E. (1992). Bilingual lexical processing: Exploring the cognate/non-cognate distinction. *European Journal of Cognitive Psychology*, 4(4), 293–310.

Schoonbaert, S., Hartsuiker, R. J., & Pickering, M. J. (2007). The representation of lexical and syntactic information in bilinguals: Evidence from syntactic priming. *Journal of Memory and Language, 56*(2), 153-171.

Schriefers H., Meyer A. S., & Levelt W. J. M. (1990). Exploring the time course of lexical access in language production: Picture-word interference studies. *Journal of Memory and Language*, 29(1), 86-102.

Shook, A., & Marian, V. (2013). The bilingual language interaction network for comprehension of speech. *Bilingualism: Language and Cognition, 16*(2), 304-324.

Siyanova-Chanturia, A., Conklin, K., & Van Heuven, W. J. B. (2011). Seeing a phrase time and again matters: The role of phrasal frequency in the processing of multiword sequences. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 37*(3), 776-784.

Sonbul, S. (2015). Fatal mistake, awful mistake, or extreme mistake? Frequency effects on off-line/on-line collocational processing. *Bilingualism: Language and Cognition*, *18*(3), 419-437.

Spivey, M., & Marian, V. (1999). Cross talk between native and second languages: Partial activation of an irrelevant lexicon. *Psychological Science, 10(3)*, 281-284.

Sprenger, S. A., Levelt, W. J. M., & Kempen, G. (2006). Lexical Access during the production of idiomatic phrases. *Journal of Memory and Language, 54*(2), 161-184.

Stanners, R. F., Neiser, J. J., Hernon, W. P., & Hall, R. (1979). Memory representation for morphologically related words. *Journal of Verbal Learning and Verbal Behavior, 18*(4), 399-412.

Strijkers, K., Costa, A., & Thierry, G. (2010). Tracking lexical access in speech production: Electrophysiological correlates of word frequency and cognate effects. *Cerebral Cortex, 20*, 912-928.

Taft, M. (1988). A morphological-decomposition model of lexical representation. *Linguistics, 26*(4), 657-667.

Taft, M., & Forster, K. (1976). Lexical storage and retrieval of polymorphemic and polysyllabic words. *Journal of Verbal Learning and Verbal Behavior, 15*(6), 607-620.

Thierry, G., & Wu, Y. J. (2007). Brain potentials reveal unconscious translation during foreign-language comprehension. *Proceedings of the National Academy of Sciences, 104(30), 12530-12535.*

Tremblay, A., Derwing, B., Libben, G., & Westbury, C. (2011). Processing advantage of lexical bundles: Evidence from self-paced reading and sentence recall tasks. *Language Learning, 61*(2), 569-613.

Wen, Y., & Van Heuven, W. J. (2016). Non-cognate translation priming in masked priming lexical decision experiments: A meta-analysis. *Psychonomic Bulletin and Review*. doi: 10.3758/s13423-016-1151-1.

Wolter, B., & Gyllstad, H. (2013). Frequency of input and L2 collocational processing: A comparison of congruent and incongruent collocations. *Studies in Second*

Language Acquisition, 35(3), 451-482.

Wray, A. (2002). *Formulaic language and the lexicon*. Cambridge: Cambridge University Press.

Yamashita, J., & Jiang, N. (2010). L1 influence on the acquisition of L2 collocations: Japanese ESL users and EFL learners acquiring English collocations. *TESOL Quarterly, 44*(4), 647-668.

Zeng, T., Pickering, M. J., & Branigan, H. P. (*in preparation*). Representation and processing of multi-word phrases in a bilingual mind: Evidence from phrase-acceptability judgment among Chinese-English bilinguals.

Zhang, T., Van Heuven, W. J. B., & Conklin, K. (2011). Fast automatic translation and morphological decomposition in Chinese-English bilinguals. *Psychological Science, 22*(10), 1237-1242.