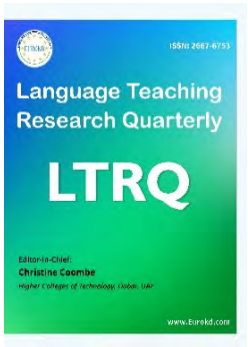

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Chunking in the Second Language: Implications for Language Learning and Teaching

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Abstract

Among the various challenges that adult and other late language learners face on their journey to achieving nativelike proficiency, chunking has been identified as one of the most difficult tasks to master. Language users are able to derive and utilize chunks during language processing—both in the first (L1) and the second language (L2)—yet the extent to which the L2 learners utilize and benefit from chunking is not on a par with L1 speakers. L2 learners are generally less sensitive to the statistical regularities in the linguistic input and possess a smaller repertoire of multiword expressions, leaving them susceptible to slower real-time language processing, hampered comprehension during conversation, and distinct production errors. Drawing on insights from Brian MacWhinney's Unified Competition Model of L1 and L2 acquisition, this review examines these unique challenges in L2 chunking as a function of differences between L1 and L2 learning. According to the Unified Competition Model, the existence of deeply entrenched L1 linguistic representations may hinder effective L2 chunking by encouraging over-segmentation in favor of L1 transference at the lexical level and diverting the necessary attention away from the grammatical elements in prefabricated multiword units. Based on these observations, we offer practical suggestions for educators to facilitate chunking in L2 learners and bring them closer to nativelike fluency.

Keywords: *L2 Learning, L1 Learning, Chunking, Multiword Sequences, Real-Time L2 Processing, L2 Instruction*

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[1]Introduction

Brian MacWhinney has had an outsized impact on the study of language over the past five decades. In addition to establishing one of the foundational resources for computational language learning research—the CHILDES database (MacWhinney & Snow, 1985)—he also introduced groundbreaking theoretical frameworks, such as the Competition Model for understanding language learning and processing (Bates & MacWhinney, 1982). In this article, we draw on MacWhinney's Unified Competition Model (e.g., MacWhinney, 2002, 2005, 2008, 2012, 2015b, 2017), which aims to provide an integrated account of both first (L1) and second language (L2) learning, in a discussion of recent work on the role of chunking in L2 learning.

Chunking, defined by Gobet et al. (2001) as the process by which the cognitive system groups multiple elements in the input together into a single unit, has emerged as a key mechanism in learning, perception, and cognition. The utilization of chunks enables more efficient processing of information, enhancing the ability to gather relevant knowledge from the environment in the face of inherent cognitive limitations (Gobet et al., 2001). The construct of chunking has also attracted growing attention in the field of psycholinguistics (e.g., Christiansen & Arnon, 2017; Christiansen & Chater, 2016; de la Cruz-Pavía et al., 2020; MacWhinney, 2005; Mauranen, 2009; McCauley et al., 2017). This pattern-based memory skill facilitates the compression of incoming input by drawing on prior experiences with co-occurring elements such as syllables, words, phrases, and syntactic patterns. In usage-based approaches, chunking is seen as a crucial mechanism through which language learners and users develop more abstract linguistic structures from statistical regularities (e.g., Christiansen & Arnon, 2017; Christiansen & Chater, 2016; de la Cruz-Pavía et al., 2020; Ellis, 2003; MacWhinney, 2005; Mauranen, 2009; McCauley & Christiansen, 2019b).

Learners of a second language rarely reach native-like fluency (e.g., Arnon & Christiansen, 2017; Clahsen & Felser, 2006; Ellis et al., 2008). While some researchers attribute such learning outcomes to a biologically determined critical period (e.g., DeKeyser, 2000; Lenneberg, 1967; Long, 2005), MacWhinney (e.g., 2008, 2015b, 2017) proposes in his Unified Competition Model that it is L1 entrenchment and transference that prevents learners from learning and processing the L2 in a nativelike way. L2 learners tend to over-analyze utterances, both grammatically and semantically, and break them down into smaller segments in favor of item-based patterns for L1 transference. Indeed, limitations in the ability to properly and efficiently form and use chunks have been extensively observed and noted as posing one of the most prominent challenges in L2 learning (e.g., Arnon & Christiansen, 2017; Conklin & Schmitt, 2012; De Cock, 1998; Ellis et al., 2008; Wray, 2000).

This review surveys research on chunking in the second language, noting both opportunities and challenges, and proposing some future directions for more effective L2 learning and teaching practices. The next section discusses the necessity of Chunk-and-Pass processing when faced with the Now-and-Never bottleneck in real-time interactions and the facilitating role of chunking in language processing in general. The subsequent section focuses on chunking in the second language, drawing on current empirical evidence regarding L2 learners' chunking abilities and exploring the theoretical implications through the lens of MacWhinney's

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(2002, 2005, 2008, 2012, 2015b, 2017) Unified Competition Model. The final section provides recommendations for L2 pedagogy, incorporating a chunk-based approach that embodies explicit chunking instructions with an emphasis on high-quality input and appropriate feedback.

To Chunk or Not to Chunk

The Now-and-Never Bottleneck and Chunk-and-Pass Processing

Language happens in the here and now. In real-life language production, the average speech rate is approximately 10-15 phonemes or 5-6 syllables per second, corresponding to 150 words produced every minute (Studdert-Kennedy, 1986). Yet the human auditory resolution for non-speech sounds maxes out at 10 sounds per second, beyond which the input is interpreted as a continuous buzz rather than discrete auditory events (Miller & Taylor, 1948). The working memory for auditory sequences is limited too, as it can hold and process only a small amount of information, ranging from 4±1 (Cowan, 2001) to 7±2 (Miller, 1956) units at a time. In the presence of such a "Now-or-Never Bottleneck" (Christiansen & Chater, 2016), the cognitive system must quickly chunk lower level linguistic units into higher level ones, from syllables to words or multiword combinations to phrases and beyond. For example, the acoustic input might initially be compressed into syllables, but once there are multiple syllables, they may interfere with one another (Brown et al., 2007); so the process is repeated, chunking multiple syllables into words and multiword sequences. This process of repeatedly recoding language input into increasingly more abstract levels of linguistic representation for semantic interpretation, called "Chunk-and-Pass" processing, allows linguistic information to be maintained across ever-longer temporal windows (Christiansen & Chater, 2016). Such Chunk-and-Pass processing allows language users to make sense of the fleeting input in the face of the Now-or-Never bottleneck.

Chunking Facilitates Language Processing

Chunking is contingent on the statistical properties of the language input. Language processing is sensitive to these properties at all levels, from phonemes to syllables, words, and multiword units in both comprehension and fluency of speech production (Ellis, 2012). Language then is strikingly, yet unsurprisingly, repetitive. For example, highly predictable, semi-preconstructed multiword units are abundant in natural language (e.g., Christiansen & Arnon, 2017; Ellis et al., 2008; Sinclair, 1991, 2004; Wray, 2002). Multiword units refer to bundles of words, typically three or more, that co-occur repeatedly at a frequency higher than expected by chance and function as coherent structural or semantic units (e.g., Biber et al., 1999; Ellis & Ogden, 2017). Erman and Warren (2000) estimate that about half of spoken and written language consists of such prefabricated multiword units. Corpus analyses have revealed that multiword units may appear as frequently as single words (Jackendoff, 1997)—up to 50% of language produced by native speakers is composed of frequently co-occurring multiword units (De Cock, 1998). A direct comparison of spoken and written corpora suggests that multiword units are even more prevalent in spoken language than in written text (Leech, 2000) because speech involves more real-time processing which imposes higher cognitive demands, and retrieving chunks from long-term memory rather than putting words together in real-time alleviates the taxing cognitive load (Ellis, 2012).

Indeed, multiword chunks are associated with both faster processing speed (Conklin & Schmitt, 2008; Jiang et al., 2020) and better memory accuracy (Isbilen et al., 2022; McCauley et al., 2017) compared to individual words and non-chunkable sentence fragments matched on word lengths and frequencies (Tremblay, 2011), pointing to a processing advantage in the face of the general cognitive constraints. In addition, Ellis et al. (2009) discovered through a series of lexical decision tasks that native speakers recognized frequent verb-argument and booster/maximizer-adjective pairs with more ease compared to less frequent ones. An eye-tracking study by McDonald and Shillcock (2003) revealed that the reading times of individual words varied as a function of transitional probabilities of the lexical components—high transitional probability sequences (e.g., *avoid confusion*) were read faster than low transitional probability sequences (e.g., *avoid discovery*) in the same sentence context. In speech production, words with high contextualized probability tend to be shortened according to analyses of articulation time for successive two-word sequences (Jurafsky et al. 2001). By focusing on verb–argument constructions, Ellis and Ogden (2017) concluded that co-occurring statistical patterns drive first language learning, facilitate online processing, and are implicated in spreading activation and prototypicality effects in semantic reference, as language users are sensitive to distributional properties and the strength of association between form and meaning. These findings substantiate the view that single words and larger sequences, such as multiword units and constructions, are stored and processed similarly by the same cognitive mechanisms, blurring the boundaries between vocabulary and grammar (e.g., Arnon & Christiansen, 2017; Bybee, 2010; Christiansen & Chater, 2016; Elman, 2009; Jolsvai et al., 2020; see Contreras Kallens & Christiansen, 2022, for discussion).

On the big picture level, the abundance of statistical regularities in language makes chunking possible and useful; on the individual differences level, the ability to chunk information together is associated with efficiency in online language processing. McCauley and Christiansen (2015) examined whether chunking ability might explain individual differences in the processing of subject (SRCs) and object relative clauses (ORCs). Through a letter chunking task and a self-paced reading task, they found that chunking sensitivity was a significant predictor of reading times for both SRCs and ORCs, as individuals with higher chunking sensitivity read both types of sentences faster than those with lower chunking sensitivity. In addition, chunking sensitivity was also found to interact with sentence types in predicting reading times, indicating that individuals with higher chunking sensitivity experienced less difficulty reading the hard-to-process ORCs than those with lower chunking sensitivity.

Taken together, these studies suggest that chunking can potentially alleviate the cognitive and computational load associated with language processing (McCauley & Christiansen, 2015). These findings are consistent with previous computational modeling work suggesting that chunking might explain important aspects of children's phonological knowledge and word learning abilities (Jones et al., 2014), as well as language learning during real-time processing (McCauley & Christiansen, 2011, 2014, 2019a). In sum, the Now-and-Never Bottleneck necessitates that language processing occurs incrementally and in real-time, emphasizing the crucial role of chunking (Christiansen & Chater, 2016).

Chunking in the Second Language

L2 Learners Also Chunk

Like L1 speakers, L2 learners also chunk. MacWhinney (2008) points out that L1 and L2 learners are faced with the same overall goals and specific tasks in language acquisition: both groups need to figure out the patterns and regularities that govern the combination of words in syntactic structures and connect their expanding vocabulary with the syntactic knowledge to achieve fluency. Indeed, as Ellis (1996; 2012) contended, language learning is in essence sequence learning, and chunking is a general process underlying both L1 and L2 acquisition. Ultimately, obtaining fluency in comprehension and production in both L1 and L2 requires acquiring memorized sequences of language: learning vocabulary entails the sequencing of the sound properties; learning discourse entails the sequencing of the lexical units (phrases and collocations); and learning grammar entails extracting and abstracting regularities from the repertoire of previously stored lexical sequencing (Ellis, 1996).

Through a series of online grammaticality judgment tasks, Jiang and Nekrasova (2007) demonstrated that both L1 speakers and L2 learners reacted more quickly and accurately to formulaic sequences than to non-formulaic sequences matched for word length and frequency (e.g., *to tell the truth* vs. *to tell the price*). Similarly, Conklin and Schmitt (2008) confirmed that both L1 and L2 speakers processed formulaic sequences faster than non-formulaic phrases generated creatively during passage reading. Nekrasova (2009) employed two controlled production tasks targeted at multiword units in both L1 and L2 speakers of English and again confirmed that multiword units are processed as coherent chunks by both groups. In the first task, participants were prompted to complete the omitted components of the target multiword units embedded in sentences. The underlying assumption is that the knowledge of multiword units as holistic entities will enable language users to recognize and reproduce the missing parts based on the surrounding context. Results showed no significant differences between L1 and advanced L2 speakers in their performance on successful phrase completion, although intermediate-level L2 speakers completed fewer multiword units than the other two groups. The second task involved elicited imitation, where participants listened to and immediately recalled a textbook passage two sentences at a time, and the target multiword units were embedded in some of the to-be-recalled sentences. Unsurprisingly, the L1 speakers were not the only ones who recalled the multiword units; both highly proficient and less proficient L2 speakers were able to recall the target multiword units as well. Moreover, the highly proficient L2 speakers even outperformed the L1 speakers on this measure. These results suggest that L2 learners, like L1 speakers, are also capable of acquiring and storing linguistic units larger than words as coherent chunks.

Despite differences between the native/highly proficient speakers and the less proficient L2 learners as shown in the Nekrasova (2009) study, the capacity to utilize chunks is not limited to only advanced level L2 speakers. Learners with lower proficiency levels also benefit from chunks during L2 acquisition (Myles et al., 1998, 1999; Skiba & Dittmar, 1992; Weinert, 1995). In an extensive analysis of longitudinal and cross-sectional corpora involving speech production by beginner (Mitchell & Dickson, 1997) and intermediate (Myles, 2002) L2 French learners in England, Myles (2004) revealed that multimorphemic sequences with rather complex syntactic features are frequently used even when the individual components have not been mastered. For example, L2 learners may produce finite verbs, case-marked pronouns, and

clitics within but not outside of formulaic chunks. Ellis (2012) highlights that such unanalyzed chunks coexist with very simple utterances, often without verbs or tenses, in early L2 production for a prolonged period of time. Moreover, Myles (2004) examined how individual learners acquire and use chunks over time, revealing a clear association between the usage of chunks and linguistic development (Ellis, 2012): rather than abandoning the chunks, L2 learners were observed to actively engage with them over the course of data collection. These chunks form part of an inventory of advanced structures that L2 learners can use before their grammatical knowledge catches up to allow them to easily produce complete novel sentences.

Gries and Wulff (2005) expanded the investigation of L2 chunking to construction-level priming. They observed significant priming effects between constructions in a sentence-fragment completion task administered to L1 German speakers learning L2 English. Participants were instructed to complete sentence fragments, some of which were primes and some were targets, and make them grammatically correct full sentences. Each prime contained a post-verbal noun phrase that represented either a recipient, which likely prompts a ditransitive (e.g., *The racing driver showed [the helpful mechanic]…*), or a patient, which likely signals a prepositional dative (e.g., *The racing driver showed [the torn overall]…*). Participants' responses to the targets, where the post-verbal noun phrases were omitted from sentence fragments, showed a clear tendency to continue using the same syntactic structure as they just produced in the prime. Gries and Wulff (2005) further established that such priming effects were strongly associated with the verb-construction preferences in corpora for native English speech and, more importantly, not with verb-construction preferences from German translation equivalents. Finally, they confirmed the constructional nature of the priming effects by a sentence sorting task, where participants exhibited strong preferences for construction-based sorting when categorizing sentences based on semantic similarity, and such tendencies were consistent with those of native speakers (Bencini & Goldberg, 2000). Based on Bock's (1986) conclusion from a series of experiments that the priming effect is attributed to cognitive processes that involve phrase structure construction or representation, the authors deduced that despite having less exposure to the input, L2 learners similarly draw on constructional knowledge, as they develop grammatical abstractions by forming and storing chunks.

Like in L1, chunking sensitivity in L2 also predicts language learning and processing at the individual differences level. Ellis (2012) identifies sequencing ability in phonological short-term memory (STM) as an important mechanism for language acquisition that predicts success in learning vocabulary and grammar in both L1 and L2. Specifically, phonological STM is associated with lexical diversity and syntactic complexity in L2 production (Wen, 2012), development of knowledge in L2 vocabulary and morphosyntactic structures (French & O'Brien, 2008), and improvement in L2 oral fluency over time, including enhanced L2 narrative skills in learners with lower proficiency and gains in correct use of function words in learners with higher proficiency (O'Brien et al., 2006). Moreover, L2 learners' knowledge of multiword units correlated strongly with multiple aspects of L2 proficiency such as the cloze test tapping into global proficiency (Keshavarz & Salimi, 2007), narrative speaking (Hsu & Chiu, 2008) and retell tasks measuring oral proficiency (Boers et al., 2006; Stengers et al., 2011), and overall quality of writing (Dai & Ding, 2010).

Using an eye-tracking paradigm, Pulido (2021) examined the relationship between chunking sensitivity and the processing of multiword units embedded in L2 sentences. The

target multiword units embedded in the relative clauses were either congruent or incongruent with the L1 translation equivalents. Congruence entailed perfect L1-L2 mapping between the constituent words in the multiword units, whereas incongruence entailed a sensible translation only at the multiword level and not at the individual word level (e.g., *pedir hamburguesas*, the Spanish functional equivalence to 'order hamburgers,' literally translates to 'request hamburgers' in English). The eye-tracking results from natural reading of L2 sentences revealed a significant two-way interaction between L2 chunking sensitivity and congruence condition in predicting the fixation time at the verb region. These results indicate that the processing difficulty associated with L1-L2 incongruent multiword units documented in prior research (e.g., Carrol et al., 2016; Wolter & Gyllstad, 2013; Wolter & Yamashita, 2018) may be alleviated by better L2 chunking. It has been concluded that since sensitivity to prefabricated chunks in natural language taps into both language experiences and domain-general chunking ability, it extends beyond mere static familiarity with fixed chunks and predicts the ability to draw upon prior experience in connecting individual elements and forming associations in real-time.

Collectively, these findings support an emergentist view that language, L1 and L2, is processed and represented in a similar manner, where learners are sensitive to the frequencies and transitional probabilities at which different linguistic patterns occur, and they acquire these statistical patterns through exposure and usage (Ellis, 2012; MacWhinney, 2015a). For both L1 and L2 learners and speakers, forming chunks and committing them to long-term storage for future use in comprehension and production serve as the foundation for language learning and for ultimately achieving automaticity and fluency (Ellis, 1996).

Caveat: L2 Learners Chunk Differently (and Less Efficiently)

Even though L2 learners are able to utilize statistical information and chunk linguistic inputs for learning and more efficient processing, research has also shown that the extent to which L2 learners chunk and benefit from chunks is rather limited compared to L1 learners and speakers, rendering chunking one of the most telling differences between L1 and L2 speakers (e.g., Arnon & Christiansen, 2017; Conklin & Schmitt, 2008, 2012; De Cock, 1998; Ellis et al., 2008). Advanced L2 speakers are reported to have rather limited knowledge of multiword units compared to L1 speakers (Arnaud & Savignon, 1997; Moon, 1997), and their mastery of formulaic language is not comparable to their vocabulary knowledge in general (Steinel et al., 2007). Pulido et al. (2024) and Pulido (2021) administered two chunking sensitivity tasks to L1 English speakers learning L2 Spanish and found significant differences between L1 and L2 chunking. In contrast to L1 speakers, advanced L2 learners also tend to opt for singular verbs (e.g., *to mention*) rather than risking making word choice or grammatical errors by using multiword lexical verbs (e.g., *to bring up*) even when the latter is more appropriate for the context (Siyanova & Schmitt, 2007).

Craig (2008) highlights that function words, such as articles and prepositions, are often omitted or misused by L2 learners, constituting an identifiable and potentially stigmatizing characteristic of L2 production (Benson et al., 1992; Reid, 1988). For example, to a native ear, phrases like *taking advantage from* or *access for electricity* immediately signals that the speaker is an L2 learner due to the distinctively foreign and unusual use of prepositions, even though the combination of content words are correct and sufficient to convey the intended

message. In corpus analyses of academic prose, Reid (1988) unveils quantitative differences in the frequency of preposition use between L1 and L2 English writers. Catalán (1996) discovers that as many as 75% of Spanish students learning English made preposition substitution errors. Additionally, Flowerdew (2006) reports that up to 68% of all errors relating to nouns that connect ideas within and across clauses are attributed to the misuse of prepositions following them (e.g., *argument in* as opposed to *argument for*; *discrimination to* instead of *discrimination against*). MacWhinney (2008, 2015b, 2017) reasons that L2 learners are more likely to focus on the lexical level during language learning and processing, overanalyzing utterances into individual words in favor of L1 translation and transference, rather than treating the multiword verbs and noun-preposition clusters as chunks functioning as single lexical items (Biber et al., 1999; Craig, 2008).

In a similar vein, research has shown that L2 learners have difficulties with collocations and idiomatic expressions, failing to correctly interpret most L2 idiomatic expressions dissimilar to their L1 (Irujo, 1986). L2 learners also tend to derive the literal interpretations of idioms that are already known to them (Cieślicka, 2006) and produce jumbled collocations with incorrect selection and ordering of the component words (Wray, 2004). Martinez and Murphy (2011) reported that lower-intermediate L2 learners may misinterpret the meaning of idiomatic expressions based on individual words (e.g., *by and large* vs. *large*, *and*, *by*) without consciously knowing they made such an error, hence overestimating how much they understood from the target texts as a function of multiword expressions that are either unnoticed or misinterpreted. Even highly proficient L2 learners generally produce less formulaic language in both speech and writing compared to L1 speakers (Howarth, 1998; Paquot & Granger, 2012), overuse a restricted range of expressions while neglecting others when they do use formulaic language (De Cock, 1998; Durrant & Schmitt, 2009), and do not benefit as much from the processing advantage that multiword units often provide (Conklin & Schmitt, 2012), displaying a non-nativelike pattern of chunk usage (see Arnon & Christiansen, 2017, for a review).

Not only do L2 learners chunk less compared to L1 speakers, but they also seem to rely on somewhat different statistical information when they chunk in the second language. In a series of simulations, McCauley and Christiansen (2017) trained a chunk-based learning model on utterances generated by three different groups of speakers: L1 children, L1 adults, and L2 adults. Using backward transitional probabilities to determine whether words should be chunked together, the model learned to generalize to novel utterances produced by the same individuals. Production performance was higher for L1 learners/speakers compared to L2 learners, suggesting that L2 learners might rely less on multiword units derived via statistical learning than L1 learners/speakers. This was confirmed by a second simulation in which chunking was based on basic frequency information instead of conditional probabilities. In these simulations, generalization performance for the L2 learners improved relative to the first simulation, whereas the performance worsened for the L1 learner/speakers. These results indicate that L2 speakers learn differently from the linguistic input, employing different chunking strategies than those used in L1. McCauley and Christiansen (2017) then conclude that while both L1 and L2 learning involves utilizing multiword sequences, how they are acquired and the extent to which they are used vary across L1 and L2 learners.

These computational findings dovetail with results from human behavioral research. Using three different experimental paradigms, Ellis et al. (2008) illustrated that even highly proficient L2 speakers attend to and utilize different statistical information in language than L1 speakers. When presented with formulaic phrases and non-phrases for grammaticality judgements, L1 speakers' reaction times to the phrases were predicted by mutual information, which measures the extent to which the words within a phrase co-occur more frequently than expected by chance (Manning & Schuetze, 1999; Oakes, 1998). By contrast, the reaction times of the L2 speakers were predicted by raw frequencies, rather than mutual information. Similarly, L1 participants' voice onset time and duration of articulation in a read-aloud task correlated with mutual information, while those of the L2 participants were associated instead with raw frequencies. These results suggest that, unlike L1 speakers who recognize the distinctive functions of formulaic sequences when processed as coherent chunks, L2 learners' sensitivity to recurring multiword units was driven by the mere high frequencies of constituent words, even when they comprise grammatical fragments (e.g., *and at the* and *that to the*).

In summary, many of the major challenges L2 learners face in achieving native-like proficiency stem from difficulties with chunking in the second language, including problems with function words, lack of awareness and mastery of collocations and idioms, and reliance on statistical regularities that differ from those that govern L1 learning and processing. Arnon and Christiansen (2017) attribute such L1-L2 differences to the differential ways in which L1 and L2 are learned: due to the presence of prior linguistic and conceptual knowledge, L2 learners differ from L1 learners in the building blocks they use during acquisition, and such a difference leads to differences in learning strategies and outcomes (Arnon, 2010).

Differences in L1 and L2 Learning

L1 and L2 learners are equipped with different tools when it comes to language acquisition (MacWhinney, 2008). Infants have the advantage of relying on a highly plastic and adaptable brain that has not yet been dedicated to any specific functions (MacWhinney et al., 2000) when simultaneously learning language and engaging in the broader task of understanding the world in a robust system of social support provided by their caregivers (Snow, 1999). Yet the adult L2 learners are left with a brain that has already been molded to deal with various tasks of processing their L1 with a comprehensive understanding of the world and human society, and they are often deeply involved in social and professional obligations conducted in their primary language, which distract them from interactions in the new language (MacWhinney, 2008).

According to MacWhinney's (2008) Unified Competition Model of L1 and L2 acquisition, language is learned through self-organizing brain networks that restructure and update themselves by adapting to the statistical information in the input. During L1 learning in infancy and childhood, the brain networks are highly malleable due to a lack of prior experience and specialization. Having limited experience with both language and the conceptual world, infants do not inherently perceive word boundaries at the beginning of language learning. It has been proposed that they extract linguistic units according to statistical and prosodic information rather than lexical knowledge: based on sensitivity to conditional (co-occurrence probabilities) and distributional statistical information (frequency distributions) in the linguistic input (Erickson & Thiessen, 2015; Saffran, 2020), infants can discover both words and multiword units as possible building blocks for language (Arnon & Christiansen, 2017). Evidence from

early language production shows that children utter "frozen" chunks, or multiword sequences consisting of elements used unproductively, even during the single-word stage of language development (Arnon & Christiansen, 2017; Peters, 1983). Children's reliance on multiword units is also reflected in the patterns of errors they make due to high-frequency co-occurrences in the input. For example, Kirjavainen et al. (2009) explain that the common *me*-for-*I* errors that children make, such as saying *me do it* instead of *I do it*, can be attributed to the high proportional use of *let me do it* in the input from their caregivers. Although L2 learners also have the capacity to employ formulaic chunks during early production (Mitchell & Dickson, 1997; Myles, 2002, 2004), the degree to which they can fully utilize such units as building blocks for language is not on a par with L1 learning children—the frozen chunks spoken by children represent up to 50% of their early multiword utterances (Lieven et al., 2003).

With more exposure to objects, actions, and concepts alike paired with verbal labels, words and multiword units encoded as form-meaning associations accumulate, comprising increasingly more elaborate and fine-tuned brain networks. The process of specialization and stabilization of these networks inevitably leads to rigidity and entrenchment with increasingly more limited potentials for future movements and less plasticity in language learning (MacWhinney, 2008). For the adult learners, years of exposure to the L1 input makes little room for change in the deeply entrenched brain networks, let alone expanding them to encompass a whole new system of L2 regularities. For them, a new L2 Korean form 사과 is simply treated as an alternative way of saying 'apple.' Moreover, the adult L2 learners, possessing rather developed brain networks and metalinguistic knowledge, are well-aware of the existence of discrete words and their role as basic-level building blocks of language. Bypassing the necessity to extract sequences with undefined boundaries based on mere statistical regularities in the input, the adult L2 learners are unlikely to acquire multiword units as a result of under-segmentation like L1 learning children do (Arnon & Christiansen, 2017; Kurvers & Uri, 2006). Therefore, rather than building a new system from scratch by associating chunked/segmented phonological sequences with newly acquired concepts like L1 learning infants, the adult L2 learners often try to transfer the entire L1 conceptual world directly to the L2 at the lexical level when they first start learning the new language (MacWhinney, 2008; Arnon & Christiansen, 2017).

As summarized in the revised hierarchical model of bilingual lexicon (Kroll & Stewart, 1994; Kroll & Tokowicz, 2005), L2 is often parasitic on the L1 during early stages of L2 learning, lacking its own independent representations because L2 learners seek to access meaning through their L1 vocabulary, rather than through a direct L2-conceptual link. The weaker L2-conceptual links are evidenced by slowed forward (L1 to L2) translation compared to backward (L2 to L1) translation (Kroll & Stewart, 1994), diminished Stroop interference in L2 compared to in L1 (Brauer, 1998; Tzelgov et al., 1990), and reduced automatic emotional reactivity to L2 stimuli compared to their L1 counterparts as measured by skin conductance (Harris et al., 2003).

Moreover, the existing L1 phonological representations and word-conceptual associations provide a convenient shortcut to L2 learning, as rapid initial progress can be achieved through L1 transference (MacWhinney 2008). For example, L2 phonological learning typically starts with massive L1 transference, embedding L1 articulatory patterns into the new L2 pronunciations (Flege & Davidian, 1984; Hancin-Bhatt, 1994; MacWhinney, 2008). This

transfer rapidly enables a reasonable level of communication early on, yet it can result in a strong L1 accent and may eventually become counterproductive as the L2 vocabulary expands. Similarly, L1 transference can lead to a 'syntactic accent' at the constructional and sentential levels (MacWhinney, 2008). For an L1 Chinese speaker, the phrase 打开电视 ('to turn on the TV') is composed of 打开 ('to open') and 电视 ('television'); it thus makes sense to them to ask if they can turn on the TV by saying *can I open the TV?* due to L1 transference when they attempt to communicate in L2 English. Indeed, MacWhinney (2008) argues that every L1 structure with an L2 counterpart will transfer, and because the transference of whole syntactic frames or sentences would not be feasible, individual predicate-argument constructions are transferred one by one, which likely leads to the over-analysis and over-segmentation of L2 sentences and constructions into smaller chunks than necessary, especially into individual words.

Having deeply entrenched L1 brain networks encourages L2 learners to rely on L1 transference at the lexical level while also reducing sensitivity to certain kinds of statistical information in the L2 input. Arnon and Christiansen (2017) point out that L2 speakers are more capable of directing their attention to content words, such as verbs and nouns that convey semantic meaning, rendering them less attentive to the grammatical elements such as how specific articles and prepositions are connected to the content words within the meaning-carrying units (Ellis, 2006). This explains not only the well-documented shallow processing and less detailed syntactic representations computed by L2 learners (e.g., Clahsen & Felser, 2006; Pulido, 2021) but also the phenomenon in which L2 learners generally have difficulties mastering function words (Benson et al., 1992; Craig, 2008; Reid, 1988), number classifiers (Hansen & Chen, 2001), and grammatical gender even after extensive exposure (Dewaele & Véronique, 2001; Scherag et al., 2004).

As an example, consider the learning of article-noun agreement in languages with grammatical gender. One way an L1 French infant can learn the article-noun pair *la pomme* ('the apple') is by initially mapping the unsegmented sequence of sounds "*la-pomme"* onto their experience with an apple. With more exposure to the language and more experience with the conceptual world, the infant likely encounters other article-noun associations featuring either the same noun (e.g., *une pomme* 'an apple') or the same article (e.g., *la fleur* 'the flower'). These subsequent encounters help with the formation of the article and the noun as separate representations, while the early three-way association among the article, the noun, and the concept is maintained into and through adulthood. Another possible way for the L1 French infant to learn this article-noun pair is through chunking, or repeated exposure to the co-occurrence of these two constituent sequences. Learning either to segment or to chunk the input while simultaneously acquiring the concept promotes the incorporation of adjacent function words into the developing concept (Sloutsky & Fisher, 2012), making the grammatical elements predictive, informative, and learnable (Arnon & Christiansen, 2017). For the adult English speaker learning L2 French, on the other hand, *la* and *pomme* are treated as two distinct representations that can be mapped onto existing concepts already learned through L1 English: *pomme* being the translation equivalent of 'apple' and *la* being the definitive article functioning as 'the.' Having learned the article-noun pair as composed of separate entities with already established form-meaning associations, the three-way article-noun-conceptual link that L1

French speakers possess is less likely to be established as easily by L2 learners. This process obscures the predictivity and informativity of the grammatical elements in the constructions and thereby directs the attention away from them (Arnon & Christiansen, 2017).

While some researchers attribute the non-nativelike usage of grammatical structures to the existence and operations of a biologically determined critical period (e.g., DeKeyser, 2000; Lenneberg, 1967; Long, 2005) where language learners lose access to universal grammar after a certain age, MacWhinney's (e.g., 2002, 2008, 2015b, 2017) Unified Competition Model offers new insight into such struggles from the perspective of L1 entrenchment and transference. Having highly developed L1 linguistic and metalinguistic knowledge, the adult L2 learners often try to transfer as much from their L1 as possible to their L2. This results in a tendency to over-segment the L2 inputs and use smaller units as building blocks for the L2, which ultimately contributes to an over-reliance on individual words (Clahsen & Felser, 2006; Silva & Clahsen, 2008) and an under-reliance on larger chunks such as multiword units (Arnon & Christiansen, 2017) as well as relevant L2-specific syntactic constructions (MacWhinney, 2008; Culicover & Jackendoff, 2005; Goldberg, 2006).

Implications and Recommendations for L2 Education

Language learning occurs incrementally as the learner processes the fleeting input in real-time, drawing on prior experiences and making new connections based on the statistical patterns through the process of chunking (McCauley & Christiansen, 2011, 2014, 2019a). The mismatch between the abundance of statistical regularities in language and L2 learners' limited inclinations to take full advantage of them while struggling to achieve native-like proficiency thus sheds light on the implications of chunking for L2 pedagogical and instructional practices. As substantiated in the previous sections, L2 learners indeed have the capacity to chunk as well as to benefit from utilizing chunks even at the early stages of L2 acquisition (e.g., Jiang & Nekrasova, 2007; Myles, 2004; Nekrasova, 2009), yet the crux of the matter lies in the limited scope and effectiveness of their chunking practices as a result of having deeply entrenched L1 brain networks. To foster efficient real-time language processing and scaffold exercises to encourage chunking, L2 pedagogy would benefit from incorporating explicit chunking instruction and providing ample opportunities for learners to practice chunking with appropriate input and feedback. By equipping L2 learners with enhanced chunking skills, language instructors can unlock the potential for improved fluency in comprehension and production, thereby facilitating successful L2 learning.

Learning to Process

Traditional L2 instruction and assessments typically separate comprehension and production into different domains of language skills, such as listening, reading, writing, and speaking. However, such artificial divisions may not be conducive to optimal learning outcomes. For example, it is not uncommon for an L2 learner to be able to read academic journals full of technical jargon and complex sentence structures yet struggle to write a simple essay free of mistakes or sustain a conversation about mundane topics with a native speaker. As suggested in the previous section, L1 entrenchment and transference naturally hinder the incorporation of grammatical elements into L2 conceptual representations. Adult L2 learners may thus benefit less from the mere input than L1 learning children, leading to a larger discrepancy between

comprehension and production performances. Fortunately, earlier iterations of McCauley and Christiansen's (2017) chunk-based learner model revealed that excellent learning outcomes for both comprehension and production can be achieved by targeting their shared underlying mechanisms—chunking and real-time processing (Chater et al., 2016; McCauley & Christiansen, 2011, 2014). Upon training with speech input from caregiver corpora, the model exhibited outstanding performance on both phrasal segmentation (comprehension) and reproduction of child utterances (production). Remarkably, the model achieved its high performance by using backward transitional probabilities to discover chunks in the input and building up an inventory of those chunks for future use in both comprehension and production. This suggest that if statistically-based chunking can be enhanced in L2 speakers then, perhaps, they may be able to improve their real-time L2 processing and overall proficiency.

Similarly, accurate L2 assessments should also reflect chunking and real-time processing skills that underlie both comprehension and production. Culbertson et al. (2020) developed an utterance recall task, simultaneously assessing both comprehension and production while tapping into chunking and real-time processing. They found that L2 chunking at the sentence level is a better predictor of real-time proficiency than some of the traditional measures such as self-report and standardized multiple-choice comprehension tests. The rationale behind such a measure is that when the lengths of the stimulus sentences exceed working memory limitations, rote memorization becomes impossible, forcing the recall to rely on semantic and structural reconstruction based on real-time comprehension paired with the retrieval of long-term L2 knowledge through top-down processing (Bowden, 2016; Hamayan et al., 1977; Jessop et al., 2007).

Ultimately, to achieve native-like fluency or to enhance L2 proficiency in general, the L2 learner needs to advance their real-time language processing skills for both comprehension and production. L2 instruction and assessments should therefore prioritize the shared underlying mechanism of chunking, helping L2 learners overcome their tendencies to fixate on individual words and instead attend to larger building blocks.

Using the Right Building Blocks

Language learning—both L1 and L2—shares the same developmental pattern, progressing from formulaic phrases to limited-scope, slot-and-frame constructions, and ultimately to fully productive schematic patterns (Ellis, 2012). Building blocks then can be an important determinant of learning outcomes—indeed, empirical evidence has corroborated that larger building blocks are associated with better learning outcomes (Arnon & Christiansen, 2017). In an artificial language learning paradigm, Arnon and Ramscar (2012) showed that grammatical gender, a linguistic feature that non-native speakers typically struggle with, is better learned if participants were first exposed to larger linguistic units (full sentences) rather than the smaller ones (the target articles and nouns as individual words). Participants who heard full sentences containing the target article-noun sequences prior to hearing the single nouns outperformed those who heard the same targets in the opposite order on both a forced-choice article selection task and a prompted production task. Similar results were replicated in a natural language learning study by Paul and Grüter (2016), where monolingual English speakers learned Chinese noun-classifier associations better when first being exposed to full sentences rather than to single vocabulary items.

Siegelman and Arnon (2015) established a more direct link between building blocks and language learning outcomes. The experimental design was similar to Arnon and Ramscar (2012), except that both conditions involved exposure to full sentences, where sentences in one condition were segmented into individual words and those in the other remained unsegmented. Participants who were first exposed to unsegmented sentences again exhibited better learning than those who were first exposed to the segmented sentences on article-noun pairings as shown in both the forced-choice article selection task and the prompted production task. Together, these results indicate that to foster the necessary skills required for real-time language processing, L2 instruction should strive to help L2 learners become better chunkers by introducing and emphasizing larger linguistic units as building blocks: multiword units, formulaic sequences, as well as collocations and idioms.

Incorporating Multiword Units in L2 Education

Given that the most pronounced challenges that L2 learners face stem from not using adequately large building blocks frequently enough for acquisition and processing, the solution is to incorporate and emphasize both the mechanism and the product of chunking in L2 learning and teaching practices. Indeed, MacWhinney (2008) proposes that to block the rather counterproductive transference from deeply entrenched L1 brain networks, construction-based patterns should be taught to the L2 learners early on. Ellis (2002, 2012) suggests that even though chunking based on the statistical learning of frequency information and transitional probabilities is an implicit process (Christiansen, 2019), it does not hurt to bring such a process to explicit attention and instruction.

To raise the awareness of chunks in context, Lewis (1997) recommended highlighting coherent and meaningful multiword units in authentic L2 text, followed by inter-learner comparisons and feedback from instructors. However, even though such a practice was indeed effective in making L2 learners notice the existence of chunks when encountering new text (Jones & Haywood, 2004), the rate of retention and usage in production yielded mixed and rather underwhelming results (e.g., Boers et al., 2006; Stengers et al., 2010). Boers and Lindstromberg (2012) reason that given the existing gap between receptive and productive knowledge of multiword units in L2 learners, the sparse encounter of each chunk across large amounts of text is unlikely to be sufficient for securing mastery.

Thus, besides fostering awareness of the existence of chunks in natural spoken and written language, it is also important to focus on a subset of items at a time to ensure these target building blocks are learned well enough for future usage. The first step then is to identify and compile corpus-based, pedagogically useful chunks suitable to serve as building blocks for L2 learning and teaching. Because L2 learners are typically more sensitive to raw frequencies than to mutual information (Ellis et al., 2008; McCauley et al., 2017), deliberately increasing the frequency of target expressions in the input will likely facilitate mastering multiword units with high mutual information. Fortunately, ample efforts have been devoted to composing academic formula lists for learners of various languages, including English (e.g., Ackermann & Chen, 2013; Martinez & Schmitt, 2012; Simpson-Vlach & Ellis, 2010), Spanish (Parra Escartín et al., 2018), Chinese (Wang, 2020), and Japanese (Taguchi, 2007). Other than using existing academic formula lists, linguists and language teachers alike can also employ corpus analysis to curate their own formula lists by identifying highly frequent and coherent multiword units

typically lacking in L2 production. Once the target chunks are identified, appropriate input for L2 learners need to be generated. By attending to concentrated repetitions of the target chunks across different contexts in full-form native inputs, L2 learners can both learn to treat frequent co-occurring sequences of words as coherent units and have a better grasp of their meaning and usage in real-life language situations. To further reduce the chance of over-segmentation from showing perceptually salient word boundaries in the visual modality, auditory presentation of such tuned inputs should be preferred and implemented as often as possible to promote real-time Chunk-and-Pass processing. When visual presentation is necessary, it would be helpful if coherent multiword units are displayed and emphasized in a typographically enhanced manner that promotes chunking.

In addition to encouraging practice with large amounts of carefully tuned native utterances containing selected multiword units on the learners' end, educators should also incorporate explicit instruction into chunk-based L2 pedagogy. Explicit instruction refers to a structured and systematic way of teaching, where the purpose and rationale for learning the target skill are stated directly, clear explanations and demonstrations for the instructional target are provided deliberately, and extensive guided practice with contingent and appropriate feedback is encouraged until students have independently mastered the target skill (Archer & Hughes, 2010). A number of pedagogical studies have proposed and assessed systematic instructions and scaffolded activities targeting multiword units in the classroom at a wide range of proficiency levels (e.g., Liou & Chen, 2018; Murray, 2017; Nergis, 2021; Taguchi, 2007). These studies typically involve direct explanations of meaning and usage in context, various in-class tasks and activities that promote engagement and practice, and homework assignments that encourage guided or free production using the target chunks taught in class. These studies have generally achieved promising preliminary results, as L2 learners indeed show broadened and deepened collocational knowledge (Liou & Chen, 2018; Murray, 2017; Taguchi, 2007), increased usage of multiword units in speech (Taguchi, 2007) and writing (Liou & Chen, 2018; Murray, 2017), as well as improved conversational skills and overall oral fluency (Nergis, 2021).

It is recommended that chunk-based L2 pedagogy should not only focus on formulaicity and idiomaticity but also consider teaching multiword units that contain grammatical components rather than pure semantic information. For example, instead of teaching intransitive verbs as standalone words followed by a list of possible prepositions up for selection, a chunk-based L2 curriculum can introduce verb-preposition combinations as coherent, meaning-carrying units. Similarly, the lists can be expanded to include other grammatical chunks, such as prefabricated noun-preposition clusters (Craig, 2008), nouns with the associated number classifiers in Japanese and Chinese (Hansen & Chen, 2001; Paul & Grüter, 2016), article-noun pairs in languages with (or even without) grammatical gender (Arnon & Ramscar, 2012; Siegelman & Arnon, 2015), as well as noun-particle-verb associations with appropriate verb endings implicating different tenses and levels of politeness in SOV languages.

Offering Academic Support for ESL Students

In addition to standard English as a Second Language (ESL) courses, workshops, and writing consultation services, some institutions for secondary and higher education also provide extra

academic support for international students through student-led ESL speaking programs. Aware of the lack of opportunities for ESL students to speak up during lectures as well as the pressure associated with performance during seminars and discussions, these programs aim to encourage ESL students to practice English speaking skills in a relatively pressure-free and comfortable environment. Nevertheless, due to practicality concerns, these programs typically pair a whole group of ESL students with only one facilitator, who may or may not be a native speaker of English themself. Moreover, the facilitators are often specifically instructed to maximize participants' speech production by minimizing talking and avoiding correcting the grammatical errors that the participants make. Under such a design feature, the benefit that these programs can provide is oftentimes limited to the mere opportunity for the participants to speak up. Speech produced by L2 learners often lacks the appropriate chunks necessary for advancing language learning (McCauley & Christiansen, 2017) and is prone to various errors because of insufficient chunking and L1 transference (Benson et al., 1992; Nekrasova, 2009; Paquot & Granger, 2012). Therefore, the participants are not likely to learn coherent multiword units frequently used in conversations. Moreover, they are also at risk for occasionally picking up creative errors made by fellow L2 participants or even the non-native English-speaking facilitator in the group, as L2 learners are generally sensitive to raw frequencies in the input (Ellis et al., 2008).

Additionally, feedback represents an important catalyst for language learning from social interactions. Frinsel et al. (2020, 2024) confirmed in an artificial language learning study that the presence of feedback is conducive to language learning compared to having no feedback at all. In a Picture Guessing Game, native English-speaking participants were asked to guess which of the four scenes corresponded to what they heard in the target sentence. Participants who received either positive feedback (when they chose the correct scene) or negative feedback (when they chose an incorrect scene) showed improved learning over time, while participants who received no feedback on their responses were unable to learn the structural regularities of the artificial language. Although participants in the no-feedback condition showed some learning of the simple statistical patterns at the word level, as reflected by high scores on a noun test at the end, their lack of progress in learning at the construction level indicates that mere exposure paired with unguided retrieval practice is insufficient for robust syntactic learning.

Considering these aspects of language learning in practice, we suggest that in addition to offering a platform for ESL students to practice production, ESL speaking programs should also pay attention to what the participants can learn from the experiences provided. It might be beneficial to recruit more native English-speaking volunteers as facilitators and co-facilitators, reduce the group sizes to dilute the concentration of inputs from fellow L2 learners, and allow the native English-speaking facilitators to engage more with the conversations. This would provide both valuable L1 linguistic input and helpful feedback that emphasizes positive reinforcements for the correct usage of multiword units such as idioms, collocations, and formulaic sequences.

Conclusion

Chunking is crucial to overcoming the Now-and-Never bottleneck imposed by the fleeting linguistic input and general human cognitive constraints—both in L1 and L2 learning and

processing (Christiansen & Chater, 2016). In the context of L2 acquisition, while adults and other late learners have the capacity to chunk, they also face unique challenges due to the influence of their deeply entrenched L1 linguistic and conceptual representations, which can interfere with the utilization and development of Chunk-and-Pass processing in the L2. The incorporation of chunk-based practices in L2 education, featuring explicit instruction that fosters chunking skills and meaningful feedback that encourages the use of larger building blocks, thus presents a promising avenue to overcoming these challenges and improving L2 proficiency. In the spirit of MacWhinney's (e.g., 2002, 2005, 2008, 2012, 2015b, 2017) Unified Competition Model, we suggest that by recognizing the importance of chunking, educators can promote a better language learning experience and facilitate the achievement of native-like fluency in L2 communication.

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References

Ackermann, K., & Chen, Y.-H. (2013). Developing the academic collocation list (ACL) – A corpus-driven and expert-judged approach. *Journal of English for Academic Purposes*, *12*(4), 235–247. https://doi.org/10.1016/j.jeap.2013.08.002

Archer, A. L., & Hughes, C. A. (2010). *Explicit instruction: Effective and efficient teaching*. Guilford Publications.

Arnaud, P. J. L., & Savignon, S. (1997). Rare words, complex lexical units and the advanced learner. In J. Coady & T. Huckin (Eds.), *Second language vocabulary acquisition: A rationale for pedagogy* (pp. 157–173). Cambridge University Press.

Arnon, I. (2010). Starting big: The role of multiword phrases in language learning and use. *Unpublished PhD dissertation*, Stanford University.

Arnon, I., & Christiansen, M. H. (2017). The role of multiword building blocks in explaining L1–L2 differences. *Topics in Cognitive Science*, *9*(3), 621–636. https://doi.org/10.1111/tops.12271

Arnon, I., & Ramscar, M. (2012). Granularity and the acquisition of grammatical gender: How order-of-acquisition affects what gets learned. *Cognition*, *122*(3), 292–305. https://doi.org/10.1016/j.cognition.2011.10.009

Bates, E. & MacWhinney, B. (1982). A functionalist approach to grammar. In E. Wanner & L. Gleitman (Eds.), *Language acquisition: The state of the art* (pp. 173-218). Cambridge University Press.

Bencini, G. M. L., & Goldberg, A. E. (2000). The contribution of argument structure constructions to sentence meaning. *Journal of Memory and Language*, *43*(4), 640–651. https://doi.org/10.1006/jmla.2000.2757

Benson, B., Deming, M. P., Denzer, D., & Valeri-Gold, M. (1992). A combined basic writing/English as a second language class: Melting pot or mishmash? *Journal of Basic Writing*, *11*(1), 58–74. https://www.jstor.org/stable/43443991

Biber, D., Johansson, S., Leech, G., Conrad, S., & Finegan, E. (1999). *Longman grammar of spoken and written English*. Cambridge University Press.

Bock, J. K. (1986). Syntactic persistence in language production. *Cognitive Psychology*, *18*(3), 355–387. https://doi.org/10.1016/0010-0285(86)90004-6

Boers, F., Eyckmans, J., Kappel, J., Stengers, H., & Demecheleer, M. (2006). Formulaic sequences and perceived oral proficiency: Putting a lexical approach to the test. *Language Teaching Research*, *10*(3), 245–261. https://doi.org/10.1191/1362168806lr195oa

Boers, F., & Lindstromberg, S. (2012). Experimental and intervention studies on formulaic sequences in a second language. *Annual Review of Applied Linguistics*, *32*, 83–110. https://doi.org/10.1017/S0267190512000050

Bowden, H. W. (2016). Assessing second-language oral proficiency for research: The Spanish elicited imitation task. *Studies in Second Language Acquisition*, *38*(4), 647–675. https://doi.org/10.1017/S0272263115000443

Brauer, M. (1998). Stroop interference in bilinguals: The role of similarity between the two languages. In A.F. Healy & L.E. Baurne, Jr. (Eds.). *Foreign language learning* (pp. 317–337). Mahwah, NJ: Erlbaum.

Brown, G. D. A., Neath, I., & Chater, N. (2007). A temporal ratio model of memory. *Psychological Review*, *114*(3), 539–576. https://doi.org/10.1037/0033-295X.114.3.539

Bybee, J. (2010). *Language, Usage and Cognition*. Cambridge University Press.

Carrol, G., Conklin, K., & Gyllstad, H. (2016). Found in translation: The influence of the L1 on the reading of idioms in a L2. *Studies in Second Language Acquisition*, *38*(3), 403–443. https://doi.org/10.1017/S0272263115000492

Catalán, R. J. (1996). Frequency and variability in errors in the use of English prepositions. *Miscelánea: A Journal of English and American Studies*. https://api.semanticscholar.org/CorpusID:61538350

Chater, N., McCauley, S. M., & Christiansen, M. H. (2016). Language as skill: Intertwining comprehension and production. *Journal of Memory and Language*, *89*, 244–254. https://doi.org/10.1016/j.jml.2015.11.004

Christiansen, M. H. (2019). Implicit statistical learning: A tale of two literatures. *Topics in Cognitive Science*, *11*(3), 468–481. https://doi.org/10.1111/tops.12332

Christiansen, M. H., & Arnon, I. (2017). More Than Words: The role of multiword sequences in language learning and use. *Topics in Cognitive Science*, *9*(3), 542–551. https://doi.org/10.1111/tops.12274

Christiansen, M. H., & Chater, N. (2016). The Now-or-Never bottleneck: A fundamental constraint on language. *Behavioral and Brain Sciences*, *39*. https://doi.org/10.1017/S0140525X1500031X

Cieślicka, A. (2006). Literal salience in on-line processing of idiomatic expressions by second language learners. *Second Language Research*, *22*(2), 115–144. https://doi.org/10.1191/0267658306sr263oa

Clahsen, H., & Felser, C. (2006). Grammatical processing in language learners. *Applied Psycholinguistics*, *27*(1), 3–42. https://doi.org/10.1017/S0142716406060024

Conklin, K., & Schmitt, N. (2008). Formulaic sequences: Are they processed more quickly than nonformulaic language by native and nonnative speakers? *Applied Linguistics*, *29*(1), 72–89. https://doi.org/10.1093/applin/amm022

Conklin, K., & Schmitt, N. (2012). The processing of formulaic language. *Annual Review of Applied Linguistics*, *32*, 45–61. https://doi.org/10.1017/S0267190512000074

Contreras Kallens, P. & Christiansen, M. H. (2022). Models of language and multiword expressions. *Frontiers in Artificial Intelligence, 5:*781962. https://doi.org/10.3389/frai.2022.781962

Cowan, N. (2001). The magical number 4 in short-term memory: A reconsideration of mental storage capacity. *Behavioral and Brain Sciences*, *24*(1), 87–114. https://doi.org/10.1017/S0140525X01003922

Craig, E. C. (2008). N+P clusters in freshman composition: A lexico-grammatical approach to academic vocabulary for second language writers. *Unpublished doctoral dissertation*, University of Georgia. https://getd.libs.uga.edu/pdfs/craig_elizabeth_c_200812_phd.pdf

Culbertson, G., Andersen, E., & Christiansen, M. H. (2020). Using utterance recall to assess second language proficiency. *Language Learning*, *70*(S2), 104–132. https://doi.org/10.1111/lang.12399

Culicover, P. W., & Jackendoff, R. (2005). *Simpler Syntax*. Oxford University Press.

Dai, Z., & Ding, Y. (2010). Effectiveness of text memorization in EFL learning of Chinese students. In D. Wood (Ed.), *Perspectives on formulaic language: Acquisition and communication* (pp. 71–87). Continuum.

De Cock, S. (1998). A recurrent word combination approach to the study of formulae in the speech of native and non-native speakers of English. *International Journal of Corpus Linguistics*, *3*(1), 59–80. https://doi.org/10.1075/ijcl.3.1.04dec

de la Cruz-Pavía, I., Werker, J. F., Vatikiotis-Bateson, E., & Gervain, J. (2020). Finding phrases: The interplay of word frequency, phrasal prosody and co-speech visual information in chunking speech by monolingual and bilingual adults. *Language and Speech*, *63*(2), 264–291. https://doi.org/10.1177/0023830919842353

DeKeyser, R. M. (2000). The robustness of critical period effects in second language acquisition. *Studies in Second Language Acquisition*, *22*(4), 499–533. https://doi.org/10.1017/S0272263100004022

Dewaele, J.-M., & Véronique, D. (2001). Gender assignment and gender agreement in advanced French interlanguage: A cross-sectional study. *Bilingualism: Language and Cognition*, *4*(3), 275–297. https://doi.org/10.1017/S136672890100044X

Durrant, P., & Schmitt, N. (2009). To what extent do native and non-native writers make use of collocations? *International Review of Applied Linguistics in Language Teaching, 47*(2), 157–177. https://doi.org/10.1515/iral.2009.007

Ellis, N. C. (1996). Sequencing in SLA: Phonological memory, chunking, and points of order. *Studies in Second Language Acquisition*, *18*(1), 91–126 https://doi.org/10.1017/S0272263100014698

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

Ellis, N. C. (2003). Constructions, chunking, and connectionism: The emergence of second language structure. In C. J. Doughty & M. H. Long (Eds.), *The handbook of second language acquisition* (pp. 63-103). Blackwell Publishing.

Ellis, N. C. (2006). Selective attention and transfer phenomena in L2 acquisition: Contingency, cue competition, salience, interference, overshadowing, blocking, and perceptual learning. *Applied Linguistics*, *27*(2), 164–194. https://doi.org/10.1093/applin/aml015

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

Ellis, N. C., & Ogden, D. C. (2017). Thinking about multiword constructions: Usage-based approaches to acquisition and processing. *Topics in Cognitive Science, 9*(3), 604-620. https://doi.org/10.1111/tops.12256

Ellis, N. C., Frey, E., & Jalkanen, I. (2009). The psycholinguistic reality of collocation and semantic prosody. In U. Römer & R. Schulze (Eds.), *Exploring the lexis-grammar interface* (pp. 89-114). Benjamins.

Ellis, N. C., Simpson-Vlach, R., & Maynard, C. (2008). Formulaic language in native and second language speakers: Psycholinguistics, corpus linguistics, and TESOL. *TESOL Quarterly*, *42*(3), 375–396. https://doi.org/10.1002/j.1545-7249.2008.tb00137.x

Elman, J. L. (2009). On the meaning of words and dinosaur bones: Lexical knowledge without a lexicon. *Cognitive Science*, *33*(4), 547–582. https://doi.org/10.1111/j.1551-6709.2009.01023.x

Erickson, L. C., & Thiessen, E. D. (2015). Statistical learning of language: Theory, validity, and predictions of a statistical learning account of language acquisition. *Developmental Review*, *37*, 66–108. https://doi.org/10.1016/j.dr.2015.05.002

Erman, B., & Warren, B. (2000). The idiom principle and the open choice principle. *Text & Talk*, *20*(1), 29–62. https://doi.org/10.1515/text.1.2000.20.1.29

Flege, J. E., & Davidian, R. D. (1984). Transfer and developmental processes in adult foreign language speech production. *Applied Psycholinguistics*, *5*(4), 323–347. https://doi.org/10.1017/S014271640000521X

Flowerdew, J. (2006). Use of signalling nouns in a learner corpus. *International Journal of Corpus Linguistics*, *11*(3), 345–362. https://doi.org/10.1075/ijcl.11.3.07flo

French, L. M., & O'Brien, I. (2008). Phonological memory and children's second language grammar learning. *Applied Psycholinguistics*, *29*(3), 463–487. https://doi.org/10.1017/S0142716408080211

Frinsel, F. F., Trecca, F., & Christiansen, M. H. (2020). The Picture Guessing Game: The role of feedback in active artificial language learning. In S. Denison., M. Mack, Y. Xu & B.C. Armstrong (Eds.), *Proceedings of the 42nd Annual Conference of the Cognitive Science Society* (pp. 2813-2819). Cognitive Science Society.

Frinsel, F. F., Trecca, F. & Christiansen, M. H. (2024). The role of feedback in the statistical learning of language-like regularities. *Cognitive Science, 48,* e13419. https://doi.org/10.1111/cogs.13419

Gobet, F., Lane, P. C. R., Croker, S., Cheng, P. C.-H., Jones, G., Oliver, I., & Pine, J. M. (2001). Chunking mechanisms in human learning. *Trends in Cognitive Sciences*, *5*(6), 236–243. https://doi.org/10.1016/S1364-6613(00)01662-4

Goldberg, A. E. (2006). *Constructions at work: The nature of generalization in language*. Oxford University Press.

Gries, S. T., & Wulff, S. (2005). Do foreign language learners also have constructions? *Annual Review of Cognitive Linguistics*, *3*, 182–200. https://doi.org/10.1075/arcl.3.10gri

Hamayan, E., Saegert, J., & Larudee, P. (1977). Elicited imitation in second language learners. *Language and Speech*, *20*(1), 86–97. https://doi.org/10.1177/002383097702000109

Hancin-Bhatt, B. (1994). Segment transfer: A consequence of a dynamic system. *Second Language Research*, *10*(3), 241–269. https://doi.org/10.1177/026765839401000304

Hansen, L., & Chen, Y.-L. (2001). What counts in the acquisition and attrition of numeral classifiers? *JALT Journal, 23*(1), 83–97.

Harris, C. L., Ayçiçeği, A., & Gleason, J. B. (2003). Taboo words and reprimands elicit greater autonomic reactivity in a first language than in a second language. *Applied Psycholinguistics*, *24*(4), 561–579. https://doi.org/10.1017/S0142716403000286

Howarth, P. (1998). Phraseology and second language proficiency. *Applied Linguistics*, *19*(1), 24–44. https://doi.org/10.1093/applin/19.1.24

Hsu, J. T., & Chiu, C. (2008). Lexical collocations and their relation to speaking proficiency of college EFL learners in Taiwan. *The Asian EFL Journal Quarterly*, *10*(1), 181–204.

Irujo, S. (1986). Don't put your leg in your mouth: Transfer in the acquisition of idioms in a second language. *TESOL Quarterly*, *20*(2), 287–304. https://doi.org/10.2307/3586545

Isbilen, E. S., McCauley, S. M., & Christiansen, M. H. (2022). Individual differences in artificial and natural language statistical learning. *Cognition*, *225*, 105123. https://doi.org/10.1016/j.cognition.2022.105123

Jackendoff, R. (1997). *The architecture of the language faculty*. MIT Press.

Jessop, L., Suzuki, W., & Tomita, Y. (2007). Elicited imitation in second language acquisition research. *Canadian Modern Language Review/ La Revue Canadienne Des Langues Vivantes*, *64*(1), 215–238. https://doi.org/10.3138/cmlr.64.1.215

Jiang, N., & Nekrasova, T. M. (2007). The processing of formulaic sequences by second language speakers. *The Modern Language Journal*, *91*(3), 433–445. https://doi.org/10.1111/j.1540-4781.2007.00589.x

Jiang, S., Jiang, X., & Siyanova-Chanturia, A. (2020). The processing of multiword expressions in children and adults: An eye-tracking study of Chinese. *Applied Psycholinguistics*, *41*(4), 901–931. https://doi.org/10.1017/S0142716420000296

Jolsvai, H., McCauley, S. M., & Christiansen, M. H. (2020). Meaningfulness beats frequency in multiword chunk processing. *Cognitive Science, 44*, e12885. https://doi.org/10.1111/cogs.12885

Jones, G., Gobet, F., Freudenthal, D., Watson, S. E., & Pine, J. M. (2014). Why computational models are better than verbal theories: The case of nonword repetition. *Developmental Science*, *17*(2), 298–310. https://doi.org/10.1111/desc.12111

Jones, M., & Haywood, S. (2004). Facilitating the acquisition of formulaic sequences: An exploratory study. In N. Schmitt (Ed.), *Formulaic sequences* (pp. 269–300). John Benjamins.

Jurafsky, D., Bell, A., Gregory, M., & Raymond, W. D. (2001). Probabilistic relations between words: Evidence from reduction in lexical production. In J. Bybee & P. Hopper (Eds.), *Frequency and the emergence of linguistic structure* (pp. 229–254). John Benjamins.

Keshavarz, M. H., & Salimi, H. (2007). Collocational competence and cloze test performance: A study of Iranian EFL learners. *International Journal of Applied Linguistics*, *17*(1), 81–92. https://doi.org/10.1111/j.1473-4192.2007.00156.x

Kirjavainen, M., Theakston, A., & Lieven, E. (2009). Can input explain children's me-for-I errors?*. *Journal of Child Language*, *36*(5), 1091–1114. https://doi.org/10.1017/S0305000909009350

Kroll, J. F., & Stewart, E. (1994). Category interference in translation and picture naming: Evidence for asymmetric connections between bilingual memory representations. *Journal of Memory and Language*, *33*(2), 149–174. https://doi.org/10.1006/jmla.1994.1008

Kroll, J. F., & Tokowicz, N. (2005). Bilingual lexical processing. In J. F. Kroll & A. M. B. DeGroot (Eds.), *Handbook of bilingualism: Psycholinguistic approaches*. Oxford University Press.

Kurvers, J., & Uri, H. (2006). Metalexical Awareness: Development, methodology or written language? A cross-linguistic comparison. *Journal of Psycholinguistic Research*, *35*(4), 353–367. https://doi.org/10.1007/s10936-006-9019-6

Leech, G. (2000). Grammars of spoken English: New outcomes of corpus-oriented research. *Language Learning*, *50*(4), 675–724. https://doi.org/10.1111/0023-8333.00143

Lenneberg, E. H. (1967). The biological foundations of language. *Hospital Practice*, *2*(12), 59–67. https://doi.org/10.1080/21548331.1967.11707799

Lewis, M. (1997). *Implementing the lexical approach: Putting theory into practice*. Language Teaching Publications.

Lieven, E., Behrens, H., Speares, J., & Tomasello, M. (2003). Early syntactic creativity: A usage-based approach. *Journal of Child Language*, *30*(2), 333–370. https://doi.org/10.1017/S0305000903005592

Liou, H.-C., & Chen, W.-F. (2018). Effects of explicit instruction on learning academic formulaic sequences for EFL College learners' writing. *Taiwan Journal of TESOL*, *15*(1), 61–100. https://doi.org/10.30397/TJTESOL.201804_15(1).0003

Long, M. (2005). *Problems with supposed counter-evidence to the Critical Period Hypothesis*. *43*(4), 287–317. https://doi.org/10.1515/iral.2005.43.4.287

MacWhinney, B., Feldman, H., Sacco, K., & Valdés-Pérez, R. (2000). Online measures of basic language skills in children with early focal brain lesions. *Brain and Language*, *71*(3), 400–431. https://doi.org/10.1006/brln.1999.2273

MacWhinney, B. (2002). Extending the Competition Model. In R. Heredia & J. Altarriba (Eds.), *Bilingual sentence processing* (pp. 31-58). Elsevier.

MacWhinney, B. (2005). A unified model of language acquisition. In J. F. Kroll & A. M. B. de Groot (Eds.), *Handbook of bilingualism: Psycholinguistic approaches* (pp. 49-67). Oxford University Press.

MacWhinney, B. (2008). A unified model. In P. Robinson & N. C. Ellis (Eds.), *Handbook of cognitive linguistics and second language acquisition* (pp. 341-371). Lawrence Erlbaum Associates.

MacWhinney, B. (2012). The logic of the Unified Model. In S. Gass & A. Mackey (Eds.), *The Routledge Handbook of Second Language Acquisition* (pp. 211-227). Routledge.

MacWhinney, B (2015a). Emergentism. In E. Dabrowska & D. Divjak (Eds.), *Handbook of cognitive linguistics* (pp. 689–706). Mouton-DeGruyter.

MacWhinney, B. (2015b). Multidimensional SLA. In T. Cadierno & S. W. Eskildsen (Eds.), *Usage-based perspectives on second language learning* (pp. 22-45). Oxford University Press.

MacWhinney, B. (2017). A unified model of first and second language learning. In M. Hickmann & M. Kail (Eds.), *Language acquisition* (pp. 287-311). John Benjamins.

MacWhinney, B., & Snow, C. (1985). The child language data exchange system. *Journal of Child Language, 12*(2), 271-295. https://doi.org/10.1017/S0305000900006449

Manning, C. D., & Schuetze, H. (1999). *Foundations of statistical natural language processing, collocations.* MIT Press.

Martinez, R., & Murphy, V. A. (2011). Effect of frequency and idiomaticity on second language reading comprehension. *TESOL Quarterly*, *45*(2), 267–290. https://doi.org/10.5054/tq.2011.247708

Martinez, R., & Schmitt, N. (2012). A phrasal expressions list. *Applied Linguistics*, *33*(3), 299–320. https://doi.org/10.1093/applin/ams010

Mauranen, A. (2009). *Chunking in ELF: Expressions for managing interaction*. *6*(2), 217–233. https://doi.org/10.1515/IPRG.2009.012

McCauley, S. M., & Christiansen, M. H. (2011). Learning simple statistics for language comprehension and production: The CAPPUCCINO Model. In L. Carlson, C. Hölscher, & T. Shipley (Eds.), *Proceedings of the 33rd Annual Conference of the Cognitive Science Society* (pp. 1619-1624). Cognitive Science Society.

McCauley, S. M., & Christiansen, M. H. (2014). Acquiring formulaic language: A computational model. *The Mental Lexicon*, *9*(3), 419–436. https://doi.org/10.1075/ml.9.3.03mcc

McCauley, S. M., & Christiansen, M. H. (2015). *Individual differences in chunking ability predict on-line sentence processing*. In D.C. Noelle & R. Dale (Eds.), *Proceedings of the 37th Annual Conference of the Cognitive Science Society* (pp. 1553-1558). Cognitive Science Society.

McCauley, S. M., & Christiansen, M. H. (2017). Computational investigations of multiword chunks in language learning. *Topics in Cognitive Science*, *9*(3), 637–652. https://doi.org/10.1111/tops.12258

McCauley, S. M., & Christiansen, M. H. (2019a). Language learning as language use: A cross-linguistic model of child language development. *Psychological Review*, *126*(1), 1–51. https://doi.org/10.1037/rev0000126

McCauley, S. M., & Christiansen, M. H. (2019b). Modeling children's early linguistic productivity through the automatic discovery and use of lexically-based frames. In A. Goel, C. Seifert & C. Freksa (Eds.), *Proceedings of the 41st Annual Conference of the Cognitive Science Society* (pp. 782-788). Cognitive Science Society.

McCauley, S. M., Isbilen, E. S., & Christiansen, M. H. (2017). Chunking ability shapes sentence processing at multiple levels of abstraction. In G. Gunzelmann, A. Howes, T. Tenbrink, & E. J. Davelaar (Eds.), *Proceedings of the 39th Annual Conference of the Cognitive Science Society* (pp. 2681-2686). Cognitive Science Society.

McDonald, S. A., & Shillcock, R. C. (2003). Eye movements reveal the on-line computation of lexical probabilities during reading. *Psychological Science*, *14*(6), 648–652. https://doi.org/10.1046/j.0956-7976.2003.psci_1480.x

Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review*, *63*(2), 81–97. https://doi.org/10.1037/h0043158

Miller, G. A., & Taylor, W. G. (1948). The perception of repeated bursts of noise. *The Journal of the Acoustical Society of America*, *20*(2), 171–182. https://doi.org/10.1121/1.1906360

Mitchell, R. & Dickson, P. (1997). *Progression in foreign language learning: Final report* (CLE Working Papers 45). University of Southampton.

Moon, R. (1997). Vocabulary connections: Multi-word items in English. In N. Schmitt & M. McCarthy (Eds.), *Vocabulary: Description, acquisition and pedagogy* (pp. 40–63). Cambridge University Press.

Murray, L. (2017). A study in enhancing L2 learners' utility with written academic formulaic sequences. *TESL Canada Journal*, *34*(3), 76–92. http://dx.doi.org/10.18806/tesl.v34i3.1274

Myles, F. (2002). *Linguistic Development in Classroom Learners of French: a cross-sectional study (End of ESRC award report R000223421)*. University of Southampton.

Myles, F. (2004). From data to theory: The over-representation of linguistic knowledge in SLA. *Transactions of the Philological Society*, *102*(2), 139–168. https://doi.org/10.1111/j.0079-1636.2004.00133.x

Myles, F., Hooper, J., & Mitchell, R. (1998). Rote or rule? Exploring the role of formulaic language in classroom foreign language learning. *Language Learning*, *48*(3), 323–364. https://doi.org/10.1111/0023-8333.00045

Myles, F., Mitchell, R., & Hooper, J. (1999). Interrogative Chunks in French L2: A basis for creative construction? *Studies in Second Language Acquisition*, *21*(1), 49–80. https://doi.org/10.1017/S0272263199001023

Nekrasova, T. M. (2009). English L1 and L2 speakers' knowledge of lexical bundles. *Language Learning*, *59*(3), 647–686. https://doi.org/10.1111/j.1467-9922.2009.00520.x

Nergis, A. (2021). Can explicit instruction of formulaic sequences enhance L2 oral fluency? *Lingua*, *255*, 103072. https://doi.org/10.1016/j.lingua.2021.103072

Oakes, M. (1998). *Statistics for corpus linguistics*. Edinburgh University Press.

O'Brien, I., Segalowitz, N., Collentine, J., & Freed, B. (2006). Phonological memory and lexical, narrative, and grammatical skills in second language oral production by adult learners. *Applied Psycholinguistics*, *27*(3), 377–402. https://doi.org/10.1017/S0142716406060322

Paquot, M., & Granger, S. (2012). Formulaic language in learner corpora. *Annual Review of Applied Linguistics*, *32*, 130–149. https://doi.org/10.1017/S0267190512000098

Parra Escartín, C., Nevado Llopis, A., & Martínez, S. (2018). Spanish multiword expressions: Looking for a taxonomy. In M. Sailer & S. Markantonatou (Eds.), *Multiword expressions: Insights from a multi-lingual perspective* (pp. 271–323). Language Science Press. https://doi.org/10.5281/zenodo.1182605

Paul, J. Z., & Grüter, T. (2016). Blocking effects in the learning of Chinese classifiers. *Language Learning*, *66*(4), 972–999. https://doi.org/10.1111/lang.12197

Peters, A. M. (1983). *The units of language acquisition*. CUP Archive.

Pulido, M. F. (2021). Individual chunking ability predicts efficient or shallow L2 processing: Eye-tracking evidence from multiword units in relative clauses. *Frontiers in Psychology*, *11*. https://www.frontiersin.org/articles/10.3389/fpsyg.2020.607621

Pulido, M. F., López-Beltrán, P., Dussias, P. E., & Christiansen, M. H. (2024). Individual chunking ability predicts online sensitivity to L2 morphosyntax: Evidence from Spanish gender agreement. *Submitted for Publication.*

Reid, J. M. (1988). Quantitative differences in English prose written by Arabic, Chinese, Spanish, and English students. *Unpublished doctoral dissertation*, Colorado State University, Fort Collins.

Saffran, J. R. (2020). Statistical language learning in infancy. *Child Development Perspectives*, *14*(1), 49–54. https://doi.org/10.1111/cdep.12355

Scherag, A., Demuth, L., Rösler, F., Neville, H. J., & Röder, B. (2004). The effects of late acquisition of L2 and the consequences of immigration on L1 for semantic and morpho-syntactic language aspects. *Cognition*, *93*(3), B97–B108. https://doi.org/10.1016/j.cognition.2004.02.003

Siegelman, N., & Arnon, I. (2015). The advantage of starting big: Learning from unsegmented input facilitates mastery of grammatical gender in an artificial language. *Journal of Memory and Language*, *85*, 60–75. https://doi.org/10.1016/j.jml.2015.07.003

Silva, R., & Clahsen, H. (2008). Morphologically complex words in L1 and L2 processing: Evidence from masked priming experiments in English. *Bilingualism: Language and Cognition*, *11*(2), 245–260. https://doi.org/10.1017/S1366728908003404

Simpson-Vlach, R., & Ellis, N. C. (2010). An academic formulas list: New methods in phraseology research. *Applied Linguistics*, *31*(4), 487–512. https://doi.org/10.1093/applin/amp058

Sinclair, J. (1991). *Corpus, concordance, collocation*. Oxford University Press.

Sinclair, J. (2004). *Trust the text: Language, corpus and discourse*. Routledge.

Siyanova, A., & Schmitt, N. (2007). *Native and nonnative use of multi-word vs. One-word verbs*. *45*(2), 119–139. https://doi.org/10.1515/IRAL.2007.005

Skiba, R., & Dittmar, N. (1992). Pragmatic, semantic, and syntactic constraints and grammaticalization: A longitudinal perspective. *Studies in Second Language Acquisition*, *14*(3), 323–349. https://doi.org/10.1017/S0272263100011141

Sloutsky, V. M., & Fisher, A. V. (2012). Linguistic labels: Conceptual markers or object features? *Journal of Experimental Child Psychology*, *111*(1), 65–86. https://doi.org/10.1016/j.jecp.2011.07.007

Snow, C. E. (1999). Social perspectives on the emergence of language. In B. MacWhinney (Ed.), *The emergence of language* (pp. 257-276). Lawrence Erlbaum Associates.

Steinel, M. P., Hulstijn, J. H., & Steinel, W. (2007). Second language idiom learning in a paired-associate paradigm: Effects of direction of learning, direction of testing, idiom imageability, and idiom transparency. *Studies in Second Language Acquisition*, *29*(3), 449–484. https://doi.org/10.1017/S0272263107070271

Stengers, H., Boers, F., Housen, A., & Eyckmans, J. (2010). Does "chunking" foster chunk-uptake? In S. De Knop, F. Boers, & A. De Rycker (Eds.), *Fostering language teaching efficiency through cognitive linguistics* (99–117). Mouton de Gruyter.

Stengers, H., Boers, F., Housen, A., & Eyckmans, J. (2011). *Formulaic sequences and L2 oral proficiency: Does the type of target language influence the association? 49*(4), 321–343. https://doi.org/10.1515/iral.2011.017

Studdert-Kennedy, M. (1986). Some developments in research on language behavior. In N. J. Smelser & D. R. Gerstein (Eds.), *Behavioral and social science: Fifty years of discovery*. In commemoration of the fiftieth anniversary of the "Ogburn Report," recent social trends in the United States (pp. 208–48). National Academy Press.

Taguchi, N. (2007). Chunk learning and the development of spoken discourse in a Japanese as a foreign language classroom. *Language Teaching Research*, *11*(4), 433–457. https://doi.org/10.1177/1362168807080962

Tremblay, A. (2011). Proficiency assessment standards in second language acquisition research. *Studies in Second Language Acquisition*, *33*(3), 339–372. https://doi.org/10.1017/S0272263111000015

Tzelgov, J., Henik, A., & Leiser, D. (1990). Controlling Stroop interference: Evidence from a bilingual task. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *16*(5), 760–771. https://doi.org/10.1037/0278-7393.16.5.760

Wang, S. (2020). *Chinese multiword expressions: Theoretical and practical perspectives*. Springer Singapore. https://doi.org/10.1007/978-981-13-8510-0

Weinert, R. (1995). The role of formulaic language in second language acquisition: A review. *Applied Linguistics*, *16*(2), 180–205. https://doi.org/10.1093/applin/16.2.180

Wen, Z. (2012). Working memory and second language learning. *International Journal of Applied Linguistics*, *22*(1), 1–22. https://doi.org/10.1111/j.1473-4192.2011.00290.x

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. https://doi.org/10.1017/S0272263113000107

Wolter, B., & Yamashita, J. (2018). Word frequency, collocational frequency, L1 congruency, and proficiency in L2 collocational processing: What accounts for L2 performance? *Studies in Second Language Acquisition*, *40*(2), 395–416. https://doi.org/10.1017/S0272263117000237

Wray, A. (2000). Formulaic sequences in second language teaching: Principle and practice. *Applied Linguistics*, *21*(4), 463–489. https://doi.org/10.1093/applin/21.4.463

Wray, A. (2002). *Formulaic language and the lexicon*. Cambridge University Press. https://doi.org/10.1017/CBO9780511519772

Wray, A. (2004). 'Here's one I prepared earlier': Formulaic language learning on television. In N. Schmitt (Ed.), *Formulaic sequences: Acquisition, processing and use* (pp. 249–268). John Benjamins.