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Processing of novel grammatical features during real-time second language production and comprehension

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Abstract

Second language (L2) learners often have difficulties acquiring grammatical features which do not exist in their first language (e.g. inflectional morphology, number agreement etc.), and exhibit real-time production and comprehension errors when these features are involved. What are the causes behind such errors? Moreover, what do they tell us about second language processing in general?

The primary aim of this thesis was to examine the nature of second language production errors and to scrutinise them with reference to each stage of accepted models of language production, specifically, whether there are consistent error patterns which reveal the source(s) of erroneous production in L2 learners. The second aim of this thesis was to examine the comprehension of novel grammatical features in the second language, more specifically, whether L2 learners could acquire the ability to consistently apply L2 grammatical knowledge relating to newly acquired grammatical features in real-time. The third aim of this thesis was to examine whether L2 learners have fundamental perceptual deficiencies or biases concerning selective L2 phonological features as a result of first language experience, and whether this would affect the perception of specific grammatical features in the L2.

This thesis addressed these questions in seven experiments by examining the acquisition of inflectional morphology among L1 Mandarin speakers of L2 English. Experiments 1, 2 and 3 investigated spoken and written production of inflectional morphology via an elicited production paradigm. The results argued against representational accounts and supported activation processing accounts of erroneous second language production. Information complexity and production modality were also found to contribute to low production accuracy. Experiments 4 and 5 investigated L2 learners' auditory and visual sensitivity to inflectional omissions using self-paced listening and self-paced reading paradigms, where auditory cues were found to facilitate the detection of inflectional omissions. Experiments 6 and 7 investigated perceptual sensitivity to phonologically variable inflectional morphemes in an auditory discrimination paradigm. Second language learners exhibited no

perceptual deficiency to novel phonological features, and no consistent perceptual biases favouring L1 phonological features relative to native speakers.

Taking these findings as whole, the results favoured a processing account of errors in language production and comprehension, whilst recognising the role of phonological constraints in both processes. Importantly, these conclusions are drawn from a broad analysis of multiple aspects of language processing, recognising the role of conceptual distinctions, grammatical representations, lexical forms, and phonological factors in second language production and comprehension. Additionally, this thesis recognises the value of both psycholinguistic models of language processing and linguistic theories of second language processing.

Lay Summary

Second language (L2) learners often have difficulties acquiring elements of grammar which do not exist in their first language (L1), and make grammatical errors when these features are involved. What are the causes behind such errors? Moreover, what do they tell us about second language processing in general?

The primary aim of this thesis was to examine the why L2 learners make grammatical errors during L2 speech and to scrutinise them with theoretical outlines of human speech production, specifically whether there are consistent error patterns which reveal the source(s) of error in speech or in writing. The second aim of this thesis was to examine L2 learners' understanding of L2 grammatical features, more specifically, whether they could acquire the ability to consistently apply grammatical knowledge in real-time. The third aim of this thesis was to examine whether L2 learners have fundamental perceptual biases about sounds in the L2 as a result of first language experience, and whether this would affect L2 learners' ability to perceive specific grammatical features in the L2.

This thesis addressed these questions in seven experiments by examining the acquisition of inflectional morphology (3rd person singular *-s* and past *-ed*) among L1 Mandarin speakers of L2 English. Experiments 1, 2 and 3 investigated how L2 learners produce L2 inflectional morphology via a scene description task. The results support the idea of processing errors to be the main cause of L2 production errors. The complexity of information marked by L2 grammatical features and modality (spoken or written) were also found to affect production accuracy. Experiments 4 and 5 investigated L2 learners' sensitivity to inflectional omissions across auditory and visual modalities, where auditory cues were found to facilitate the detection of inflectional omissions. Experiments 6 and 7 investigated L2 learners' perceptual sensitivity to inflectional morphemes with different phonological features. Overall, the findings showed that L2 learners did not perceive L2 phonological features differently relative to native speakers, and that L2 learners do not have consistent perceptual biases towards L1 phonological features.

Taking these findings as whole, the results favoured processing errors over representational errors in producing and understanding L2 grammatical features, whilst recognising the role of phonological constraints in both processes. Importantly, these conclusions are drawn from multiple aspects of language processing, recognising the role of conceptual distinctions, grammatical representations, lexical forms, and phonological factors in second language production and comprehension. Additionally, this thesis recognises the value of both psycholinguistic models of language processing and linguistic theories of second language processing.

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Chapter 1

Introduction

In a modern, multilingual society, it is very common, and often necessary for people to learn new language(s) in addition to their own native language during adolescence and adulthood. However, learning a new (second) language can be a notoriously difficult and lengthy process, and people do it with varying degrees of success. To achieve high second language (L2) proficiency, a learner must have a good command of L2 vocabulary, as well as a mastery of L2 grammar. One of the most common obstacles for L2 learners is learning new L2 grammatical features which do not exist in their native language (L1), for example, inflectional morphology, tense agreement and case marking. As such, one may frequently observe L2 learners make grammatical errors when producing L2 speech in everyday situations, even when they 'know' the correct grammatical forms. What are the causes behind such errors? And what can these error patterns tell us about second language acquisition and processing?

What might be the first steps to learning a new language? First, a beginner might start with learning new words: their sounds and their meanings, how they are written, and how they are pronounced. At the same time, he / she learns how words have different functions, and how they connect to express a message. For adult learners, the rules of how words should be constructed organised can be straightforward to learn in the form of metalinguistic knowledge (e.g. a subject is always followed by a verb, or *-ed* must be attached to the verb when the action took place in the past), but it could be much more difficult for them to apply these types of knowledge spontaneously in everyday situations e.g. in a conversation. As such, learners often 'know' the correct grammatical rules, but often make mistakes which violate these rules when speaking or writing (e.g. placing the verb before the subject, or omitting *-ed* for action verbs in a past context). Why do they make such errors? Is it because their language systems do not 'understand' or 'access' these L2 grammatical features, especially when they don't exist in the learner's L1? Or is it because they

cannot consistently 'remember' the forms which L2 grammatical features take? Or is it because they cannot generate or process the sounds representing these grammatical features? All these are plausible explanations for L2 grammatical errors in L2 production, but few attempts have been made to tease these explanations apart in psycholinguistic research. In order to address this question, the first aim of this thesis is to examine the nature of L2 grammatical errors with reference to psycholinguistic frameworks of language production.

Another way to examine whether L2 learners apply L2 grammatical knowledge is to investigate whether they are sensitive when these grammatical rules are violated during real-time L2 comprehension (e.g. listening or reading L2 input where past *-ed* is missing in a context which requires it). In order to fully comprehend a message, L2 learners must monitor all relevant grammatical features which may affect the interpretation of the sentence. Selective attention to grammatical features which provide crucial information, or the lack of integration between different linguistic cues could result in misinterpretation of the message. For example, '*yesterday the girls play in the park*' may be perfectly acceptable to a Mandarin learner of English who does not use *-ed* as a cue for temporal information, but a native English speaker may find the sentence confusing as *play*, indicating present tense, does not fit with the temporal context indicated by *yesterday*. In other words, in order to achieve native-like understanding of language, an L2 learner must go beyond knowing L2 features as metalinguistic knowledge, but also acquire the ability to use these grammatical features in understanding the L2 in a sentential context. The second aim of this thesis is to examine whether L2 learners make use of L2 grammatical features when attempting to understand the L2. Moreover, depending on how L2 grammatical features are learnt, people may be more sensitive to how they look in text form rather than how they sound in the auditory form. In fact, we often see L2 learners experience more difficulties when listening to L2 speech compared with reading L2 text. If people do in fact find L2 speech more difficult to understand, then L2 learners may be less sensitive to grammatical violations when listening to L2 speech than reading L2 text. Thus, the third aim of the thesis is to examine whether L2 learners have different levels of sensitivity to grammatical violations in auditory and visual

comprehension, specifically, whether learners are less sensitive 'hearing' than 'seeing' L2 grammatical violations.

As we acquire our native language, we become sensitive to how minute distinctions in sounds may denote different meaning in the L1. Consequently, distinctions which are irrelevant for differentiating meanings in the L1 are gradually lost (e.g. length of vowel, tonal distinctions). In speech, L2 learners may find some L2 words difficult to 'hear', as minute differences between sounds can denote different meanings in the L2 but do not in the L1. For example, a Mandarin learner of English may mistake *sheep* for *ship* as the length of the vowel can denote different meanings in English but does not in Mandarin. Things become more complicated when new sounds represent new grammatical features. For example, consonants (e.g. /s/) may come at the end of an English word to mark an inflection (e.g. 3rd person singular -*s*) which results in a consonant cluster (e.g. /ts/ in *shouts*). However, if such consonants clusters are not permitted (or rare) at the end of Mandarin words, Mandarin learners of English may fail to 'hear' this sound, or do not interpret it as an inflectional marking. To complement previous questions on whether L2 grammatical features are harder to 'hear' in the auditory form compared with in the visual form, the fourth aim of the thesis is to examine L2 learners' perceptual sensitivity to sounds created by L2 grammatical features, and whether L2 learners are more sensitive to sounds which are permitted (or frequent) in their L1 than those which are not (or rare).

Aims and structure of thesis

The main aim of this thesis is to examine how L2 learners use and apply L2 grammatical features during real-time L2 production and comprehension. In Chapter 2, I will examine L2 grammatical errors in production and scrutinise them with reference to each stage of accepted models of language production. Particularly, I consider whether there are consistent error patterns during production of inflectional markings which could reveal the source(s) of erroneous production. I contemplate two main possibilities: Are grammatical errors in L2 production caused by representational deficits, or breakdowns in processing? Moreover, to what extent does the modality of production (spoken or written) affect grammatical accuracy?

In Chapter 3, I will examine how L2 learners process L2 grammatical features (those absent in the L1) during real-time L2 comprehension. Particularly, I consider whether L2 learners could acquire the ability to consistently assimilate and integrate semantic and syntactic information from L2 grammatical features in a native-like manner. Do L2 learners experience comprehension difficulties if the L2 contains grammatical violations? Moreover, does modality of comprehension (auditory or visual) affect L2 learners' sensitivity to these grammatical violations?

In Chapter 4, I will examine how L1 phonological properties influence the L2 learner's ability to perceive and produce L2 speech sounds. Particularly, I consider whether L2 learners have fundamental perceptual biases concerning selective phonological features as a result of L1 acquisition, and whether this in turn would affect the comprehension and production of specific L2 grammatical features. Do L2 learners find L2 phonological features shared by the L1 easier to detect? If so, does the overlap of phonological features between L1 and L2 help L2 learners to become more sensitive to the relevant L2 grammatical features in comprehension?

For the rest of this chapter, I will present a selection of relevant empirical research on factors affecting L2 grammatical attainment and processing, as well as psycholinguistic models of production and comprehension.

First, I will examine existing research on L2 acquisition, specifically those concerning the acquisition of inflectional morphology. I will also evaluate key factors influencing L2 grammatical attainment, including age, L1 background and L1 phonological influence. Subsequently, I will review current accepted psycholinguistic models of language production, with specific focus on monolingual and bilingual grammatical processing. For comparison, I will also examine second language learning theories which provide explanations for L2 inflectional errors during production. Then, I will review monolingual models of auditory and visual comprehension with emphasis on the effect of modality. Then, I will focus on how bilinguals process information from L2 inflectional morphology during real-time processing. In the last part of Chapter 1, I will introduce the different ways in which Mandarin and English express temporal information, and key differences in their phonological properties. These details will be useful when we introduce the motivations for each set of experiments in Chapters 2, 3 and 4.

To summarise, this thesis investigates sources of error for L2 language production and integration of information in L2 comprehension, taking multiple aspects of language acquisition (conceptual distinctions, grammatical representations, lexical forms, phonological factors) into account. Simultaneously, I examine non-native like L2 production and comprehension using both traditional psycholinguistic frameworks and second language learning theories, with a view to reconcile different approaches to second language processing and to highlight common grounds. Detailed discussions concerning production and comprehension of inflectional morphology in L2 learners will follow in Chapters 2, 3 and 4 as I discuss the motivations for each set of experiments.

Literature Review

1.1. L2 grammatical processing and factors affecting L2 grammatical attainment

What does it mean to acquire a second language (L2)? One may argue that like acquiring the native language (L1), successful second language acquisition is not simply learning a new set of words and rules of about how they connect together, but also learning to linguistically interact in the L2 in a spontaneous manner. Highly proficient L2 learners not only can accurately understand L2 auditory and written input, but are also able to produce utterances that are both pragmatically appropriate and adhere to L2 grammatical rules. During this process, successful acquisition of L2 grammatical features is fundamental to both real-time L2 comprehension and production.

Acquiring L2 grammatical features (e.g. number agreement, inflectional morphology etc.) is a complex task which requires the L2 learner to learn new associations between words and their functions. As such, researchers past and present have used acquisition of L2 grammar as an indicator of L2 attainment. To what extent is L2 grammatical processing in L2 learners similar to L1 grammatical processing in native-L1 speakers? Are we presented with qualitative or quantitative differences in L1 and L2 grammatical processing?

Past research has shown fundamental qualitative differences between L1 and L2 grammatical processing using both neurological and behavioural measures. Event-related potential (ERP) studies have revealed disparities in P600 responses between L1 and L2 learners when encountering grammatical violations during comprehension (Chen, Shu, Liu, Zhao & Li, 2007; Frenck-Mestre, Foucart, Carrasco, & Herschensohn, 2009; Frenck-Mestre, Osterhout, McLaughlin, & Foucart, 2008; Jiang, 2004; 2007; Osterhout & Mobley, 1995). Among other cases, L1 Chinese[1]

[1] The terms *Chinese* and *Mandarin Chinese* are used interchangeably according to the descriptions in individual studies. Though the Chinese language encompasses many dialects, they are assumed to have the same underlying grammatical properties (excluding Cantonese, Hokkien, Hakka etc. which are grammatically distinct).

learners of English were found to lack native-like P600 responses evident in L1-English speakers when processing subject-verb agreement violations (e.g. *the price of the car were too high*), a grammatical feature which is absent in Mandarin Chinese (Chen et al., 2007). Importantly, Chen et al. (2007) found that whilst L1 Chinese learners of English exhibited non-native-like neurological responses during on-line comprehension, they performed as well as native English speakers on explicit grammaticality judgement tasks, indicating that non-native-like grammatical processing in L1 Chinese learners was restricted to real-time comprehension.

Looking at behavioural studies which examined sensitivity to syntactic agreement during sentence comprehension, there is further evidence for fundamental differences in L1 and L2 grammatical processing. In reading studies which focus on subject-verb agreement and plural marking, L2 learners must integrate local syntactic information as well as processing suffixes. Jiang (2004, 2007) showed that L1 Chinese learners of English were not sensitive to English subject-verb agreement (e.g. *The bridges to the island was about ten miles away**[2]) and plural marking (e.g. *The child was watching some of the rabbit in the room**) violations during real-time reading comprehension, even though they exhibited offline knowledge of both types of L2 agreement. Insensitivity to inflectional morphemes found in these studies could be interpreted as the result of a lack of real-time syntactic integration between the relevant linguistic cues (e.g. plurality of *bridges* and singular form of *be*).

On a morphological level, one prominent study by Silva and Clahsen (2008) showed that L2 English learners do not decompose English morphological structure to the same depth as L1 English speakers. Four priming experiments tested L1 Chinese, German and Japanese speakers of English in their processing of inflected and derivational word forms in L2 English. The findings showed that unlike L1 English speakers who consistently showed priming effects across both derivational and inflected forms (i.e. *humid – humidity* produced faster reaction times than *humid – loud*; and *boil – boiled* produced faster reaction times than *boil - jump*), L2 learners showed only partial priming effects for derivational but none for inflected forms (i.e. *humid – humidity* produced faster reaction times than *humid – loud*, but *boil – boiled*

[2] * denotes ungrammaticality throughout this thesis.

did not produce significantly faster reaction time compared to *boil - jump*). This indicated that L2 learners store derivational forms as semantically related words but inflected forms as uninflected wholes rather than as stem + suffix combinations (Ullman, 2004; 2005). The authors also discussed these findings in relation to previous research which suggested that L2 English learners could fail to acquire L2 functional categories for the past tense grammatical feature at a syntactic level, or they could have problems with feature specifications for inflections[3]. In other words, non-native like processing of inflected forms could reflect one of two underlying problems: 1) missing representation for a grammatical feature, or 2) failure to map feature to form. Overall, current findings indicate that L2 learners do not decompose morphologically complex words in a native-like manner (also see Clahsen, Felser, Neubauer, Sato & Silva, 2010, and Clahsen & Felser, 2018, for review and discussion).

To summarise, a number of studies has shown that L2 learners have generalised difficulties processing and integrating L2 grammatical features in a native-like way. What are the key factors affecting L2 grammatical attainment? In the next section, I review a selection of studies investigating the extent of influence imposed by age (critical period), L1 background and phonological development.

1.1.1. Critical period and late bilingualism

Over the years, researchers have recognised the different ways in which individuals could become fully functioning bilinguals with a good command of the L2. Whilst some learners successfully acquire both languages simultaneously after birth, others acquire one language after the other either during childhood or later in life. With a view to focus on a specific group of late L2 learners, we must recognise the effect of age and maturation on the L2 population. That is, the effect of a *critical period* on L2 learners who have already developed their L1 since birth.

[3] See 1.3.3 for details of these accounts.

Second language researchers have long argued for an effect of age and maturation on level of language attainment (Lenneberg, 1967). Particularly, researchers proposed the concept of a *critical period*, where a significant difference in L2 attainment could be observed for L2 learners who began acquiring the L2 within and outside the critical period (see Birdsong, 2005). Second language studies have shown clear differences in proficiency between L2 learners who acquired the L2 at different ages. For example, Johnson and Newport (1989) tested L2 grammatical proficiency in L2 English learners from L1 Mandarin or L1 Korean backgrounds who lived in the US, with their age of arrival (3 to 39) used as a proxy for age of acquisition. The findings most notably showed that L2 learners who arrived before reaching the end of puberty bore a significant advantage for grammatical proficiency over those who arrived after puberty. Among early arrivals (before the end of puberty, age 17), the correlation between age and performance declined after age seven. Moreover, grammatical proficiency as measured by grammatical judgement tasks was significantly more variable with no clear trend between individuals who arrived after puberty (after age 17). Such patterns were found across different types of L2 grammatical features, including the focus on the current thesis - English inflectional morphology.

The critical period assumption is not without controversy. Studies have also shown that near-native levels of grammatical attainment are possible for learners who acquired the L2 after puberty. Previous brain imaging studies have shown that native-level grammatical processing is achievable, if the learner's L1 shares considerable similarity with the L2 (Tolentino & Tokowicz, 2011). Using behavioural measures, Hopp (2010) showed that L2 learners (from Russian, Dutch and English L1s) who acquired the second language after puberty were able to achieve near-native level performance in offline (explicit) grammaticality judgement and (implicit) self-paced reading tasks relating in German number and case marking. He hypothesized that if L2 learners were as sensitive as native-L1 speakers to L2 grammatical violations, they should show similar accuracy in grammaticality judgement tasks, and similar increased processing effort (in reaction time) in reading tasks. His findings showed that it was possible for the most proficient L2 learners to

exhibit near-native sensitivity (in grammaticality judgment) and native-like processing (in self-paced reading) to L2 grammatical violations.

What was most interesting about Hopp's (2010) findings is how L2 groups performed against the native-L1 group in tasks with high processing load. Data from the speeded grammaticality judgement task in these studies showed that L2 learner's performance declined in this task compared with previous offline and real-time language processing tasks. But crucially, the native-L1 group also showed a decline in performance in the condition with the highest processing load, despite showing a robust advantage over L2 groups at lower processing loads. This demonstrated that native-L1 speakers were not immune to making inaccurate grammatical responses, rather that native-L1 speakers had a higher threshold for making processing errors compared with L2 learners. Hopp claimed that these findings demonstrated that the differences observed between L1 and L2 performance are more likely a quantitative difference in processing efficiency, rather than a qualitative difference in grammatical representation (see also Kilborn, 1992). I argue that these two sets of evidence from Johnson and Newport (1989) and Hopp (2010) are not strictly opposing in nature, and that apparently conflicting assumptions about critical period constraints and near-native L2 acquisition could be compatible at least in some cases. In other words, the critical period constraint on L2 grammatical proficiency is not a binary concept. Instead, the extent of the constraint could be lessened or exacerbated, depending on individual cognitive abilities. In fact, even for theories which support a qualitative difference in grammatical processing between L1 and L2 learners (e.g. *The Fundamental Differences Hypothesis*, Bley-Vroman, 1988, 2009), proponents recognise individual differences (e.g. role of verbal-analytical skills) in helping L2 learners to achieve near-native levels of grammatical proficiency (DeKeyser, 2000). Such cognitive skills could benefit L2 learning on an individual basis, irrespective of whether a critical period fundamentally constrains L2 grammatical attainment.

To summarise, research studies have found significant differences in performance between L2 learners who acquired the L2 before and after puberty. Such evidence has been argued in support of a critical period for language acquisition. However, other research has also found near-native levels of

grammatical attainment in some late L2 learners, with native-L1 speakers also producing similar errors in cognitively demanding situations.

Further questions regarding the role of L1 (in L2 learners) remain unresolved: Do all L2 learners find aspects of L2 acquisition equally difficult, or does the degree of similarity between L1 and L2 contribute to the ultimate attainment of L2 grammar? In other words, could L2 learners experience acquisitional difficulties as a result of L1-specific constraints?

1.1.2. L1-specific effects

Do all L2 learners find L2 acquisition equally difficult, or do similarities between L1 and L2 grammar facilitate L2 acquisition in some L2 learners? One may speculate that L2 learners could find aspects L2 grammar particularly difficult to process in real-time if the learner's L1 does not have an equivalent grammatical feature which serves a similar function (e.g. using inflectional morphology to convey temporal information). Researchers have argued that the extent of differences between L1 and L2 grammar can influence the nativelikeness of L2 grammatical processing (see Tolentino & Tokowicz, 2011, for review). That is, L2 learners would perform less well if their L1 did not share similar grammatical features than if it did. In fact, Hopp (2010) found that L1 Russian learners of German, with a morphologically rich L1, were more native-like in their real-time L2 sentence processing than L1 Dutch and L1 English learners of German, indicating an L1-based advantage in the L2 group. In a similar way, Liu, Bates and Li (1992) have found strong L1 influence on both Chinese-English and English-Chinese late bilinguals on their use of animacy-based and word order strategies during L2 sentence processing. However, previous findings from a number of studies on on-line syntactic processing seemed to argue against this assumption (see Marinis, Roberts, Felser & Clahsen, 2005; Felser, Clahsen, Roberts & Gross, 2003 and Papadopoulou & Clahsen, 2003 for evidence against L1-induced parsing biases). Hence, there are mixed interpretations of whether similarities between the learner's L1 and L2 would pose significant advantages in L2 grammatical attainment, especially concerning L2

learners' ability to apply L2 grammatical knowledge in real-time (this topic will be expanded further in 1.5.).

Turning to the target population of the current thesis, a good number of second language studies have examined L1 Chinese learners of English on their acquisition of English grammar, due to the fact that many English grammatical features are absent in Mandarin Chinese, e.g. inflectional morphology, subject-verb agreement. One notable case is the study of one native Mandarin / Hokkien speaking individual (named Patty), who had been living in the US for over ten years at the time of investigation. Lardiere (1998a; 1998b; 2000; 2003) studied her oral and written production data over a period of eight years. Notably, Patty's oral production data contained low accuracy in regular past tense inflection (5.8%) even after prolonged L2 immersion. This stands in contrast with her written production data, which was substantially more accurate for regular past tense marking (78%). Similar production error patterns have been found for L1 Mandarin learners of L2 English across different age groups, showing that this is not simply an individual case of recurrent production errors, but rather a common trend across L2 English learners from L1 Mandarin backgrounds (Paradis, Tulpar & Arppe, 2016; Hsieh, 2008). Is L2 English morphology more difficult to acquire for L1 Mandarin learners of English compared with L2 learners from other L1s?

Looking back at the study by Silva and Clahsen (2008), among the three groups of L2 English learners from L1 Chinese, German and Japanese backgrounds, the L1 Chinese group exhibited less priming effects, producing significantly higher error rates and longer primed reaction times than the L1 German group. Crucially however, all three groups showed similar response patterns, exhibiting priming effects for derivational forms, but not inflected forms, which were significantly different from native-L1 speakers. Therefore, the authors concluded that despite performance was better in L2 learners from L1s which share similar linguistic properties to L2 English (i.e. rich morphology of German and past tense suffix in Japanese), they did not make L2 learners' acquisition more native-like than L2 learners from L1s without shared linguistic properties (i.e. Mandarin Chinese).

In L2 production, L1 (Mandarin) Chinese learners of English have been found to exhibit higher error rates than learners from other L1 backgrounds. For example, Hawkins and Lizska (2003) contrasted L1 Chinese, German and Japanese learners of English on the spontaneous oral production of past tense markings. Given that all participants were advanced L2 learners as measured by offline grammar tests, L2 learners from L1 Chinese backgrounds were significantly less accurate in spoken production than L2 learners from L1 German and L1 Japanese backgrounds on both regular past tense *-ed* forms (e.g. *talked*) and irregular past tense forms (e.g. *ran*). These findings have been attributed to the absence of past tense feature in the L1 Chinese instead of other L1 factors (e.g. phonological properties). In another study, Amaro, Campos-Dintrans and Rothman (2018) contrasted past *-ed* production in L1 Spanish, Japanese and Mandarin learners of English based on the phonological properties of their L1s. Specifically, all three L1s restrict consonant clusters but only Japanese has a prosodic structure[4] which allows adjunction of the past *-ed* morpheme. In spoken production, all three L2 groups exhibited significantly lower accuracy in past *-ed* than native-L1 controls. Consistent with previous research, L1 Mandarin learners again showed the lowest accuracy of past *-ed* production across all three L2 groups. Across groups, L1 Mandarin learners were significantly less accurate than L1 Japanese learners, but were not significantly less accurate than L1 Spanish learners of English in their spoken production of past *-ed*. Importantly, L1 Spanish learners of English were not significantly less accurate than L1 Japanese learners of English either. The authors argued that given only Japanese uses prosodic structure which allows for the adjunction of the past tense morpheme, they should outperform both L1 Spanish and L1 Mandarin groups if prosodic structure was the determining factor for past *-ed* production. However, this was not the case, and therefore L1 phonological properties, especially prosodic structure could not solely account for errors in past *-ed* production.

To summarise, studies which contrasted production accuracy of L2 learners from multiple L1 backgrounds have not shown a distinct and deterministic effect of L1-specific properties on production of L2 inflectional morphology. Instead, researchers

[4] see 1.3.3 and Chapter 4 for detailed explanations of *prosodic structure*.

found a generalised disadvantage in L2 learners, but could not yet agree on the primary cause of L2 inflectional errors.

1.1.3. Phonological acquisition and L1 influence

One of the key challenges potentially facing L2 learners is L2 phonological acquisition, which is critical for L2 perception and production. Due to the language-specific nature of phonology, L2 learners must learn to perceive and identify phonological units (e.g. phonemes and syllables) in L2 speech as well as rules governing how these units could be combined (i.e. phonotactics; Stockwell, 1954; cf. Hill, 1958) during L2 acquisition. Unlike L2 grammatical acquisition, which can be facilitated by explicit learning, L2 phonological processing relies primarily on implicit learning, which could be fundamentally constrained by exposure to the learner's L1. Here, I review a selection of studies examining the extent of L1 phonological constraints on L2 phonological acquisition, as non-native like L2 phonological processing can affect how L2 speech is perceived as well as how it is produced.

Different from more explicit forms of learning, phonological development is driven by implicitly-learned perceptual sensitivity to speech sounds, which could begin with minimal language exposure. L1 learners develop increased perceptual sensitivity to phonological distinctions in their native language starting from a very young age (see Best, 1994; Maurer & Werker, 2014, for review). For example, this can relate to phoneme categories, stress or pitch, depending on the phonological features which mark semantic distinctions in the L1. As perceptual sensitivity to these phonological distinctions become more prominent, sensitivity to distinctions irrelevant in the L1 are gradually lost (*Speech Learning Model*; Flege, 1995). Consequently, during the initial stages of L2 acquisition, L2 learners may interpret L2 phonological features in terms of articulatory similarity to the L1 (*Perceptual Assimilation Model*, Best, 1995). This perceptual bias favouring L1 phonological distinctions can be problematic for L2 speech perception and production if selective L2 phonological distinctions are irrelevant in the L1. For example, phonological

distinctions between the phonemes /r/ and /l/ are important for an L1-English speaker as they mark semantic distinctions in English phonology (e.g. it distinguishes the word *race* from the word *lace*), but this distinction do not denote different meanings in Japanese. Consequently, L1 Japanese learners of English are known to be insensitive to distinctions between the phonemes /r/ and /l/, and exhibit difficulties in both perception of words involving these phonemes (Goto, 1971). If L2 learners are unable to perceive selective L2 phonological distinctions, such insensitivities may also contribute to the erroneous production of these distinctions, though studies have shown that initial deficiencies in perception and production can be improved through exposure and training (Strange & Dittmann, 1984; Bradlow, Pisoni, Akahane-Yamada & Tohkura, 1997). If we take these findings in the context of acquisition of L2 grammar, selective insensitivity or perceptual bias to L2 phonemes which mark important L2 grammatical features (e.g. inflectional morphology) can influence how these grammatical features are perceived and produced in real-time.

Similar to learning phonological distinctions, infants also implicitly learn about the likelihood of speech sounds cooccurring in their native language (phonotactics) from a very young age. Such statistical regularities pose constraints on speech perception in a way that facilitates the identification of words and word boundaries (see Romberg & Saffran, 2010, for review). Empirical evidence has shown that infants begin to assimilate phonotactic information from a very young age (Jusczyk., Luce & Charles-Luce, 1994; Friederici & Wessel, 1993), with effects persisting through adulthood (Vitevitch, Luce, Charles-Luce, & Kemmerer, 1997). If we assume that the constraints imposed by phonotactic information apply in a language-specific way, then all L2 learners are faced with the task of 'relearning' new phonotactic regularities during L2 acquisition. Again, this could be especially problematic when L2 phoneme combinations which violate L1 phonotactic rules mark important grammatical features in the L2, and thus affecting how an L2 message should be interpreted. For example, an L2 English learner must recognise all possible phonological cues for past *-ed* marking (i.e. [t], [d], [ɪd]) in combination with the relevant verbs in order to successfully comprehend past events, though this may not always be permissible in the learner's L1. In fact, according to McQueen and Cutler (1998) and Cutler and Clifton (1999), although listeners do not

obligatorily decompose morphologically complex words in their phonological form for spoken word recognition, higher-level processing requires the extraction of information from phonological cues. Failure to establish the link between phonological cues and constituent morphemes would theoretically be detrimental to the correct interpretation of spoken sentences.

1.2. The influence of processing modality

Whilst most researchers recognise the production-comprehension distinction in language acquisition (e.g. Flynn, 1986), modality distinctions within L2 production and comprehension have not received as much attention in psycholinguistic research (Meyer, Huettig & Levelt, 2016). These distinctions have both methodological and theoretical implications with respect to the validity of data and the conclusions we draw from them. To put it another way, it is important that we do not solely rely on data from one modality (auditory or visual) for generalised conclusions of language acquisition and processing. As will be discussed in 1.3 and 1.4, language production and comprehension have distinct stages of processing depending on the modality of output and input. However, relatively few research studies on second language acquisition have directly contrasted production and comprehension data across auditory and visual modalities in a controlled manner.

Returning to Johnson and Newport's (1989) study on the effect of age on L2 English grammatical attainment, Johnson (1992) noted that as the stimuli in the grammaticality judgement task was presented only in the auditory modality, age effects could have been confounded by errors in L2 speech segmentation (also see Anderson, 1980). Consequently, Johnson replicated the study presenting the same stimuli to the same participants but in the visual (reading) modality. Johnson's findings showed that grammaticality judgement accuracy in L1 Mandarin and Korean learners improved substantially for late arrivals, with over twice as many errors in the auditory versus the visual modality. Johnson attributed the results to the visual nature of the stimuli, and that participants were much more likely to perform well if they could review previous segments of the sentence and did not have time restrictions, whereas this would not be possible in the auditory modality. Murphy

(1997) replicated the auditory disadvantage on grammaticality judgement accuracy using new stimuli, with reaction time data from a grammaticality judgement task also supporting an auditory disadvantage on processing speed. Specifically, participants produced longer reaction times for auditory compared with visual grammaticality judgements, supporting the claim that auditory speech adds processing load during L2 comprehension. Such findings raise questions of modality biases in research methods, such that auditory measures of L2 grammatical attainment must account for the influence of L2 speech processing before making generalised conclusions.

In L2 production research, Lardiere (1998a; 1998b; 2000) collected both oral and written production data from Patty, the L1 Mandarin / Hokkien L2 English learner who had been living in the US for over 10 years. The data were analysed for the accuracy of regular and irregular English verb production. Most notably, Lardiere's findings showed that Patty's production accuracy on regular English verbs (requiring past *-ed*) was substantially more accurate in the written production compared to oral production (78% vs. 5.8%). This pointed towards an effect of articulation on increased errors during oral production. Of course, one may argue that as most production data are spontaneous, and researchers do not have control over the content and syntactic context that production takes, direct comparisons between data across production modalities are not conclusive in this way. Therefore, to improve the validity of production data comparisons, it is essential that both production content and modality are controlled for in future production studies. One good example which implemented this comparison is a study by Amaro et al. (2018), which contrasted past *-ed* production accuracy in spoken and written modalities across L2 English learners from L1 Mandarin, L1 Japanese and L1 Spanish backgrounds. Not only did they investigate past *-ed* production in both spoken and written modalities, they also restricted participants' responses by supplying the bare verb for sentence completion tasks. Their findings again showed higher accuracy in written compared with spoken production, such that L2 learners from L1 Mandarin and L1 Spanish backgrounds were as accurate as L1 English controls in written accuracy for past *-ed*.

To summarise, past studies which focused on L2 modality effects have found that modality affects both grammatical sensitivity in L2 comprehension and grammatical accuracy in L2 production. However, potential confounding factors and the implications of existing evidence require further examination.

Interim summary

In section 1.1., I have discussed a selection of research studies examining the neurological evidence for L1 and L2 grammatical processing. The majority of ERP studies demonstrated that L2 processing use different mechanisms compared to native-L1 learners on a non-behavioural level, especially with regard to L2 grammatical / syntactic violations. This effect is mediated by factors such as L2 modality, L2 proficiency, L1-L2 similarity etc. Subsequently, I reviewed key research concerning three major influencing factors over L2 grammatical attainment: age (critical period), L1 specific effects, and phonological constraints. First, past research suggested late L2 learners exhibit low performance accuracy compared with early L2 learners, pointing towards a constraining effect of age and maturation (Johnson & Newport, 1989). However, more recent research suggested that native-level attainment is possible in some cases (Hopp, 2010). Research on production of L2 grammar suggested that L2 learners from some L1 backgrounds can experience more difficulties if L2 grammatical features are absent in the L1 (Hawkins & Liszka, 2003), though a L1-specific disadvantage is still unclear with regard to L2 comprehension. Lastly, research studies suggested a role of phonological development in L2 production and comprehension. With maturational changes during L1 acquisition affecting perceptual sensitivity to phonological distinctions and phonotactic learning, I argue that L2 learners are likely encounter difficulties during perception of L2 grammatical features if the relevant phonological and phonotactic constraints are not permitted in the L1. This may in turn affect production of these features as well.

In 1.2., I examined existing research on the effect of modality on L2 comprehension and production. Previous studies show significant differences in L2 performance depending on the modalities of comprehension and production. Such

findings highlight the modality-specific nature of L2 comprehension and production and raise the methodological importance of conducting studies across multiple modalities. The precise contribution of speech segmentation and articulation to L2 comprehension and production will be discussed in 1.3.

1.3. L2 language production: accounts and issues

When we speak, we must first think about the message we wish to convey, retrieve the concepts and words we wish to use, organise them in a way that adheres to the grammar of the language spoken (L1 or L2), retrieve corresponding sounds, before articulating the message in the form of an utterance. This is a complex, multi-stage process which occurs at great pace during language production. Given this, it is predictable that L2 learners, given the non-native nature of their acquisition, could make grammatical errors when producing L2 speech. Psycholinguistic models of language production have formalised this process for monolingual speakers and have adapted versions for bilingual speakers. Here, I will briefly outline of the basic components of language production models before discussing possible underlying causes of L2 grammatical errors in speech production. I will focus on spoken production errors first, before moving on to discuss the implications for written production.

1.3.1. Monolingual language production frameworks

Current psycholinguistic models commonly recognise a modular structure where each stage of the language production process is responsible for a different aspect of language processing (see Figure 1.2). First, the speaker must conceptualise the message (*conceptualisation*), and decide on the communicative intention, perspective and semantic relationships of the message (*macroplanning* and *microplanning*). At this stage, the *preverbal message* is not yet language-specific. However, according to Levelt (1989), the speaker takes the grammatical properties of the intended language spoken into account, and selectively processes information necessary for the overt production (also see Schlesinger, 1977 and Slobin, 1987).

Second, the preverbal message undergoes *grammatical encoding*. At this stage, *lexical concepts* or lexical representations concerning the message are also selected, which in turn activate the syntactic structure of each concept, otherwise known as the *lemma*. Lemmas are part of the *mental lexicon*, which contain syntactic information (such as syntactic category, e.g. noun, verb), as well as diacritic features (e.g. tense, aspect, number) of the concepts. The activation of the lemma produces the surface structures necessary for subsequent processing. Note that in Bock and Levelt's (1994) account of grammatical encoding (Figure 1.1), *function assignment* is added to grammatical encoding as a separate step following lemma activation. Function assignment allows syntactic information from the lemma to be used to assign syntactic relations and grammatical functions. Important for our discussion, Bock and Levelt also claimed the generation of fine-grained details of words (e.g. inflectional morphemes) are encoded as part of *positional processing* as the speaker assembles the order of words (including position of morphemes) in the message.

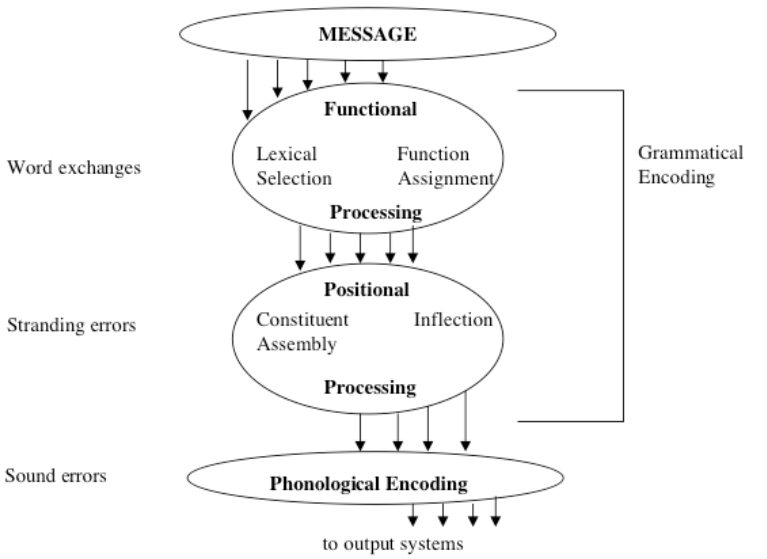


Figure 1.1. Stages of grammatical and phonological encoding in language production. Taken from Bock and Levelt (1994).

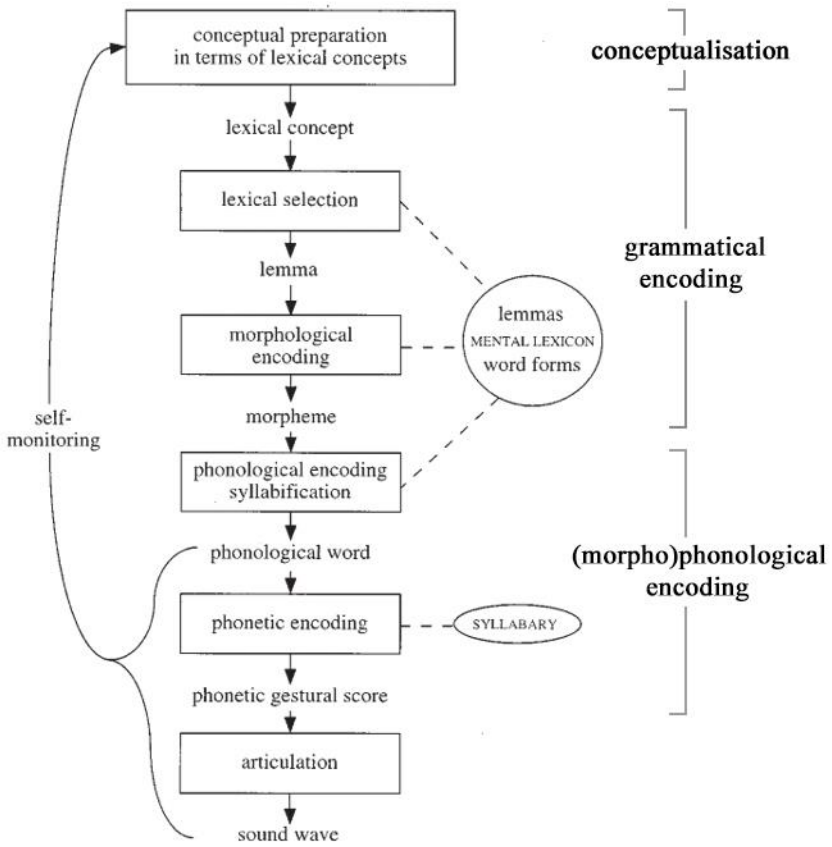


Figure 1.2. A theoretical outline of language production, containing 6 main steps from conceptualisation to articulation. Taken from Levelt, Roelofs and Meyer (1999) and annotated.

Following this, the message undergoes (morpho) phonological encoding, where the phonological codes of each word (*lexemes*) are retrieved from the mental lexicon. In this process, phonemes and phonological properties (stress, pitch) of morphemes become available to the speaker and *syllabification* takes place to create the *phonological word* of the message. During syllabification, default canonical forms are 'resyllabified' to accommodate the phonological context of speech. For example, the speaker must allow for the fact that inflectional morphemes might add additional syllables to words (e.g. *predict* with *-ed* inflection must be syllabified as *pre-dic-ted*). Subsequently, *phonetic encoding* activates the articulatory gestures and converts them into *articulatory score*. Finally, the message is converted into overt speech by executing the articulatory score (*articulation*). It should be noted that in written

production, it is assumed that orthographical and motor gestural information are activated instead (see van Galen, 1991, for detailed descriptions).

Under Levelts' assumptions, this production process relies on spreading activation principles which work in a feed-forward manner without between-level interactions. This means that node representations with the highest activation at each level are selected for further processing (Dell, 1986), and activation at each stage of production is unidirectional without feedback from later stages.

1.3.2. Bilingual adaptations of language production models

Bilingual adaptations of Levelt's (1989) original model suggested several important changes. For example, in de Bot's (1992) adaptation, bilingual speakers select the choice of language during conceptualisation and language information is contained within the preverbal message. In addition, bilinguals have a single mental lexicon which contain subsets of items (lemmas and lexemes) for each language. With regard to how the two languages interact, L1 and L2 lexical items have been suggested to share conceptual representations but have separate lexical representations for each language (Kroll, 1993). Moreover, bilingual speakers have a single articulator for the overt execution of articulatory score.

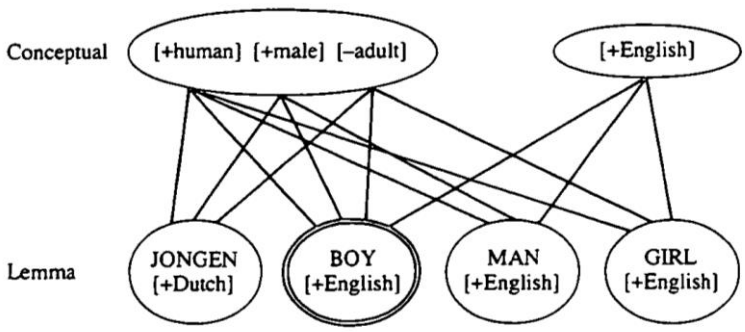


Figure 2.1. Selection of language-specific lemma from conceptual level information. Taken from Poulisse and Bongaerts (1994).

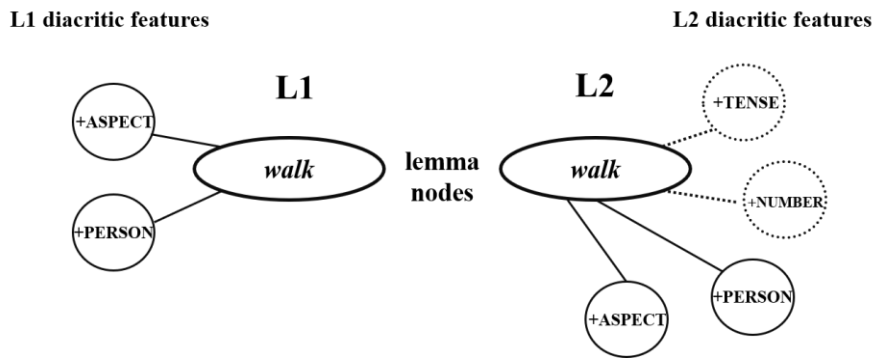


Figure 2.2. A blueprint of L1 and L2 diacritic features connected to lemma level nodes. Solid lines indicate complete acquisition of features; Dotted lines indicate partially acquired, or missing features. Adapted based on Levelt et al., (1999).

Important for our discussion, is how the L2 subset within the mental lexicon is created and activated. If we take the structure of lemmas from the monolingual production model, we expect lemmas to contain diacritic features which specify the various syntactic properties of the corresponding concepts. In this way, as languages are different in their syntactic properties, lemmas are in essence language-specific. Indeed, this is the stance taken by later adaptations of Levelt's (1989) model (Poulisse & Bongaerts, 1994). As seen in Figure 2.1 and 2.2., lemmas contain language-specification as well semantic and syntactic information regarding the concepts. The appropriate lemmas are activated based on the concepts and the choice of language from conceptual level information. This is compatible with findings by Poulisse and Bongaerts (1994) which suggested morphological encoding is also pre-determined by the choice of language (see also Myers-Scotton, 1992). The authors claimed that L2 lemmas would not activate L1 inflectional morphemes. In other words, L2 learners would not mix L1 inflections with L2 words during L2 speech. For example, an L1 Dutch speaker of English would not use L1 Dutch morphemes with L2 English words if the language spoken is intended in the L2. This has implications for discussions of L2 inflectional errors in 1.2.3.

With respect to L2 phonological encoding, de Bot's (1992) bilingual production model assumes L1 and L2 use the same large set of sounds (basic units of speech production). L2 learners use L1 sounds as much as possible during L2 acquisition, and novel L2 sounds are only developed if necessary. This is consistent with Flege's

(1995) *Speech Learning Model* where he claimed that L2 learners equate L2 phonemes with L1 phonemes with similar sounds at the very beginning of the acquisition process, and only develop new sound categories after prolonged L2 exposure.

More relevant to our discussion, is how sequences of speech sounds are prepared during syllabification for phonetic encoding. Based on the principles of WEAVER (Word Encoding by Activation and VERification; Roelofs, 1997), speakers construct phonological representations of words in an incremental fashion where default canonical forms are 'resyllabified' to accommodate the phonological context of speech. However, there is currently little consensus over how phonological encoding accounts for sounds from different languages during syllabification, especially when L1 and L2 have different rules regarding the formation of syllables (but see Roelofs, 2015 for how WEAVER++ can be applied to Mandarin and Japanese). If we assume that some L1 phonological representations are 'borrowed' for L2 acquisition, then is quite possible that L2 learners would encounter problems when L1 phonological representations, together with L1 rules for syllabification are used in L2 phonological contexts, leading to errors in forming the phonological word. For example, an L1 Mandarin learner of English may fail pronounce the word '*walked*' due to L1 syllabification rules which forbids the phonemes /k/ and /t/ in the word-final position. This may result in Mandarin learners' inability to pronounce these consonants successively at the end of words. In this case, a Mandarin speaker may add additional vowels at the end of '*walked*' to facilitate pronunciation of the *-ed* morpheme, or omit the allophone [t] (for *-ed*) altogether.

1.3.3. Sources of L2 inflectional errors

As reviewed in 1.1.2, L2 learners frequently make inflectional errors during L2 production. How could we explain L2 inflectional errors using the psycholinguistic framework? Through this framework, we can attempt to tease apart the different possibilities for the loci of L2 inflectional errors.

The first one concerns representation of L2 conceptual distinctions and selective information processing during the formation of the preverbal message. If Levelt's (1989) assumptions stand regarding selective information processing during conceptualisation, then the L2 learner might not routinely encode information that is not grammatically marked in the L1. As a result, even when the preverbal message is intended to be articulated in the L2, key information (e.g. tense) might be missing for L2 inflectional production.

The second possibility concerns the representation and activation of diacritic features at the lemma level for the L2 (e.g. tense, aspect, number etc.; see Figure 2.2.). If L2 lemmas do not contain the diacritic features necessary for inflectional morphemes (e.g. due to incomplete acquisition), then the lemma would not be able to provide the correct syntactic structure for the retrieval and production of inflectional morphemes. Alternatively, diacritic features at the lemma level could be present but not consistently activated during production.

The third possibility lies with the retrieval of morphological forms. If we assume diacritic features necessary for inflectional production are present for an L2 learner, then based on the spreading activation principle (Dell, 1986; outlined in 1.3.1.), it is still possible that morpheme retrieval might fail due to inappropriate levels of activation, leading to errors in production of L2 inflectional morphemes.

Another possibility lies within the final stages of phonological / phonetic encoding preceding articulation. It is possible that L2 learners apply rules of L1 phonology to L2 forms during syllabification. Specifically, if the L1 does not permit certain phonological structures in the L2, then the L2 learner would have difficulty generating the appropriate phonological word for subsequent phonetic encoding and articulation.

Turning to linguistic theories concerning second language production, researchers have specifically addressed the underlying causes of L2 inflectional errors. Whilst some have argued that L2 learners have fundamental representational deficits with regard to inflectional morphology (Hawkins & Chan, 1997; Hawkins & Liszka, 2003), others lean towards an account based on processing breakdowns (Haznedar & Schwartz, 1997; Prevost & White, 2000).

Representational accounts of L2 inflectional errors assume a fundamental deficit with acquisition of 'functional categories' or 'features' beyond the critical period (Hawkins & Chan, 1997). Proponents claim that any L2 features which are absent in the L1 cannot be acquired after the end of the critical period. Therefore, failures of L2 inflectional production in L2 learners are caused by the absence of grammatical features (e.g. tense marking) at an abstract level, resulting in total (L2) inflectional omission. This is comparable with missing diacritic features at the lemma level presented in psycholinguistic language production models. Without appropriate diacritic features in L2 lemmas, the L2 learner would not have the correct morphological structure for lexical retrieval. However, this account of absolute omission would not explain 'optional' production as often seen in L2 production, systematically consisting of some inflected forms (which require lemma-level representations) but not others.

In contrast, processing based accounts of L2 inflectional errors claim that L2 learners can acquire the underlying L2 functional features, but have problems with realising the corresponding surface inflectional forms (Prevost & White, 2000). In other words, L2 learners might have knowledge of tense and agreement, but cannot consistently access the appropriate inflections for production. This is comparable to problematic retrieval of inflectional morphemes from the mental lexicon.

Examining L1 phonological influences, Goad, White and Steele (2003) claimed that L1 prosodic structure may fundamentally constrain their ability to attach inflection morphemes to the prosodic word in the L2. In other words, if L1 phonology follows a structure which does not permit attaching inflectional morphemes to words as suffixes, then such constructions in the L2 would be difficult for learners to produce. This could be compared with how phonological encoding accommodates L1 and L2 phonological rules to produce the phonological word in psycholinguistic models. Syllabification might be problematic if L1 phonological rules constrain the learner's ability to form a wider range of sound combinations in the L2.

There are other theories which provide other explanations concerning the cause of L2 grammatical errors. For example, Hawkins (2007) attributed some cases of inflectional errors to the complexity of grammatical features (e.g. including multiple features, such as tense, subject number etc.). Empirical evidence from Chondrogianni and Marinis (2012) confirmed this by showing production asymmetry between 3SG *-s* and past *-ed* inflectional morphemes, with more production errors found for contexts requiring 3SG *-s* (contains subject number and tense features) than past *-ed* (contains only tense feature). Lardiere (2008) proposed the *Feature Reassembly Hypothesis* where she claimed that L2 grammatical acquisition involves the reconfiguration of lexical features in the learner's L1. However, this theory cannot account for all grammatical errors in production. As White (2009) pointed out, reorganising existing L1 grammatical features is sometimes not enough, and errors would still occur if specific L2 grammatical features are absent in the L1 and cannot be acquired through 're-organisation' alone. In the context of the current thesis, it does not sufficiently explain how L2 learners acquire L1-absent features. These accounts will be discussed in more detail Chapter 2 as I expand further on theories explaining L2 inflectional errors in production.

To summarise, L2 language production involves complex stages of processing where both representational and processing errors could occur. By reviewing stages of production in the monolingual and bilingual psycholinguistic production models, we can begin to systematically examine where errors may occur for L2 learners. This is complemented by existing second language learning theories regarding L2 acquisition and production errors. Evidently, they share commonalities with respect to their explanations for L2 inflectional errors even though they take different perspectives. I will further examine these possibilities and their assumptions in Chapter 2 with the first set of experiments (Experiments 1, 2 & 3).

1.4. L2 language comprehension: auditory and visual accounts

Language comprehension is a demanding task, which not only requires the learner to have sufficient explicit knowledge of vocabulary and grammar, but also

the ability to perceive and integrate linguistic cues. Auditory and visual linguistic cues demand different processing mechanisms for lexical activation but do not differ in their end goal, which is to comprehend a message in the form of an utterance or text. Compared with L1 speakers, L2 learners are faced with the challenging task of processing and integrating auditory and visual linguistic cues which may not match the linguistic properties of their L1. At the same time, L2 learners may face competition from items with similar auditory or visual cues from their L1. In order to discuss L2 language comprehension, we must start with how basic units of speech and visual text are perceived and recognised. In 1.4.1, I will briefly discuss connectionist models of monolingual language comprehension in auditory and visual modalities. Then, in 1.4.2., I will examine the implication of these models in a bilingual scenario where I will discuss potential problems L2 learners could experience during L2 comprehension.

1.4.1. Models of auditory and visual comprehension

When a listener hears a word, he /she must first extract the basic information from the acoustic speech signal, map them onto larger units of speech (i.e. phonemes), before matching these speech sounds onto word representations.

Connectionist accounts of speech perception assume interactive activation between levels of detector units (e.g. *TRACE*, McClelland & Elman, 1986). For example, the TRACE model comprises three layers of detectors, each responsible for a type of speech signal (feature, phoneme and word levels) with competing activation at each level. Specifically, nodes with the highest level of activation at each level trigger nodes at the next level. At the same time, existing knowledge regarding the context and language-specific properties of the message influences word recognition in a 'top-down' fashion. As one set of nodes is activated, competing nodes are inhibited. For example, when a listener encounters the word 'boat', acoustic properties of speech will activate node detectors at the feature level. Features of speech (e.g. acuteness, nasality, voicing) will compete to activate the phonemes /b/- /o/- /a/- /t/. Once activated, based on the sequence information of phonemes, nodes at

the phoneme level will activate the word *'boat'* at the word level. Moreover, if the listener knows that the message is spoken in English, then this top-down information would facilitate the activation of the English word 'boat' from the lexicon, instead of words with similar acoustic properties in other languages.

In a similar way, when a person encounters written text, visual features of symbols must map onto larger units of symbols (e.g. letters) before activating word representations. Earlier accounts of visual word recognition provide explanations similar to TRACE for activation of words in the written form (e.g. *the Interactive Activation Model*, Rumelhart & McClelland, 1982). Instead of detecting features from acoustic signal, the reader must detect visual features (i.e. parts of letters) at the feature level in order to activate larger units of symbol (i.e. letters). At the letter level, positional information is taken into account to activate words. Again, at each level, the detector nodes compete for activation levels, and the nodes with the highest activation levels trigger activation at the next level.

These accounts of auditory and visual word comprehension will serve as the basis for bilingual adaptation of auditory and visual comprehension discussed in the next section.

1.4.2. Sources of L2 comprehension errors

How do L2 learners understand L2 speech? There are three stages: First, L2 learners must be able to perceive speech sounds correctly and identify the relevant language. Second, as mentioned in 1.4.1. the L2 learner must be able to perceive and map speech sounds onto the correct words. Then, at the sentence level, L2 learners must be able to integrate lexical and grammatical information to understand the message.

The first issue relates to the categorical perception of phonemes. Relevant empirical research studies were discussed in 1.1.3, and will not be expanded further here. The second issue relates to lexical access in bilingual speech perception. Specifically, how phonological and grammatical properties of the L1 constrain the

perception of phonemes and how they form meaningful words in the L2. If we use the architectural framework from McClelland and Elman (1986), then bilingual models of speech perception must include mechanisms which distinguishes L2 from L1 input. According to the *Bilingual Interactive Model of Lexical Access* (BIMOLA, Grosjean, 1997; Léwy & Grosjean, 2008; Figure 3), feature level nodes are non-language-specific, but bilinguals have subsets of language-specific nodes at phoneme and word levels, which accounts for language-specific (at the phoneme level) and lexical (at the word level) information from L2 speech input (see Figure 2.1). Moreover, much like the model for monolingual auditory recognition (McClelland & Elman, 1986), activations between phoneme and word levels are bidirectional. In other words, just as phonotactic information can facilitate the identification of phoneme and word subsets, choice of language can also influence the activation of word subsets in a top-down manner, triggering lower level phoneme subsets, hence the interactive nature of this model. Similar to the model for monolingual visual word recognition (Rumelhart & McClelland, 1982), the *Bilingual Interactive Activation* model contains visual feature nodes at the lower level instead of acoustic features, and letter level nodes instead of phoneme nodes at higher levels (Dijkstra & Van Heuven, 1998). Importantly, the model claims that letter level activation is not language selective, and language is only determined at the word level.

This is an interesting theoretical point regarding the orthographic nature of the speaker's two languages. What if the L2 learner has an L1 with non-alphabetic orthography (e.g. Mandarin Chinese)? In which case, do L2 learners acquire distinct sets of 'letter' level nodes during L2 comprehension? To put it another way, if letter recognition is only relevant for the learner's L2 but not the L1, do we still expect 'letter' level nodes not to be language selective? Alternatively, do letter level nodes implicate a wider range of features for a bilingual? This prompts an interesting theoretical discussion, but it will not be the focus of this thesis. For the purpose of our discussion, we assume that top-down activation is strong enough so that only one set of languages is activated during L2 comprehension, with no interference from the learner's L1.

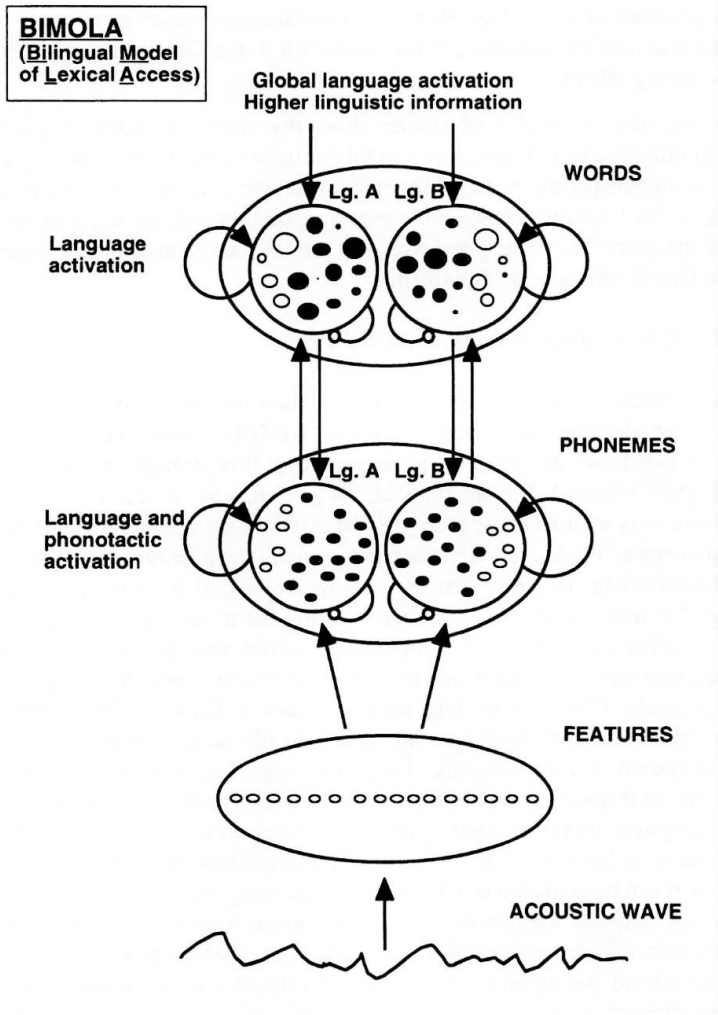


Figure 3. *Bilingual Interactive Model of Lexical Access, with feature, phoneme and word level representations for L1 and L2. Taken from Lévy and Grosjean (2008).*

The last, and most important issue in the context of this thesis relates to how L2 learners integrate linguistic cues from multiple sources within an utterance or text. Languages differ in their grammatical properties and have different rules governing the construction of sentences. Similar to how phonotactic knowledge facilitates the phonological perception and identification of words, knowledge of grammatical properties also facilitates the understanding of sentences or discourse during real-time comprehension. In essence, by knowing the grammatical rules of a language, the listener or reader would also know which cues are important for understanding messages in that language. Problems arise when L1 and L2 differ in their grammatical properties, and the L2 requires obligatory agreements between words in

a given context, which may either different or absent in the learner's L1 (e.g. the use of temporal inflections as indicated by temporal adverbials).

Connectionist theories have offered explanations for how L2 learners acquire linguistic cues (e.g. case marking, inflectional morphology etc.) for L2 comprehension (*The Competition Model*; Bates & MacWhinney, 1989). The basic assumption of this model is that learners (of any language) rely on the reliability of cues to meaning (or form-function mappings) during language acquisition. This means that language learners acquire the most reliable cues to meaning first, and less reliable cues later. For example, if inflectional morphology is obligatory for conveying temporal information, then after exposure and acquisition, learners would consider inflectional morphemes an effective and reliable cue for understanding the temporal context of the message. Using the terminology from this theory, inflectional morphology would have high *cue validity* in the context of temporal information. On the other hand, if temporal adverbials (e.g. *every day; last week*) provide additional, but not essential temporal information, then they would have low cue validity in this language.

In order to accurately understand L2 speech or text, L2 learners must learn to prioritise highly valid linguistic cues in the L2, even if they are not highly valid in the L1. Problems would potentially arise when L1 cue validity is applied to L2 comprehension. Take the example above, if inflectional morphology is obligatory in the expression of temporal context (as determined by L2 grammar), then L2 learners must prioritise information from inflectional morphemes when listening or reading L2 input. Failure to prioritise this information could result in insensitivity to grammatical violations concerning inflectional morphology (e.g. failing to detect past *-ed* omissions with *yesterday* as a temporal adverbial).

Usage-based approaches have characterised the processing of L2 linguistic cues in a similar way. Specifically, under the *Associative Learning* assumptions, L2 learners have been found to focus on certain aspects of linguistic cues but not others, depending on the saliency and frequency of cues (i.e. *learned attention*). An example given in Ellis and Wulff (2008) is the acquisition of tense inflections alongside temporal adverbials in French. Their claim was that it is often unnecessary for L2

French learners to interpret both temporal adverbials and tense inflections for meaning. Given the low saliency of inflectional markings, they could be considered redundant in the overall interpretation of the sentence compared to temporal adverbials during initial acquisition. This is consistent with previous studies documenting slow acquisition of inflectional markings among L2 learners (see Bardovi-Harlig, 2000).

Interim summary

In sections 1.3. and 1.4., the basic stages of bilingual language production and comprehension have been outlined. Given the architecture of these models, I discussed possible sources of inflectional errors during L2 production, including conceptualisation errors, representational deficits at the lemma level, and processing breakdowns during activation of representations and retrieval of inflectional forms, and also phonological processing for articulation. In L2 comprehension, I discussed ways in which L2 speech signals and text could be recognised and processed, and reasons for lack of L2 grammatical mapping and integration at a more abstract level. These theoretical accounts will serve as the basis for the experiments in Chapters 2, 3 and 4, where I will examine the nature of inflectional errors during L2 production, and integration of information (from inflectional features) during L2 comprehension.

1.5. Real-time L2 sentence processing in L2 learners

Successful real-time sentence comprehension requires the listener or reader to assimilate and integrate each part of linguistic input as it becomes available. This is a fast-paced event which requires the listener or reader to apply their knowledge of lexical and morphosyntactic cues in an incremental fashion. Real-time sentence comprehension could be particularly demanding for non-native L2 learners as they must not only acquire the relevant L2 metalinguistic knowledge, but also efficiently apply this knowledge in real time. In the context of the current thesis, existing literature on how L2 learners process different types of L2 constructions in comparison to native-L1 speakers will be informative in several ways. Firstly, it could reveal whether L2 learners could, at least in some circumstances, adopt a native-like incremental processing strategy during L2 sentence comprehension. Secondly, existing research could demonstrate to what extent L2 learners' ability to parse and interpret sentences is affected by the grammatical properties of their L1. Thirdly, existing research could reveal to what extent individual cognitive capacity plays a part in L2 sentence processing. Lastly, past research studies could also reveal how learners under different task demands could exhibit different processing behaviour during real-time comprehension. Taking these factors into consideration, one can begin to hypothesise how L2 learners may learn to process sentences with temporal markings that are substantially different to their L1, and more importantly, whether L2 learners could be sensitive to potential mismatches between lexical and morphosyntactic temporal cues in the linguistic input in real time.

1.5.1. Incremental sentence processing in L2 learners

A major discussion surrounding real-time L2 sentence processing concerns the notion of incrementality. Incremental parsing allows the listener or reader to interpret linguistic input as each part of sentence becomes available, instead of interpreting all parts of a sentence together after the sentence is complete. Past research has famously shown via the 'garden-path' phenomenon that native speakers assimilate words of a sentence incrementally by interpreting each word as it is encountered

based on the simplest syntactic structure possible (see *Minimal Attachment and Late Closure*, Frazier, 1978) - that is, until the sentence becomes syntactically ambiguous or semantically implausible, prompting a reanalysis of the sentence for another interpretation (e.g. *the horse raced past the barn fell*). It is therefore of interest whether L2 speakers could also parse L2 sentences incrementally in a native-like way. Such investigations would provide insight into whether L2 learners could apply L2 linguistic knowledge in real time by showing processing difficulties when mismatches occur between lexical and morphosyntactic cues.

Using a self-paced reading paradigm with an online grammaticality judgement task, Juffs and Harrington (1995) examined how Chinese learners of L2 English process 'garden-path' sentences with pre-posed adjuncts (e.g. *After Bill drank the water proved to be poisoned*) and with complement clauses (e.g. *Sam warned the student cheated on the exam*) compared to non-garden-path sentences (e.g. *After Sam arrived the guests began to eat*). Participants viewed each sentence on a word-by-word basis and made a grammaticality judgement after each word is revealed. The findings showed that Chinese learners of English were significantly slower to make grammaticality judgements (longer reaction times) after viewing the disambiguating verb (*proved / cheated*) than with the unambiguous intransitive verb (*arrived*), indicating that they interpreted L2 sentences incrementally and encountering processing difficulties at the disambiguating verb. However, although L2 learners experience processing difficulties with garden-path sentences like native-L1 speakers, their attempt at reanalysing the sentence is not always successful. As demonstrated by Juffs and Harrington (1996), Chinese learners of L2 English did not always respond accurately to comprehension questions following trial sentences, indicating that they have not successfully recovered from garden-path difficulties and correctly reinterpreted these sentences. As a result, though there was clear evidence that L2 learners did experience processing difficulties at the point of disambiguation in garden-path sentences, they do not behave like native-L1 speakers in resolving these difficulties (also see Felser et al., 2003). By showing significant processing difficulties when the initial interpretation became implausible, existing findings support the idea that L2 learners do in fact apply their knowledge of L2 linguistic properties incrementally during sentence comprehension. However, non-native-like

processing was still evident in L2 learners from their overall interpretation of syntactically ambiguous (or garden-path) sentences.

1.5.2. Extent of L1 effects on L2 sentence processing

The second point relevant to the current thesis relates to how L1 grammatical properties affect incremental parsing of L2 sentences, and in turn affect interpretation of these sentences in real-time. The key idea is that if a specific L2 syntactic construction is shared by the L2 learners' L1, then these L2 learners should be more native-like in their parsing of L2 sentences than L2 learners whose L1 do not share similar constructions.

Again using a self-paced reading task, Marinis, Roberts, Clahsen and Felser (2005) examined how adult L2 English learners from German, Greek, Chinese and Japanese L1s process long distance *wh*-dependencies in L2 English sentences. In particular, whether they make use of intermediate gaps when processing sentences with fronted *wh*-phrases (e.g. *The nurse <u>who</u> the doctor argued that the rude patient had angered is refusing to work late*). Though proficient L2 English learners in this study successfully comprehended these L2 sentences (unlike Juffs & Harrington, 1996), they did not show native-like sensitivity to syntactic cues (i.e. postulate intermediate gaps) during real-time processing. Critically, L2 English learners from German and Greek backgrounds did not exhibit native-like reading times despite the presence of subjacency constraint in their L1, indicating a lack of L1 transfer effects. Instead, their reading times were similar to that shown by L2 English learners from Chinese and Japanese backgrounds with no subjacency constraint in their L1.

Similarly, in an earlier study by Williams, Möbius and Kim (2001) examining the processing of filler-gap dependencies in English *wh*-questions, L2 English learners from L1 Korean, Japanese and Chinese backgrounds also behaved similarly in their online plausibility judgement to garden-path questions (e.g. *Which shop did the criminal <u>kill</u> in the city yesterday evening?)* despite differences in *wh*-construction in their L1. However, although both native-L1 and L2 learners postulated gaps at the first position consistent with L2 grammar, native-L1 speakers

reanalysed the sentence more quickly than L2 learners (as indicated by shorter reading times in the segment following an implausible verb e.g. *kill*). Overall, these findings argue against the notion of L1 transfer effects, and are partially in favour of fundamental differences between L1 and L2 real-time sentence processing.

The relationship between L1 effects and L1-L2 fundamental difference is far from clear-cut. Returning to Hopp (2010), where Russian, Dutch and English learners of German were tested on their offline knowledge and online processing of German number and case marking, the experiments showed a between-group effect between L2 learners from different L1s. Specifically, though it was clear that all L2 learners could apply their offline knowledge of German number and case marking (as observed through sensitivity to sentences with ungrammatical or dispreferred word ordering), advanced Russian learners of L2 German (with a morphologically complex L1) were closer to the native-L1 group than Dutch and English learners in their reaction times in critical segments. Such evidence has been used to argue in favour of L1-specific effects.

1.5.3. Cognitive capacity and task demands

The third point of discussion concerns how individual differences in cognitive capacity affect how L2 learners parse and interpret L2 sentences in real-time. Take the processing of English filler-gap dependencies in *wh*-questions, successful real-time comprehension of such sentences requires L2 learners to store words or segments of a sentence in working memory to allow for additional syntactic processing or reanalysis after the initial interpretation becomes implausible. Using the example from Williams et al. (2001), the implausibility of *kill* is only evident if the participant (native-L1 speakers or L2 learners) stores all previous segments of the sentence (i.e. *Which shop did the criminal*). In a later study by Williams (2006), among advanced Korean, Chinese and German learners of L2 English, only those with high working memory capacity (as measured by a memory probe task) showed native-like online plausibility judgements after each segment when comprehending *wh*-questions (e.g. *Which girl / river did the man push a bike into late last night?*).

Similar effect of working memory capacity was also shown in grammaticality judgement tasks in Chinese speakers of English (Dussias & Piñar, 2010), and across different L1 backgrounds (McDonald, 2006).

The final point of concern relates to how task demands affect the nativelikeness of L2 processing. Previous studies mentioned in 1.5.1 and 1.5.2 have used a mixture of tasks examining online processing (i.e. self-paced reading) and offline knowledge, some relate to experimental items (e.g. plausibility, grammaticality judgement), others relate to measures of general L2 proficiency. Some may argue that the differences found in the degree of nativelikeness and L1 effects were driven by the nature of the offline task. In other words, it is possible that real-time L2 processing behaviour could depend on whether L2 learners were asked to specifically monitor for grammatical violations or read for meaning.

Jackson and colleagues conducted a series of studies examining the effect of task demands again on the processing of *wh*-constructions. Using identical stimuli, the contrasting data from Jackson and Bobb (2009) and Jackson and Dussias (2009) showed that L2 learners could show native-like processing when explicitly required to make grammaticality judgements. However, when the experimental task also probes into the L2 learners' understanding of experimental items, L2 learners do not show the same native-like recovery or reanalysis of the sentence. This indicates that despite showing native-like online processing difficulties initially, L2 speakers do not always recover from processing difficulties in a native-like manner. Instead, as noted by Roberts, Mackey and Marsden (2016), L2 learners could be more likely to carry out delayed parsing decisions, meaning that real-time processing could be less incremental following the critical ungrammatical / disambiguating segment.

To summarise, studies on real-time sentence processing in L2 learners have demonstrated that L2 learners can, in some cases, process syntactic constructions incrementally in a native-like manner. This has been reflected in their sensitivity to syntactic ambiguities (garden-path sentences). However, the degree to which real-time L2 sentence processing is affected by the grammatical properties of their L1 remains somewhat debatable. Whilst some have shown that L2 learners from specific L1 can be more sensitive to specific grammatical features (e.g. number and case

marking in Hopp, 2010), others have failed to find significant differences between different L2 groups with significantly different typology in their L1 (e.g. Marinis et al., 2005; Felser et al., 2003; Papadopoulou & Clahsen, 2006). The nativelikeness of L2 real-time sentence processing is also likely to be influenced by individual cognitive capacity, as well as the nature of experimental tasks, though neither is unrefuted.

1.5.4. Temporal information processing in the L2

Turning to the topic of the current thesis, how can one falsify whether L2 learners of English process L2 inflectional morphology in a native-like way during real-time sentence comprehension? Presuming the presence of explicit grammatical knowledge of L2 inflectional morphology (e.g. that regular English verbs should have a past *-ed* suffix with a past temporal adverbial), sensitivity to mismatches between lexical and morphosyntactic should reveal whether L2 learners could apply their knowledge of inflectional use in real-time. Moreover, one can show the extent of L1 influence by contrasting real-time sentence processing in L2 English learners from multiple L1 backgrounds (like Marinis et al., 2005 and Williams et al., 2001) by testing whether L2 learners with different temporal marking properties in the L1 would respond differently to temporal mismatches in the L2.

Roberts and Liszka (2013) examined whether L2 English learners from French and German L1 backgrounds would exhibit sensitivity (or processing difficulties) to temporal mismatches in L2 sentences, and whether their responses would be significantly different to those in L1-English speakers. L1 French and L1 German learners of English in this study, despite demonstrating proficient offline L2 grammatical knowledge to temporal markings, responded differently to L1-English speakers and to each other when encountering past simple and present perfect temporal mismatches (e.g. *When / Since she first started her job, Emma loved / has loved the work very much*). L1 French learners of English experienced significant processing difficulties (observed via longer reaction times) to temporal markings in both present perfect and past simple contexts, whilst L1 German learners of English

did not exhibit such processing difficulties in either context. Unlike previous studies like Marinis et al. (2005) and Williams et al. (2001) which found no obvious processing differences between L2 English learners from typologically different L1 backgrounds, Roberts and Liszka found significant differences between how L2 English learners from French and German backgrounds responded to temporal mismatches in L2 English. According to Roberts and Liszka, sensitivity to past and present perfect temporal mismatches was contingent on whether their L1 uses overt aspect markings, thus attributing real-time sensitivity to L2 temporal mismatches to L1 transfer effects. What was more interesting, was that L1 English speakers in this study did not exhibit a behaviourally observable processing cost when the temporal mismatch occurred in a past simple context (e.g. *Since* she first started her job, loved the work very much*), contrary to ERP evidence in monolingual English speakers from an earlier study (Steinhauer & Ullman, 2002). This seemed to indicate that L1 English participants found a present perfect adverbial (e.g. *Since*) with a past simple verb form (e.g. *loved*) more grammatically acceptable than a past temporal adverbial (e.g. *When*) with a present perfect verb form (e.g. *has loved*). In the authors' words, there appeared to be 'different degrees of ungrammaticality' for the two types of temporal mismatches, thus the former case did not cause observable processing difficulties for L1 English participants.

Findings from Roberts and Liszka (2013) has important implications for the current thesis. First, if real-time comprehension of temporal information in L2 English is dependent on L2 learners' ability to incrementally process segments of a sentence for temporal information, then any mismatch between the temporal adverbial and the verb form (e.g. where *-ed* inflection is omitted when the temporal adverbial unambiguously indicates a past tense context) should cause processing difficulties in the form of slower reading times at or just after the verb segment. Second, if L1 grammatical properties distinctly affects the degree of sensitivity to temporal mismatches in the L2, then one would also expect L2 learners from L1s with few or no temporal (inflectional) markings to exhibit little or no sensitivity to such mismatches (e.g. L1 Mandarin learners of L2 English). These possibilities will be discussed further in Chapter 3.

Interim summary

In section 1.5., a range of literature on real-time L2 sentence processing has been reviewed in relation to several themes: the incremental nature of L2 sentence processing, the extent of L1 effects on L2 sentence processing and the effect of cognitive capacity and task demands. This provides the backdrop to our discussion to how L2 learners might in principle process temporal information in sentential contexts during L2 comprehension. More importantly, this discussion has provided insight to whether L2 learners can process temporal information from grammatical features which are absent in their L1. This in turn informs us about how L1 Mandarin learners of L2 English, with no inflectional morphology in their L1, can process temporal information from inflectional markings during real-time English sentence comprehension.

1.6. Linguistic properties of Mandarin Chinese and English

As we examine L1 Mandarin learners of L2 English, it is essential that the basic linguistic properties of Mandarin Chinese are detailed, particularly, the way Mandarin conveys temporal information, as well as Mandarin phonology with regard to temporal markings. In 1.6.1, I give a brief description of how temporal information is expressed in Mandarin and in English, and where the main commonalities and differences lie. These distinctions will be relevant in Chapter 2, where I examine the conceptualisation of temporal information during L2 production. Moreover, I explain the basic properties of Mandarin phonology with regard to temporal markings and how they contrast with English. These distinctions will be relevant in Chapter 4, where I examine possible perceptual biases in L1 Mandarin learners of L2 English.

1.6.1. Expressions of temporality

Mandarin Chinese and English are grammatically distinct languages in the way they express temporal information (temporality), especially with regard to expressions of tense (event-external) and aspect (event-internal; Comrie, 1976; 1985). Though there are differing opinions regarding whether Mandarin Chinese is categorically tense-free (see J. Lin, 2010; T. Lin, 2015 for arguments for and against), it is commonly accepted that Mandarin does not have overt morphology to mark temporal information (Li & Thompson, 1981; Smith, 1991). Instead, Mandarin uses aspectual markers and adverbials which mark temporal contexts to denote event-internal properties of an event (Smith, 1994; Tang, 2016). In contrast, English together with many other Indo-European languages use inflectional morphology to convey tense and aspect information of an event (Booij, 2005).

Mandarin has no overt morphology to indicate tense, and the temporal status of an event is conveyed mainly through perfective and imperfective aspectual markers attached to a Mandarin verb (Li & Thompson, 1981). There are two recognised perfective aspectual markers in Mandarin: *le* and *guo*. *Le*, the most common perfective aspectual marker, usually indicating that the action denoted by the verb is complete and still holds at the time of speaking. In the example a) , the perfective property of *go* is expressed by placing the aspectual marker *le* after the verb *qu*. *Le* can also be detached from the verb and come at the end of the sentence, though with a slightly different interpretation depending on its context. This is sometimes known as the imperfective *le*, where the action denoted by the verb may still be ongoing (Chan, 1980; Li & Thompson, 1981; Chen, 2009). Given the example below, the action of *shui* (*sleep*) in (b) can be interpreted as an event which has begun but not yet completed. The aspectual marker *guo* after the verb also gives the verb a perfective meaning. In example (c), it is unambiguous that the endpoint of the event no longer holds at the time of speaking. This distinct property is what differentiates *guo* from *le*. As they denote different temporal properties of the event, these two markers are not mutually exclusive.

a)	*ta*1	*qu*4	***le*0**	*shang*1*dian*4
	she	go	**[PERFECTIVE ASPECT]**	shop
	She	has gone / went	to the	shop.
b)	*ta*1	*shui*4	***le*0**	
	she	sleep	**[IMPERFECTIVE ASPECT]**	
	She	is sleeping.		
c)	*ta*1	*chi*1	***guo*4**	***le*0**
	She	eat	**[PERFECTIVE ASPECT]**	**[PERFECTIVE ASPECT]**
	She	has	eaten.	
d)	*ta*1	*chi*1	***zhe*0**	*fan*4 ne0
	She	eat	**[IMPERFECTIVE ASPECT]**	meal
	She	is eating	a meal.	
e)	*ta*1	***zai*4**	*chi*1	*fan*4 ne0
	She	**[IMPERFECTIVE ASPECT]**	eat	meal

*** bold text** indicates aspectual markers and corresponding features.

Apart from *le* which can have an imperfective interpretation, there are two other imperfective aspect markers in Mandarin, namely *zai* and *zhe*. *zai* usually comes before a verb and expresses progressive aspect (imperfective). In the example in d), the act of eating (*chi*1) is still in progress at the time of speaking. On the other hand, *zhe*, attached after the verb, indicates the ongoing state of the situation with a view on the result (see e). Both imperfective aspectual markers can be used in combination with temporal adverbials (e.g. *mei*3*tian*1, *shang*4*zhou*1) to refer to periods of time in

the present as well as the past in Mandarin. It should be noted that temporal adverbials can only occur at sentence-initial position in Mandarin.

Compared with Mandarin, which expresses temporality using aspectual markers without tense markings, English require inflectional morphology to mark tense and aspectual information. Inflectional morphology by definition creates derivative forms by conjugating the verb (Booij, 2005). In f), the past tense inflection *-ed* is attached as a suffix to the end of the verb to indicate the act of walking is complete at the time of speech. Aspectual information in English can be much more ambiguous, as it is not always marked by a distinct morpheme. The habitual aspect is one such example. In morphological terms, 3rd person singular *-s* (3SG *-s*) contains tense information (present) but also the number of subjects taking part in the action (singular). However, if 3SG *-s* is used in conjunction with a temporal adverbial (e.g. *every day*), which may occur in a variety of positions in an English sentence, then the temporal property of the action takes on a habitual aspect (see g). Other aspectual markings include the progressive *-ing*, which denotes the ongoing nature of an action, are also used in conjunction with temporal adverbials. However, they go beyond to the scope of this thesis and will not be discussed further.

f)	Last week [TEMPORAL ADVERBIAL]	the girl	walk	***-ed*** [PAST]	a mile
g)	Every day [TEMPORAL ADVERBIAL]	the girl	walk	***-s*** [PRESENT] [SINGULAR]	a mile

* **bold text** indicates inflectional morphemes and corresponding features

To summarise, Mandarin Chinese conveys temporal information through aspectual markers (*le* and *guo* - perfective; *zai* and *zhe* - imperfective) without tense marking, whereas English conveys both tense and aspectual temporal information through inflectional morphology. Moreover, both Mandarin and English share the use of temporal adverbials (e.g. *mei3tian1* - *every day*, *shang4zhou1* - *last week*) in

temporal expression. Moreover, English marks 3rd person singular with *-s* in the present tense.

1.6.2. Phonological properties of morphemes

Mandarin Chinese and English are also distinct in their phonological properties. Aside from its tonal nature, Mandarin is also much less varied in its phonological structure compared to English. In this section, I will briefly discuss some key phonological distinctions between Mandarin and English and how different phonological features can be formed by Mandarin and English morphemes.

Mandarin is traditionally classified as a tonal language, which marks semantic distinctions with lexical tones. For example, the sound *shu* can have four distinct and unrelated semantic interpretations depending its tone (Table 1).

Table 1.

Examples of tone-based semantic distinctions in Mandarin Chinese with Pinyin transcriptions and English translations.

Chinese character	**书**	**熟**	**鼠**	**树**
Pinyin	*shu*1 / shū	*shu*2 / shú	*shu*3 / shǔ	*shu*4 / shù
Tone	flat	rising	falling and rising	falling
Translation	*book*	*familiar*	*mouse*	*tree*

As seen above, one of the most distinct features of Mandarin is that it consists mainly of monosyllabic morphemes (Smith, 1991). Generally speaking, single Mandarin syllables have a CGVX structure (Duanmu, 2000): C (consonant), G (glide), V (vowel) and X (consonant or extension of long vowel). Although there is some debate over whether Mandarin consists of consonant clusters at all, it is generally accepted that multiple consonants rarely occur together in the word-final

position. In contrast, English allows consonant clusters in a variety of positions within a morpheme or word (e.g. word-initial: *flower*; word-final: *last*; mid-word: *citron*).

Table 2.

Pinyin transcriptions and English translations of Mandarin bimorphemic words.

	Morpheme A	Morpheme B	Bimorphemic word (A+B)
Pinyin	*hua*1 / huā	*pen*2 / pén	*hua*1*pen*2 / huā pén
Translation	*flower*	*pot*	*flowerpot*
Pinyin	*hua*1 / huā	*bao1 /* bāo	*hua*1*bao*1 / huā bāo
Translation	*flower*	*bud*	*flower bud*

Relevant to our discussion, are the phonological properties of Mandarin and English in the context of adjacent morphemes: That is, distinct phonological features when multiple morphemes are placed together in a single word. Similar to English, monosyllabic morphemes in Mandarin can be placed together to form a bimorphemic word (see Table 2). Importantly, the Mandarin morphemes would retain their syllabic properties and would not create new phonological features when placed together in a new word. For example, the basic phonetic realisation for *hua*1 (*flower*) would not change if it was placed with '*pen*2' (*flowerpot*), or with *bao*2 (*flower bud*). The same rule applies to aspectual markers following verbs (e.g. *le* after *qu*4 or *chi*1). This stands in contrast with English inflectional morphology, which may have different phonetic realisations depending on its phonological context. Take example f): the past tense morpheme *-ed* is realised as [t] in *walked*, but could be realised as [d] in *yelled* and [ɪd] in *shouted*. Such phonological variability could be problematic for L2 English learners during comprehension, especially if the learner's first language (e.g. Mandarin Chinese) does not allow for context-dependent phonological variability for morphemes. Implications of this issue will be further discussed in Chapter 4.

Summary of literature review and research questions

Existing research suggests that L2 learners are prone to grammatical errors during production and comprehension, which might be exacerbated if L2 grammatical features are absent in the learner's L1. This difficulty is mediated by the way in which L2 attainment is being measured. Specifically, modalities which necessarily impose time restrictions on the L2 learner also require more demanding cognitive processing, resulting in lower performance accuracy than those without time restrictions. Given these findings, studies which examine L2 production and comprehension errors across multiple modalities would be valuable, especially for L2 learners acquiring grammatical features which are absent in the L1.

As previous research studies have demonstrated, L1 Mandarin learners of L2 English frequently exhibit difficulties producing L2 English inflections. However, systematic investigations controlling for temporal context and production modality are currently lacking. In Chapter 2, I will present data from three experiments (Experiment 1, 2 and 3) where L1 Mandarin speakers[5] of L2 English produced inflectional markings in controlled temporal contexts in spoken and written modalities. The main research questions are: 1) Whether the reoccurrence of inflectional errors in L2 production is a representational and/or processing problem; 2) Whether complexity of information contained in inflectional markings affects inflectional accuracy during L2 production; and 3) Whether oral articulation induces more inflectional errors in spoken than in written production.

As previous research studies have also shown, L1 Mandarin learners of L2 English do not process English subject-verb agreement and morphology in a native-like way (Jiang, 2007), whilst exhibiting proficient grammatical knowledge (Chen et al., 2007). It is possible that whilst L2 learners have explicitly learnt the grammatical rules, they do not have a comprehension mechanism to apply them appropriately in real-time. In Chapter 3, I present data from two experiments (Experiment 4 and 5)

[5] L1 Mandarin learners of L2 English will be referred to as 'L1 Mandarin speakers' in the context of L2 production in Chapter 2. For the rest of the thesis, L2 English learners from Mandarin backgrounds will be referred to as 'L1 Mandarin learners of L2 English' in the context of L2 comprehension and in the context of phonological processing.

where L1 Mandarin learners of L2 English comprehended L2 English sentences with grammatical violations (inflectional omissions) in auditory and visual modalities. The main research questions are: 1) Whether L2 learners can integrate semantic and syntactic linguistic cues for L2 temporal comprehension (i.e. temporal adverbials and inflectional morphology); 2) Whether auditory stimuli would make L2 comprehension more difficult for the L2 learner compared with visual stimuli.

Given known phonological constraints imposed by L1 phonological development, L2 learners may find sounds or sound combinations shared by their L1 to be easier to detect and process, and those which are novel in the L2 to be more difficult to detect and process. Such perceptual biases may result in comprehension difficulties. In Chapter 4, I present two additional experiments (Experiments 6 and 7) examining the effect of phonological features on perception of L2 grammatical features and the extent of L1 phonological influence on L2 production. Given the syllabic nature of Mandarin morphemes, L1 Mandarin learners of L2 English may find syllabic endings more salient in perception compared with consonant clusters (which are rare in Mandarin). The main research questions are: 1) whether L1 Mandarin learners of L2 English differ from L1 English learners in the perception of syllabic and consonant cluster inflectional endings; 2) whether saliency of phonological features affect the processing of temporal information in inflectional markings; and 3) whether production difficulties in phoneme adjunction are restricted to inflectional morphemes.

In Chapter 5, I will sum up the key experimental findings presented in this thesis and discuss their implications for the field. Discussions for Experiments 1 to 3 will focus on the likely causes affecting inflectional accuracy during L2 production, and how my findings fit in with psycholinguistic models of language production and existing production studies in the field. Discussions for Experiment 4 and 5 will focus on the application of grammatical knowledge in real-time comprehension, and how comprehension modality affects this process. Discussions for Experiment 6 and 7 will focus on the effect of phonological saliency in speech perception and comprehension, and the extent of L1 phonological influence on L2 production. methodological considerations will be evaluated, including both positive aspects and potential limitations, and how these points will be valuable going forward.

Chapter 2

Spoken and written production of L2 temporal inflections in L1 Mandarin speakers of L2 English

Second language (L2) speakers from different native language (L1) backgrounds have been widely observed to make errors when producing morphological inflections in their L2. I report three experiments that investigated how such inconsistency might arise within the language production system, focusing on L2 English speakers whose L1 does not mark tense grammatically and does not use a morphological system to indicate temporal properties of events. L1 Mandarin and L1 English (control) participants produced spoken (Experiments 1 and 2) or written (Experiment 3) descriptions of events involving different temporal contexts. In all three experiments, L1 Mandarin participants showed sensitivity to L2 temporal cues when producing present and past morphemes. These results indicate that L2 speakers may acquire and process features that do not occur in their L1 but cannot always activate and retrieve these features accurately during spoken and written production. Critically, L1 Mandarin speakers found the featurally complex inflection (3rd person singular *-s*) more difficult to produce accurately than the featurally less complex inflection (past *-ed*), indicating that the complexity of inflectional morphemes also affects accuracy of production. Finally, given that similar patterns of inflectional errors were found not only in spoken but also written production, the loci of erroneous inflectional production could not be solely attributed to articulatory problems.

2.1. Introduction

Second language (L2) speakers often make errors when producing inflectional markings in their L2. For example, L2 English speakers frequently omit the past tense inflection *-ed* when the grammatical context demands it, e.g., *Yesterday the chef shout at the waiter in the restaurant**. Although there is abundant evidence for erroneous inflectional production by L2 speakers from different L1 backgrounds, there is little agreement over the causes of such inconsistencies (Goad, White, & Steele, 2003; Hawkins & Chan, 1997; Lardiere, 2008; Prévost & White, 2000), and, in particular, little consideration of how morphological errors might be accounted for within psycholinguistic models of language production. For instance, do they reflect L2 speakers' failure to acquire conceptual distinctions that are absent in their L1, inability to represent and activate grammatical features, inconsistent retrieval of inflectional forms, or difficulties in articulating inflectional markings? In this chapter, I focus on the spoken and written production of English tense inflections (i.e., 3rd person singular *–s* and past tense *–ed*, as in *walks* and *walked*) in L2 learners whose L1 (Mandarin) does not overtly mark for tense morphology, in order to investigate the locus of erroneous morphological inflections in L2 language production.

Many previous studies on inflectional production have found that L1 Mandarin speakers are particularly prone to inflectional errors in L2 English production, especially in comparison with L2 English speakers with tense marking in their L1s. In a series of longitudinal studies, Lardiere (1998a; 1998b; 2000; 2003) found that a native Mandarin-Hokkien speaking adult, Patty, who had been living in the US for more than 10 years, showed only 5.8% regular past tense marking in her spoken production even after prolonged L2 immersion. Similarly, a picture-description study with L2 upper-intermediate to advanced adult speakers of English from L1 Mandarin backgrounds also showed past inflectional production at chance level or below after 6 months of L2 immersion (Goad et al., 2003). Converging evidence from different production tasks also revealed that L2 English users from L1 Mandarin backgrounds have a consistent tendency to omit past tense marking especially compared with L2

English speakers from other L1 backgrounds (Bayley, 1996; Hawkins & Liszka, 2003).

One important factor which might play a role in L1 Mandarin speakers' poorer performance on English inflectional production is differences in the temporal properties across languages: Whilst English uses a combination of tense (event external) and aspectual morphemes (event internal) to express temporal information, Mandarin is a non-inflectional language that does not overtly mark for tense on the verb and uses aspectual marker with temporal adverbials which mark contexts (Smith, 1991). In Mandarin, the perfective aspectual marker *le* is used to indicate the completed status of events, with additional temporal adverbial marking that the event is in the past (see h), whereas in English, tense is an obligatory feature and is marked by an inflection when producing a verb phrase (see i).

h)	*zuo*2 *tian*1	*ta*1	*kan*4	***le*0**	*wang*3*qiu*2	*bi*3*sai*4
	yesterday	she	watch	**[PERFECTIVE ASPECT]**	tennis	match
i)	*yesterday*	*she*	*watch*	*-ed*	*(a) tennis*	*match*
	yesterday	she	watch	**[PAST]**	tennis	match
				[PERFECTIVE ASPECT]		

'Yesterday she watched a tennis match'

Therefore, for an L1 Mandarin speaker learning English to show high accuracy in temporal inflectional production, they must not only conceptualise tense distinctions (e.g., present vs. past) and represent the appropriate grammatical forms which mark these distinctions (e.g., 3rd person singular *-s* vs. past *–ed*), but must also then use these distinctions and produce the correct inflectional markings in the appropriate contexts during processing. That is, successful inflectional production involves factors relating to both conceptualisation, representation and processing of tense distinctions during inflectional production.

2.1.1. Theories of L2 inflectional production errors

What factors might underlie L1 Mandarin speakers' poor inflectional accuracy in English? Previous research cited within theoretical linguistic frameworks has proposed several possible sources for L2 inflectional errors, implicating representational deficits, morphological processing failures, and/or prosodic or articulatory failures in language production. Given that morphemes can be broken down into smaller units or features (e.g. number, person, tense etc.), some theories locate difficulties in inflectional production in specific representational deficits on these features. For example, L2 speakers are unable to acquire new L2 featural representations after the critical period if they are absent in the speaker's L1 (*Failed Functional Feature Hypothesis*; Hawkins & Chan, 1997). As Mandarin speakers do not have tense features, they would not be able to form new functional categories for tense inflections during L2 acquisition. As a consequence, this theory would likely predict that L1 Mandarin speakers would never produce correct inflections. However, another possibility would be optional inflectional production without necessarily having specific representation of their temporal features.

Other representational accounts proposed that prosodic constraints affect inflectional production, and specifically that the use of L1 prosodic features in L2 production is solely responsible for L2 inflectional omission (*Prosodic Transfer Hypothesis*; Goad et al., 2003). If the speaker's L1 does not permit the use of certain prosodic structures (e.g. adjunction of inflection to the phonological word), L2 speakers are likely to fail to process the corresponding inflectional markings. For instance, the study by Goad and White (2006) showed adjunction to the prosodic word (e.g. attaching [ɪd] to [ˈʃaʊtɪd]), an phonological operation not permitted in Mandarin, was more difficult to acquire [drʌŋk] compared with phonological operations inside the prosodic word (e.g. [drɪŋk] becoming [drʌŋk]). Since *-ed* adjunctions are essential to English past tense marking, the inability to perform this phonological operation due to L1 restrictions would significantly hinder the accurate production of *-ed* in required contexts. In another study, a Mandarin-Hokkien speaker Patty showed consistent difficulty with word-final consonant clusters on English regular verbs, a pattern that was plausibly linked to L1 prosodic constraints

and difficulties with articulating specific phonemes (Lardiere, 2003). This hypothesis was further supported by evidence that omission of -t/-d phonemes in Mandarin speakers occurred in other non-tense contexts as well (Bayley, 1996; Hawkins & Liszka, 2003). Given that phonological representations are most strongly implicated in spoken production, prosodic constraints should result in inflectional errors primarily in the spoken modality (Goad et al., 2003).

Other accounts postulate that L2 inflectional errors are not the result of representational deficits, rather inconsistent retrieval of L2 inflectional forms (*Missing Surface Inflection Hypothesis, MSIH*; Prevost & White, 2000). This account is thus more in keeping with existing data of 'inconsistent production' instead of 'absolute omission'. Cross-linguistically, inconsistent inflectional retrieval has been linked to the complexity of information an inflection contains (*Featural Complexity Theory*; Hawkins, 2007): Inflections that contain more complex features are more difficult for L2 speakers to produce accurately. For example, the featurally complex 3rd person singular *-s* (3SG *-s*), which codes for person, subject number and tense whereas to past *-ed* which codes only for tense. Empirical research has found that Turkish-English sequential bilingual children (L2 English) had particularly high error rates for the featurally complex 3SG *-s*, compared with past *-ed*. Critically, although production was variable, they were sensitive to inflectional omissions as ungrammatical constructions, indicating intact L2 syntactic representations rather than deficits in syntactic representations (Chondrogianni & Marinis, 2012).

These linguistic accounts provide plausible proposals for why L2 speakers might produce inflectional errors, but they are not embedded within psycholinguistic models of processing. Therefore, these accounts do not elucidate the specific representational and processing deficits that lead to inflectional errors in L2 speakers' language production in the first place.

2.1.2. Morphological processing in language production

Our concern in this study was to consider how L2 speakers' erroneous inflectional production can be explained within psycholinguistic models of language production. Current modular models standardly assume that L1 production involves stages of constructing a preverbal message (*conceptualization*); activating lexical representations, assigning grammatical functions/syntactic structure, retrieving word forms, activating phonological representation, forming phonological words and associated phonetic plans (*grammatical* and *phonological encoding*); and finally executing phonetic articulatory gestures (*articulation*; Bock, 1982; Bock & Levelt, 1994; Garrett, 1975; Levelt, 1989, 2001; Levelt, Roelofs, & Meyer, 1999). Adaptations of this model, assuming the same basic architecture, have been proposed for bilingual language production (de Bot, 1992; 2003; de Bot & Schreuder, 1993). In these adapted models, L1 and L2 share conceptualization and articulatory processes but have separate subsystems for grammatical encoding and lexical access.

To exemplify the relevant processes, consider an L1 English speaker describing an event in which a chef is shouting at a waiter in a restaurant. During conceptualization, the speaker constructs a preverbal message that contains not only concepts such as *chef, waiter, restaurant* and *shout*, but also semantic relations such as the concept of *in*, and crucially, temporal properties of the event. This message is assumed not to be language-specific, but nevertheless encodes only information strictly relevant to the language of the intended utterance (*microplanning*; Levelt, 1989). Hence the L1 English speaker would code information about the event that included tense and aspect.

In the following stage, the speaker activates the relevant lexical representations (lemmas; e.g. syntactic structure relating to *chef / waiter / shout / restaurant*) with the associated diacritic features such as number, tense etc. She also determines relevant grammatical functions or syntactic relations, e.g., subject number, by consulting the preverbal message. Activation of features at the lemma level underlies subsequent morphological processing of the relevant inflections at the form level (e.g., activation of the *perfective aspect* and *present tense* features associated with the verb lemma, together with *third person* and *singular* features associated with the

subject lemma, underlie subsequent processing of *–s*). The speaker subsequently retrieves relevant phonological representations, including phonemes, syllable and stress information, and carries out syllabification to form the phonological word. The phonological word then undergoes phonetic encoding, where articulatory gestures are planned. Finally, during articulation, the speaker executes the relevant phonetic articulatory gestures to form the sounds for *chef, waiter, restaurant* etc.

Typically, activation flows smoothly from one stage to another, resulting in successful production of *The chef shouts at the waiter in the restaurant,* but on rare occasions breakdowns in transmitting activation between levels can result in a speech error, e.g., **The chef shout at the waiter in the restaurant* (see Dell, 1986; Dell, Chang, & Griffin, 1999; Dell, Schwartz, Martin, Saffran, & Gagnon, 1997; Foygel & Dell, 2000). Note that the nature of activation is not binary, but rather relies on activation from one level to another reaching a sufficient threshold for transmission to progress onto the next level.

Within this model, we can identify a range of ways in which inflectional errors might in principle arise during L1 Mandarin speakers' production of L2 English. First, errors might arise from representational or processing deficits during conceptualization. If L2 speakers are unable to represent conceptual distinctions that do not exist in their L1, L1 Mandarin speakers would fail to encode event-external information (in our example, how the act of shouting as a whole relates to the time of speech) in the preverbal message, because Mandarin does not grammaticalize such information. As the preverbal message representation drives subsequent linguistic formulation, and event-external information is critical to determining tense, speakers would fail to produce (i.e., would always omit) tense inflections. Equally, if L2 speakers are able to represent conceptual distinctions that do not exist in their L1, but experience difficulty in processing conceptual distinctions that do not exist in their L1, this would result in a tendency to produce tense inflections inconsistently (showing optionality; i.e., sometimes correctly but sometimes incorrectly).

Alternatively, errors might arise during formulation. At the lemma level, there could be a representational deficit for the relevant diacritic features (consistent with Hawkins and Chan's account). If L2 speakers can make relevant conceptual

distinctions but do not have corresponding diacritic feature representations (as Mandarin does not encode these features), they would not be able to encode the temporal features necessary for subsequent morphological encoding (in our example, the *present tense* feature underlying subsequent processing of *–s*) and so would omit inflections. If L2 speakers represent these diacritic features but experience difficulty in activating them appropriately, this would lead to inconsistent production.

A further deficit at the lemma level might lie in the association between syntactic functions (who-did-what-to-whom) and properties of morphological features (e.g. 3SG *-s* inflection following a third person singular subject). If L2 speakers do not have knowledge of these associations (i.e., a representational deficit), they would never activate the appropriate feature representations. If they had a processing deficit, they might do so inconsistently; in our example, failure to appropriately assign the subject syntactic function to '*chef*' and process its number information would result in the inconsistent production of 3SG *-s*.

At the word form level, L2 speakers might have a processing deficit in transmitting activation from morphological feature representations and to corresponding word (inflectional) forms sufficiently for successful retrieval. This would lead L2 speakers to produce inflections inconsistently (consistent with Prevost and White's (2000) Missing Surface Inflection Hypothesis, which claimed difficulties in realising surface form). In our example, an L2 speaker might have the conceptual distinction of tense and the relevant diacritic feature representations but still fail to produce the correct inflectional morphology on some occasions because she could not effectively activate and retrieve the *–*3SG *–s* inflection.

Lastly, there could be representational or processing deficits at the phonological level. If L2 speakers do not represent specific phonemes or their use is restricted by L1 phonological constrained operations (i.e. syllabification), they may fail to activate L2 phoneme patterns or perform phonological operations that blend sounds together. For example, [ɪd] (*-ed*) in [ʃaʊtɪd] (*shouted)* is not a plausible phoneme combination in Mandarin. So, in order to produce a word like [ʃaʊtɪd] (*shouted)*, L2 speakers would need both the relevant phonemic representations and

the ability to assemble them to form the appropriate inflection. In this case, the phonological operation that creates a consonant cluster like [tɪd] also has morphological correspondents (i.e. *t-ed*). Therefore, the absence of such phonological operations would give rise to omission of specific phonemes in inflections. This is partially consistent with Goad et al.'s (2003) account on L1 prosodic transfer which claimed that speakers have fundamental difficulties performing phonological adjunctions which are illegal in the L1 during L2 inflectional production. In the previous example, it is possible that even though the L2 speaker recognises the temporal context of 'shouting', the syntactic structure which indicates the person who performed the act of shouting and the inflectional forms past *-ed* or 3SG *-s*, generating the phonological structure required for processing (and producing) *shouted* could still be difficult if the adjunction of [ɪd] to [t] is not permitted in the speaker's L1.

Finally, errors might have an articulatory source: L2 speakers' articulatory gestures may be limited to permitted phoneme combinations of their L1, so that they do not acquire additional articulatory gestures for L2 phonemes. This would give rise to consistent omission of specific phonemes in the spoken modality (e.g., failure to articulate 3SG *–s* in our example, since /ts/ is not a permissible combination in Mandarin). This would be consistent with Lardiere's (2003) finding of a discrepancy between Patty's written versus oral accuracy in past tense inflection (78% vs. 5.8%).

To summarize, a psycholinguistic model of language production offers several potential loci for L2 inflectional errors in production: Such errors might in principle occur because of representational or processing deficits, and these deficits might be associated with conceptualization, formulation (at the lemma, morphological, and/or phonological level), and/or articulation.

2.1.3. The current study

To investigate whether L2 inflectional errors in production might arise from representational versus processing deficits, and to identify the level(s) at which such deficits might occur, I now report three experiments that investigated the production

of L2 temporal morphology in adult L1 Mandarin speakers of L2 English (and a control group of L1 English speakers). Spoken (Experiment 1 & 2) and written (Experiment 3) responses were elicited using a description paradigm, in which participants produced (under a time limit) descriptions of action scenes, using temporal cues (calendar pictures indicating either Present Habitual or Past temporal contexts), regular verbs (e.g. *shout*) and pictures of people, objects and locations (e.g., *Every day the chef shouts at the waiter in the restaurant*). I analysed participants' production of inflections (3SG *-s* & past *-ed*) with respect to inflectional accuracy, inflectional type (3SG *-s* and past *-ed*) and inflectional omission.

I investigated two broad possibilities for why L1 Mandarin speakers of L2 English might make errors when producing (temporal) inflectional morphology. Specifically, it is unclear whether the source of error lies with representational deficits or processing breakdowns at different stages of language production.

Representational deficits can be implicated at multiple stages of language production. First, if L2 speakers do not conceptualize information relevant to L2 morphological production when the relevant conceptual distinction does not exist in their L1, they should not produce the relevant morphological inflections under any circumstances. This account predicts that L1 Mandarin speakers of L2 English should show significantly poorer performance in inflectional production (i.e., lower accuracy) than L1 English speakers across the board, and specifically that they would fail to produce 3SG *-s* and past *-ed* inflections entirely (i.e., absolute omission), in any temporal context (i.e., whether in a Present Habitual context or a Past context). Second, if L2 speakers do not have associations between syntactic functions (who-did-what-to-whom), they would never activate the appropriate diacritic features under the correct syntactic contexts (e.g., activating the values 3rd and **SINGULAR** for a verb lemma's **PERSON** and **NUMBER** diacritic features respectively, following a 3rd person singular subject). This account does not rule out L2 inflectional production altogether but predicts that L1 Mandarin speakers of L2 English would produce inflections randomly without accounting for temporal or syntactic contexts. Third, if L2 speakers do not have representations for relevant diacritic features at the lemma level, they should not systematically produce inflections associated with those features. This account again predicts that L1 Mandarin speakers should show

significantly poorer performance than L1 English speakers across the board (i.e., they would fail to produce both 3SG *-s* and past *-ed* inflections in the appropriate contexts), and that they would do so to the same extent for both inflection types.

Processing breakdowns can also occur at multiple stages during language production. First, L2 speakers may represent the relevant diacritic features at the lemma level, but cannot activate and integrate them consistently in relation to the verb. This account predicts inconsistent inflectional production, but as the number of diacritic features differs for different inflections, it would further predict asymmetrical patterns for inflections with different numbers (or complexity) of features. For example, L1 Mandarin speakers of L2 English should make more errors for inflections involving both subject number and tense information (i.e., 3SG *-s*) than inflections involving only tense information (i.e., past *-ed*). Second, L2 speakers may represent the relevant associations between syntactic functions, but cannot activate them consistently under the correct syntactic contexts. This account predicts inflectional production that is unsystematic and insensitive to temporal and syntactic contexts. For example, L1 Mandarin speakers of L2 English should produce 3SG *-s* inconsistently, but at the same time, they should not be more likely to produce 3SG *-s* in Singular Subject conditions than in Plural Subject conditions. Equally, they should not be more likely to produce past *-ed* in Past contexts than in Present Habitual contexts. Third, L2 speakers, given the appropriate conceptual and lemma level representations and activations, may still experience difficulties in activating and retrieving the relevant inflectional forms during morphological encoding. Specifically, L2 speakers may find inflections which require more than one feature connection from the lemma level to the morphemic level more difficult to retrieve consistently than inflections which require a single feature. This account predicts that L1 Mandarin speakers should show poorer performance than L1 English speakers, sometimes producing the correct inflection and sometimes omitting it (i.e., displaying optionality), but crucially they would do so in a way that was sensitive to the temporal context. That is, they would be more likely to produce 3SG *-s* inflections in Present Habitual contexts than in Past contexts, and more likely to produce past *-ed* inflections in Past contexts than in Present Habitual contexts.

Finally, if articulation difficulties contribute to L2 inflectional errors, L1 Mandarin speakers' performance should be significantly better in written production (which does not involve overt articulation) compared with spoken production (which does involve overt articulation). The specific pattern of performance across the two modalities would be informative about the extent to which articulation underlies inflectional errors. If articulation is the primary source of such errors (i.e., speakers do not have other representational and processing difficulties during earlier stages of production), L1 Mandarin speakers would produce errors in spoken production but not in written production. If, however, articulatory difficulties exacerbate other representational and processing sources of error at earlier stages, then L1 Mandarin speakers would produce similar patterns of error in both spoken production and written production but the error rate would be higher in spoken production than in written production.

2.2. Experiment 1

2.2.1. Methods

Participants

16 native Mandarin (L1 Mandarin) speakers of English aged 19-25 (M= 22.6, SD=1.3) and 18 monolingual native English (L1 English) speakers aged 21-33 (M= 25.1, SD=3.0) from the University of Edinburgh participated in Experiment 1. The L1 Mandarin group (i.e., L2 English) consisted of late learners of English who only had regular exposure to English after the age of five. The monolingual English control group (L1 English) consisted of native English speakers who were not exposed to any other languages before the age of five. The L1 Mandarin participants had achieved an overall score of at least 6.5 on the International English Language Testing System (IELTS, assessing speaking, listening, reading and writing) within the last two years, indicating intermediate to advanced L2 proficiency; all L1 Mandarin participants were within 24 months of their first arrival in the UK[6].

[6] See Appendix A for additional information on Mandarin participant's language background.

Materials

For the scene description task, nine transitive experimental verbs with alveolar consonant endings were chosen, eliciting phonologically salient inflectional endings in the past temporal context (see Appendix B). In addition, 36 scenes depicting these transitive actions (four per verb) were created as PNG image files for display on a 1024 x 768 pixel computer screen (see Figure 4 for example). Each scene contained four clip-art items: a calendar image depicting the temporal context of the action (*every day*, *yesterday*), and three images depicting the entities taking part in the action (an agent, a patient and an instrument or location). The calendar was placed top-centre and the three action images were placed below from left to right, congruent with the direction of reading. Nine additional transitive and intransitive filler verbs were chosen and 36 additional filler scenes were created (Appendix B). 96 entities (people, objects, animals, location etc.) were used multiple times to create 72 action scenes (Appendix C for the full collection of stimuli). Singular and plural subjects were counterbalanced across both temporal contexts for each verb. A vocabulary list and a pictorial legend were also prepared to familiarise participants with items the scene description task (Appendix D).

The Oxford Placement Test (Allan, 1992) was prepared on paper for participants to complete by hand (see Appendix E).

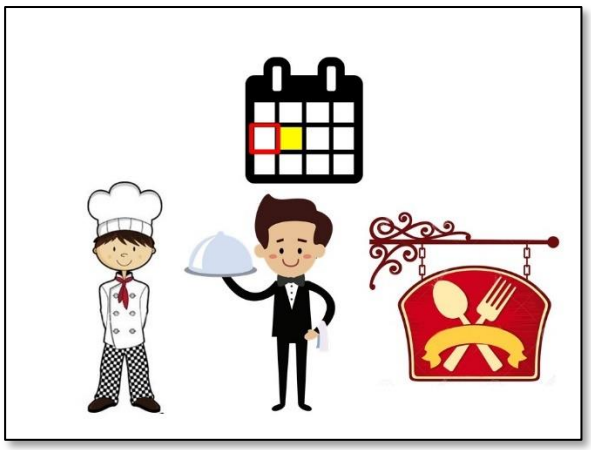


Figure 4. Experiment 1: Example of trial image from the scene description task, including a temporal cue (calendar image) and entities in the action (chef, waiter, restaurant).

Design

This experiment used a 2 x 2 x 2 mixed design with subject number (singular vs. plural), temporal context (present habitual vs. past) as within-subject variables, and group (L1 Mandarin vs. L1 English) as a between-subject variable. The experimental design was identical in Experiment 2 and 3.

Procedure

At the beginning of the session, all participants provided demographic details. The Mandarin group also provided information about the history of their L2 acquisition, L2 proficiency, and current L2 usage. Subsequently all participants completed the scene description task.

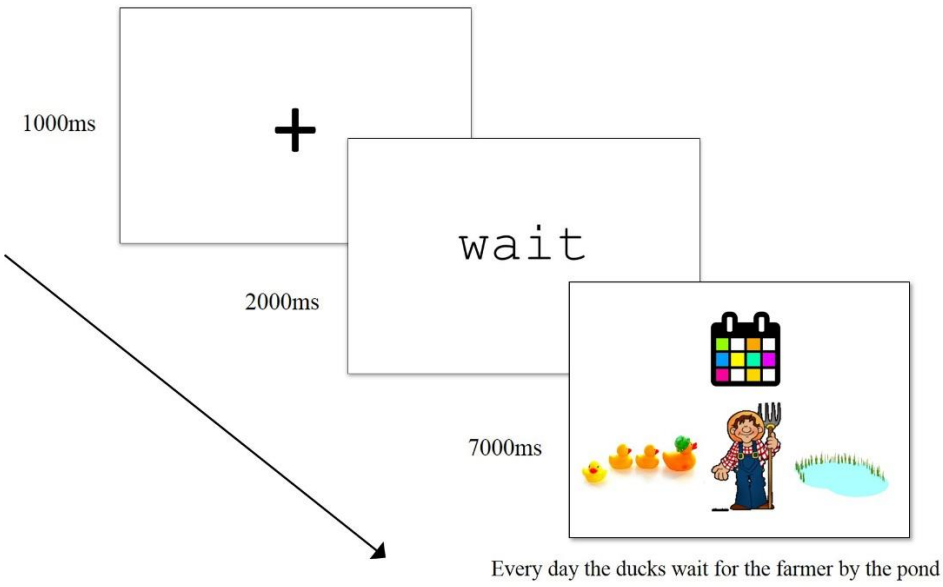


Figure 5. Experiment 1: Three-step trial procedure for the scene description task, including the presentation of fixation (1000ms), target verb (2000ms), and trial image (7000ms).

Before completing scene description task, the experimenter explained the interpretation of the calendars, i.e., that a multi-coloured calendar represented that

the action in the scene took place habitually (*every day*) and a red-yellow calendar represented that the action in the scene was completed once in the past (*yesterday*). Participants were given further examples of the trial procedure on paper, in which temporal adverbials (*every day* or *yesterday*) appeared at the beginning of each sentence. However, participants were not told explicitly that temporal adverbials were obligatory in their description. Participants then studied the vocabulary list. If they did not understand any concepts, the concepts were explained first in English, and then – if still unclear – in Mandarin.

Participants then completed the scene description task on a computer. Scenes were presented using E-Prime (Version 2.0; Schneider, Eschman & Zuccolotto, 2002). A headset with microphone was prepared to record participants' responses.

On each trial, a fixation point was presented for 1000 milliseconds (ms) followed by the target verb (see Figure 5). The verb was presented on-screen for 2000 ms. This was followed by the action scene, which was presented for 7000 ms. Participants described the action scene aloud using the given verb and all items on the screen within the given time; responses were recorded via a microphone. Each trial was immediately succeeded by the next trial. Participants had five practice trials before the main experiment began. All participants provided descriptions for all 72 action scenes in two blocks of 36 (18 verbs repeated across singular and plural subjects, in both Present Habitual and Past temporal contexts), separated by a self-paced break. Presentation order was randomised for each participant. (Participants subsequently repeated this procedure with the same 72 items in a different randomised order, but these data are not discussed further here).
Participant subsequently completed a 100-item English grammar test[7].

The experiment lasted approximately 30 minutes, and participants were either offered cash (£5) or course credit for their participation.

[7] The L2 English grammatical proficiency measure (*Oxford Placement Test*; Allan, 1992) did not predict production responses across analyses in Experiment 1 (but see Appendix F for a descriptive summary with analysis).

Coding and Scoring

All trials were recorded as 7000 ms audio files via E-Prime, and were transcribed exactly as spoken. Only the first response attempt was coded, as participants' initial production response was most comparable across trials; any corrections were ignored (some correction attempts occurred after time-limit and therefore were not reliably recorded). 8% of responses with non-target verbs were excluded. The subject of the sentence was coded for number (singular or plural); trials where the subject number in participants' response was incongruent with the image (e.g. the speaker used 'duck' instead of 'ducks' for an image of more than one duck) were excluded. Target verb inflections were coded into three categories: zero inflection (e.g. *wait*), past tense *-ed* (e.g. *waited*) and 3rd person singular *–s* (3SG *-s*, e.g. *waits*); five responses containing other verb inflections (e.g. *progressive -ing*) or auxiliary verbs (e.g. *have been waiting*) were excluded. Non-target past *-ed* responses in Present Habitual contexts (Past Habitual response) were included as they were necessary for past *-ed* likelihood analyses.

Verbs with zero inflection, past tense *-ed* and 3SG *–s* responses were then scored for inflectional accuracy (1 or 0) based on the temporal context and subject number (see Table 3). For trials scored as incorrect, error type and subject number were coded as: *omission error* when an obligatory inflection was omitted, e.g. missing 3SG *-s* for singular subject in Present Habitual context or *commission error* when an incorrect inflection was produced, e.g. 3SG *-s* in Past contexts. Only omission responses will be presented from here on.

Table 3.

Coding and scoring criteria for inflectional production responses in Experiments 1, 2 and 3.

Temporal Context	**Subject Number**	**Verb**	**Inflection**		**Accuracy**	**Error Type**
Present	Singular		Past *-ed*	(*Shout-ed*)	0	Commission
Habitual	(*the Chef*)	*Shout*	3SG *-s*	(*Shout-s*)	1	--
(*Every Day*)			Zero Infl.	(*Shout*)	0	Omission
	Plural		Past *-ed*	(*Wait-ed*)	0	--
	(*the Ducks*)	*Wait*	3SG *-s*	(*Wait-s*)	0	Commission
			Zero infl.	(*Wait*)	1	--
Past	Singular		Past *-ed*	(*Applaud-ed*)	1	--
(*Yesterday*)	(*the Teacher*)	*Applaud*	3SG *-s*	(*Applaud-s*)	0	Commission
			Zero Infl.	(*Applaud*)	0	Omission
	Plural		Past *-ed*	(*Paint-ed*)	1	--
	(*the children*)	*Paint*	3SG	(*Paint-s*)	0	Commission
			Zero Infl.	(*Paint*)	0	Omission

2.2.2. Results

Outcome variables (response accuracy, responses of different inflectional types, and of inflectional errors) from Experiment 1 were analysed using logistic mixed effects regression models (LMEs). a forward model building strategy was used with a maximal random effects structure (Barr, Levy, Scheepers & Tily, 2013). Predictor variables (Group, Temporal Context and Subject Number) were contrast-coded before being included as fixed effects predictors. Participant was included as a random intercept. Item and Temporal Context were included as random slopes if they significantly improved model fit. Log-likelihood ratio tests (chi-squared test) were used to compare alternative logit regression models in order to decide whether the new model with additional fixed and random effect variables significantly improved the goodness-of-fit.

Three sets of analyses were carried out on the data from the scene description task. The first and second set focused on the overall accuracy of inflection depending on temporal context and number regardless of morpheme (with accurate responses coded as **1**, and inaccurate responses coded as **0**) and the likelihood of production for

each type of morpheme (3SG *-s* and past *-ed*). For both sets of analyses, a logistic mixed effects regression model was built with Group, Temporal Context and Subject Number as fixed effect predictors. Participant was then included as a random intercept. Item was included as a random intercept or slope if the log-likelihood chi-squared model comparison showed it significantly improved the fit of the model. Separate subgroup analyses were also conducted for L1 Mandarin (L2 English) and L1 English groups, deducting group as a fixed effects predictor but keeping all other variables the same.

The third set of analyses focused on responses involving inflectional omissions[8]. For these analyses, Bayesian logistic mixed effects models (BLME) were built to address the problem of partial separations (Rainey, 2016; Zorn, 2005). This was caused by the missing response category of plural subject omission in the present habitual temporal context, i.e. participants cannot make omission errors if the condition requires zero inflection, leading to consistent scores of 0 in this error category. This in turn led to the maximum likelihood estimate (Wald's Test) of a non-Bayesian logistic regression model tending towards infinity for the outcome variable (See Hauck & Donner, 1977). Consequently, a BLME model was used to impose a fixed prior to the fixed effect parameters, improving parameter estimates for inflectional error. Note that although Subject Number was not included as a predictor for omission error analyses (for reasons stated above), few numbers of errors across conditions and groups still qualified the use of a Bayesian model. As error patterns is expected to differ substantially across groups, subgroup analyses were conducted for L1 Mandarin and L1 English groups. The BLME model consisted of temporal context as the only fixed effects predictor, and participant as random intercept and item as random slope. Subject number was not included as fixed effects predictor due to missing response category. Other instances of model non-convergence were dealt with using the '*bobyqa*' algorithm for constrained optimisation by increasing the number of iterations to 10000.

Our presentation focuses on key main effects and interactions; see Tables 5-8 for complete inferential statistics for each model.

[8] Only omission errors were analysed as the numbers of commission error responses were very low across conditions.

Overall Inflectional Accuracy

Response accuracy in each temporal context and subject condition was first analysed (i.e., 3SG *-s* responses in the Present Habitual Singular Subject condition; zero-inflection responses in the Present Habitual Plural Subject conditions; and past *-ed* responses in the Past Singular / Plural Subject conditions; Figure 6).

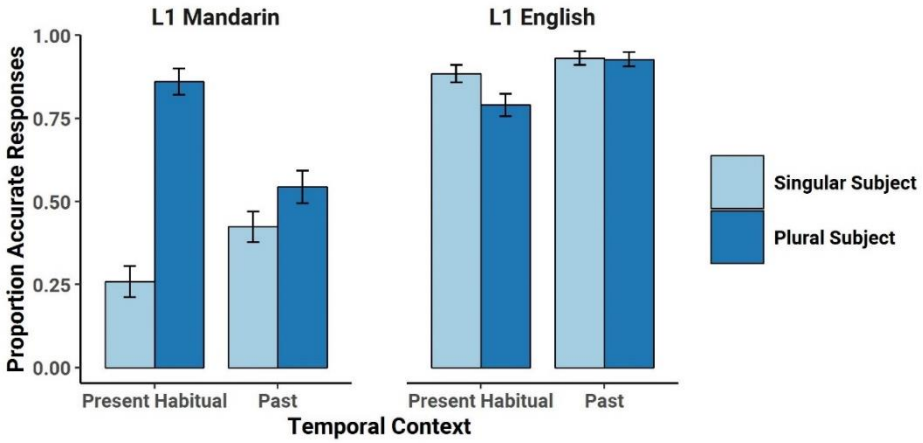


Figure 6. Experiment 1: Average proportion of accurate inflectional responses in Present Habitual and Past temporal contexts in Scene description task for L1 Mandarin and L1 English groups (N=16;18). Error bars denote +/- 1 SE.

There was a significant main effect of Group. Inflectional accuracy was more variable across conditions in the L1 Mandarin group than in the L1 English group, with the L1 Mandarin group producing most accurate responses in the Present Habitual Plural Subject condition (which did not require any inflection) and fewest accurate responses in the Present Habitual Singular Subject condition (which required the 3SG *-s* inflection; M=0.86 vs. M=0.26; L1 English: M=0.79 vs. M=0.89). There was a significant three-way interaction between Group, Temporal Context and Subject Number (Table 5). Subgroup analyses revealed that in the L1 Mandarin group, Temporal Context interacted with Subject Number; in the L1 English group, there was no such interaction.

Inflectional Type

3rd Person Singular -s (3SG -s) responses

Further analyses were conducted 3SG *-s* responses in each condition (Figure 7). Note that a 3SG *-s* response was a grammatically correct response in the Present Habitual Singular Subject condition, but an error (i.e., production of an incorrect inflection [commission error]) in all other conditions.

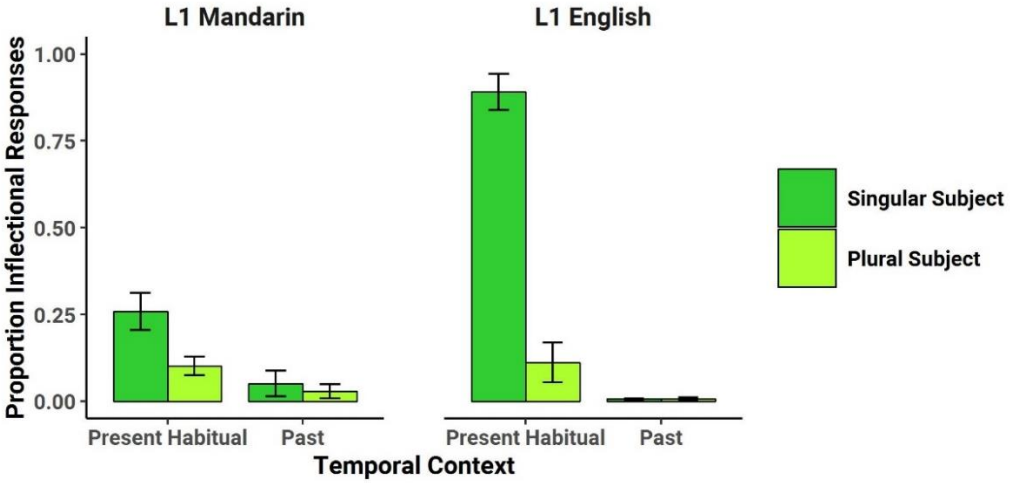


Figure 7. Experiment 1: Average proportion of 3SG *-s* inflectional production across Present Habitual and Past temporal conditions for L1 Mandarin and L1 English groups (N=16;18). Error bars denote +/- 1 SE.

There was a significant main effect of Temporal Context and of Subject Number, with a significant three-way interaction between Group, Temporal Context and Subject Number (Table 6): Although the L1 Mandarin group produced more 3SG *-s* inflections in the Present Habitual Singular Subject context (M=0.26) than in other contexts, they did so to a lesser extent than the L1 English group (M=0.89).

Subgroup analyses confirmed the effect of Temporal Context in each group. They also revealed that in the L1 Mandarin group, there was a significant effect of Subject Number, with participants significantly more likely to produce 3SG *-s* inflections following a singular subject than a plural subject (M=0.16 vs. M=0.08). But critically, there was not a significant interaction between Subject Number and

Temporal Context: Participants did not produce significantly more 3SG *-s* inflections in the Present Habitual Singular Subject condition than in other conditions.

In the L1 English group, there was a significant effect of Subject Number, with participants more likely to produce 3SG *-s* inflections following a singular subject than a plural subject. There was also a significant interaction between Subject Number and Temporal Context: Participants produced more 3SG *-s* inflections in the Present Habitual Singular Subject condition than in other conditions.

Past -ed responses

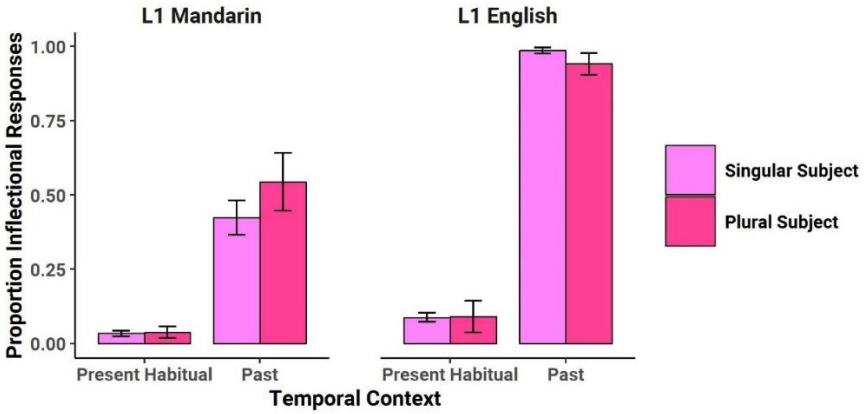


Figure 8. Experiment 1: Average proportion of past *-ed* inflectional production across Present Habitual and Past temporal contexts for L1 Mandarin and L1 English groups (N=16;18). Error bars denote +/- 1 SE.

Further analyses examined past *-ed* responses in each condition (Figure 8). Note that a past *-ed* response constituted a grammatically correct response in the Past conditions, but an error in the Present Habitual conditions. Further analyses examined past *-ed* responses in each condition.

There was a significant main effect of Group and of Temporal Context, with a significant two-way interaction between Group and Temporal Context (Table 7): Although the L1 Mandarin group produced more past *-ed* inflections in the Past conditions (M=0.48) than in the Present Habitual conditions (M=0.04), they did so to a lesser extent than the L1 English group (M=0.95 vs. M=0.09). Subgroup analyses revealed that in the L1 Mandarin group, there was a significant effect of Temporal

Context but no other significant effects, and that in the L1 English group, there was similarly a significant effect of Temporal Context but no other significant effects.

Inflectional Omission responses

Table 4.

Experiment 1: Number of inflectional omission responses out of all inflectional errors (in each condition) for L1 Mandarin and L1 English groups across Present Habitual and Past temporal contexts.

	L1 Mandarin	L1 English
Present Habitual Singular Subject	63/66 (95%)	3/17 (18%)
Present Habitual Plural Subject	0/11 (0%)	0/30 (0%)
Past Singular Subject	62/68 (91%)	1/10 (10%)
Past Plural Subject	44/47 (94%)	8/11 (73%)
Total	*169 / 192 (88%)*	*12 / 68 (18%)*

Inflectional omission responses were analysed across the Present Habitual Singular Subject and Past Singular / Plural conditions (Table 4). Note that participants could not make omission errors in the Present Habitual Plural Subject condition, where a zero inflection would be grammatical (e.g., *Every day the chefs shout*). A BLME model was therefore used to analyse the likelihood of inflectional omission out of all inflectional errors using Group and Temporal Context as predictors; Subject Number was not included as a predictor due to the missing response category for the Present Habitual Plural Subject condition.

There was a significant main effect of Group (Table 8): The L1 Mandarin group was significantly more likely to produce inflection omission responses than the L1 English group. There was also a main effect of Temporal Context: On average, there were more inflection omission responses in the Past contexts than in the Present Habitual contexts. However, there was no significant interaction between Group and Temporal Context, indicating that the effect of Temporal Context did not differ significantly between the L1 Mandarin and L1 English groups. Subgroup analyses revealed that there was no significant effect of Temporal Context in the L1 Mandarin group but there was in the L1 English group.

Table 5.

Experiments 1, 2 and 3: Logistic mixed-effects statistics for inflectional accuracy for L1 Mandarin and L1 English groups.

		Experiment 1 (N=16;18)		Experiment 2 (N=37;36)		Experiment 3 (N=48;46)	
		B (SE)	***p***	**B (SE)**	***p***	**B (SE)**	***p***
Main Model							
	Intercept	1.92 (0.31)	**<.001**	1.55 (0.16)	**<.001**	1.81 (0.14)	**<.001**
	Group (***L1 Mandarin*** *vs. L1 English*)	2.73 (0.60)	**<.001**	2.56 (0.29)	**<.001**	2.07 (0.27)	**<.001**
	Temporal Context (***Present Habitual*** *vs. Past*)	0.38 (0.24)	.109	-0.22 (0.17)	.191	-0.13 (0.16)	.401
	Subject Number (***Singular*** *vs. Plural*)	0.25 (0.24)	.307	0.43 (0.17)	**.010**	0.30 (0.16)	.060
	Group × Temporal Context	2.41 (0.46)	**<.001**	-0.07 (0.26)	.780	-1.55 (0.31)	**<.001**
	Group × Subject Number	-2.99 (0.46)	**<.001**	-0.83 (0.26)	**.001**	-0.24 (0.31)	.432
	Temporal Context × Subject Number	-0.81 (0.46)	.082	-1.16 (0.34)	**<.001**	-1.30 (0.32)	**<.001**
	Group × Temporal Context × Subject Number	4.03 (0.89)	**<.001**	2.45 (0.52)	**<.001**	-0.35 (0.63)	.573
L1 Mandarin							
	Intercept	0.27 (0.39)	.478	0.24 (0.17)	.156	0.77 (0.16)	**<.001**
	Temporal Context	-1.05 (0.30)	**<.001**	-0.18 (0.19)	.331	0.67 (0.21)	**<.001**
	Subject Number	2.03 (0.29)	**<.001**	0.84 (0.19)	**<.001**	0.42 (0.21)	**.043**
	Temporal Context × Subject Number	-3.20 (0.58)	**<.001**	2.38 (0.38)	**<.001**	-1.05 (0.42)	**.012**
L1 English							
	Intercept	3.06 (0.47)	**<.001**	2.91 (0.29)	<.001	3.03 (0.30)	**<.001**
	Temporal Context	1.36 (0.35)	**<.001**	-0.28 (0.23)	.211	-0.94 (0.27)	**<.001**
	Subject Number	-0.96 (0.36)	**.006**	0.04 (0.22)	.873	0.17 (0.27)	.544
	Temporal Context × Subject Number	0.80 (0.67)	.233	0.05 (0.45)	.918	-1.52 (0.55)	**.006**

Table 6.

Experiments 1, 2 and 3: Logistic mixed-effects statistics for 3SG -s responses for L1 Mandarin and L1 English groups.

		Experiment 1 (N=16;18)		Experiment 2 (N=37;36)		Experiment 3 (N=48;46)	
		B (SE)	***p***	**B (SE)**	***p***	**B (SE)**	***p***
Main Model							
	Intercept	-2.89 (0.34)	**<.001**	-2.70 (0.36)	**<.001**	-2.82 (0.48)	**<.001**
	Group (***L1 Mandarin*** *vs. L1 English*)	0.05 (0.55)	.920	1.06 (0.32)	**.001**	0.81 (0.28)	**.004**
	Temporal Context (***Present Habitual*** *vs. Past*)	-4.09 (0.55)	**<.001**	-2.39 (0.63)	**<.001**	-2.65 (0.87)	**.002**
	Subject Number (***Singular*** *vs. Plural*)	-1.75 (0.56)	**.002**	-	-	-	-
	Group × Temporal Context	-3.76 (0.87)	**<.001**	-2.07 (0.34)	**<.001**	-1.90 (0.39)	**<.001**
	Group × Subject Number	-1.35 (0.91)	.135	-	-	-	-
	Temporal Context × Subject Number	3.27 (1.08)	**.002**	-	-	-	-
	Group × Temporal Context × Subject Number	4.19 (1.74)	**.016**	-	-	-	-
L1 Mandarin							
	Intercept	-2.76 (0.36)	**<.001**	-2.61 (0.28)	**<.001**	-2.49 (0.24)	**<.001**
	Temporal Context	-1.77 (0.44)	**<.001**	-1.80 (0.26)	**<.001**	-2.49 (0.37)	**<.001**
	Subject Number	-0.88 (0.45)	**.040**	-1.15 (0.26)	**<.001**	-2.22 (0.38)	**<.001**
	Temporal Context × Subject Number	0.60 (0.87)	.486	1.44 (0.51)	**.005**	0.53 (0.76)	.483
L1 English							
	Intercept	-3.03 (0.51)	**<.001**	-3.57 (0.80)	**<.001**	-1.69 (0.13)	**<.001**
	Temporal Context	-5.70 (0.88)	**<.001**	-5.04 (1.42)	**<.001**	-3.11 (0.26)	**<.001**
	Subject Number	-2.43 (0.88)	.006	-	-	-	-
	Temporal Context × Subject Number	5.29 (1.70)	.002	-	-	-	-

Table 7.

Experiments 1, 2 and 3: Logistic mixed-effects statistics for past -ed responses for L1 Mandarin and L1 English groups.

		Experiment 1 (N=16;18)		Experiment 2 (N=37;36)		Experiment 3 (N=48;46)	
		B (SE)	***p***	**B (SE)**	***p***	**B (SE)**	***p***
Main Model							
	Intercept	-0.32 (0.30)	.297	-0.89 (0.27)	**.001**	-0.49 (0.18)	**.008**
	Group (***L1 Mandarin*** *vs. L1 English*)	2.76 (0.60)	**<.001**	1.24 (0.52)	**.016**	-0.12 (0.36)	.739
	Temporal Context (***Present Habitual*** *vs. Past*)	5.64 (0.39)	**<.001**	5.48 (0.31)	**<.001**	5.05 (0.25)	**<.001**
	Subject Number (***Singular*** *vs. Plural*)	-0.35 (0.34)	.301	0.00 (0.23)	.985	-0.24 (0.18)	.174
	Group × Temporal Context	3.42 (0.73)	**<.001**	4.75 (0.50)	**<.001**	3.26 (0.45)	**<.001**
	Group × Subject Number	-1.11 (0.65)	.089	0.42 (0.34)	.219	-0.53 (0.35)	.132
	Temporal Context × Subject Number	-0.76 (0.67)	.253	-0.37 (0.46)	.419	-0.34 (0.36)	.333
	Group × Temporal Context × Subject Number	-2.05 (1.31)	.117	0.07 (0.69)	.914	0.13 (0.71)	.851
L1 Mandarin							
	Intercept	-2.05 (0.50)	**<.001**	-1.51 (0.35)	**<.001**	-0.43 (0.26)	.097
	Temporal Context	3.64 (0.50)	**<.001**	3.08 (0.27)	**<.001**	3.53 (0.30)	**<.001**
	Subject Number	0.32 (0.44)	.467	-0.20 (0.26)	.431	0.07 (0.26)	.779
	Temporal Context × Subject Number	0.49 (0.93)	.599	-0.43 (0.51)	.400	-0.40 (0.51)	.438
L1 English							
	Intercept	0.78 (0.36)	**.028**	-0.29 (0.39)	.450	-0.55 (0.27)	.046
	Temporal Context	6.80 (0.56)	**<.001**	7.71 (0.51)	**<.001**	6.66 (0.46)	**<.001**
	Subject Number	-0.80 (0.47)	.094	0.22 (0.29)	.442	-0.50 (0.30)	.091
	Temporal Context × Subject Number	-1.57 (0.92)	.087	-0.35 (0.58)	.546	-0.28 (0.60)	.645

Table 8.

Experiments 1, 2 and 3: Bayesian logistic mixed-effects statistics for inflectional omission for L1 Mandarin and L1 English groups.

		Experiment 1 (N=16;18)		Experiment 2 (N=37;36)		Experiment 3 (N=48;46)	
		B (SE)	***p***	**B (SE)**	***p***	**B (SE)**	***p***
Main Model							
	Intercept	1.28 (0.43)	**.003**	0.59 (0.40)	.145	0.03 (0.62)	.958
	Group (***L1 Mandarin*** *vs. L1 English*)	-2.64 (0.67)	**<.001**	-1.61 (0.43)	**<.001**	-0.63 (0.59)	.285
	Temporal Context (***Present Habitual*** *vs. Past*)	1.44 (0.61)	**.019**	-2.04 (0.63)	**.001**	1.52 (0.87)	.078
	Subject Number (***Singular*** *vs. Plural*)	-	-	-	-	-	-
	Group × Temporal Context	0.12 (0.15)	.868	-0.08 (0.61)	.900	0.23 (0.75)	.762
	Group × Subject Number	-	-	-	-	-	-
	Temporal Context × Subject Number	-	-	-	-	-	-
	Group × Temporal Context × Subject Number	-	-	-	-	-	-
L1 Mandarin							
	Intercept	2.34 (0.57)	<.001	0.94 (0.41)	.022	0.12 (0.58)	.842
	Temporal Context	-1.12 (0.79)	.157	-2.02 (0.62)	**.001**	1.50 (0.80)	.062
	Subject Number	-	-	-	-	-	-
	Temporal Context × Subject Number	-	-	-	-	-	-
L1 English							
	Intercept	-1.01 (0.54)	.061	-0.76 (0.76)	.315	-0.01 (0.78)	.993
	Temporal Context	-1.38 (0.64)	**.030**	1.13 (0.93)	.228	-0.97 (0.97)	.313
	Subject Number	-	-	-	-	-	-
	Temporal Context × Subject Number	-	-	-	-	-	-

2.2.3. Interim discussion

Experiment 1 showed that although L1 Mandarin speakers made errors when producing temporal inflections, with an overall accuracy rate of only 52% across conditions, they nevertheless showed sensitivity to temporal context. That is, they were more likely to produce 3SG *–s* and *-ed* inflections in a temporal context that was appropriate for those inflections than in a temporal context that was inappropriate for those inflections. However, their performance was not uniform across temporal inflections. Notably, they showed particularly low accuracy in the Present Habitual Singular Subject condition (requiring 3SG *-s*), relative to L1 English speakers' performance in the same condition, and relative to their own performance in the Past Tense conditions (requiring past *–ed*). These results suggest that L1 Mandarin speakers are able to conceptualise and linguistically encode relevant tense distinctions, but that they are not able to produce them consistently, with one inflection type being more susceptible to error than another.

In Experiment 2, I sought to replicate these findings, with a larger sample and a more robust experimental paradigm. In Experiment 1, which used speeded presentation, participants mis-recalled the verb on 8% of trials. Consequently, Experiment 2 used self-paced verb presentation to increase the proportion of valid responses.

2.3. Experiment 2

2.3.1. Methods

Participants

37 L1 Mandarin speakers of L2 English aged 20-29 (M=23.4; SD=1.8) and 36 L1 English speakers aged 19-46 (M=24.3; SD=5.5) took part in Experiment 2. In addition to the participant recruitment criteria for the L1 Mandarin group (L2 English) in Experiment 1, Mandarin participants were also required to have at least a score of 5.5 on the spoken component of the IELTS exam. Recruitment criteria for the L1 English group was identical to those in Experiment 1.

Materials

I used the images, verbs, vocabulary list and legend aid from Experiment 1, with minor adjustments to remove ambiguity in some items. Each combination of experimental verb and scene was presented only once (hence, the total number of trials was halved to 72 trials). Trial presentation was self-paced to allow participants more time to remember the verb.

Design

The experimental design was identical to Experiment 1.

Procedure

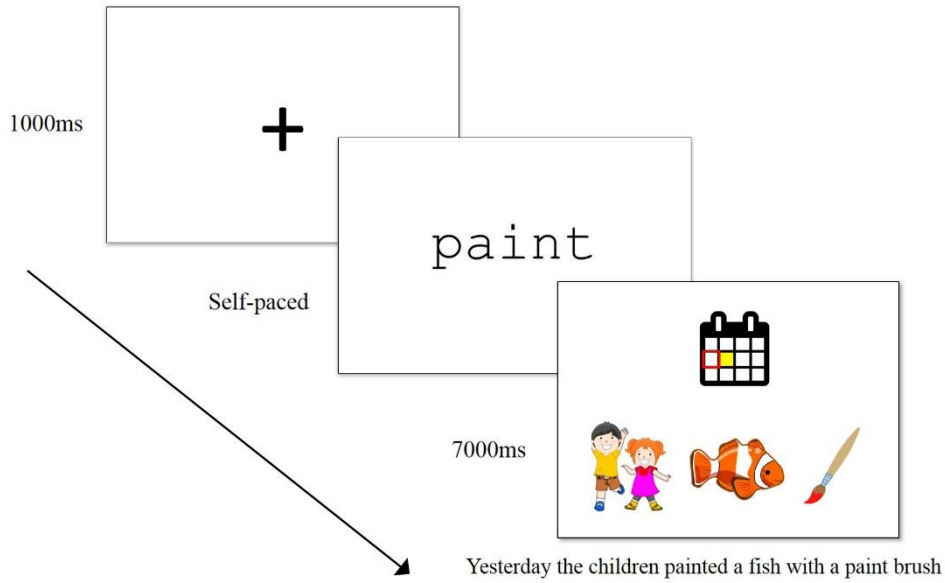


Figure 9. Experiment 2: Three-step self-paced trial procedure for the scene description task, including presentations of fixation (1000ms), target verb (self-paced) and target image (7000ms).

The experimenter followed the same protocol as Experiment 1 but emphasised the self-paced element of the scene description task (Figure 9). Before the start of the experiment, participants were reminded that they should remember the verb before viewing the action scene, use the objects in the scene from top to bottom and left to right, and avoid using auxiliary verbs in descriptions.

The trial procedure was identical to Experiment 1, except that participants controlled the progress of each trial by pressing the [**SPACE BAR**] after reading the target verb. Participants had five practice trials before commencing the 72 experimental trials. Participants were paid £5 in cash or given course credit for their time.

Coding and Scoring

The coding and scoring procedures for the scene description task were identical to Experiment 1.

2.3.2. Results

Analyses were conducted as in Experiment 1, except where otherwise stated.

Overall Inflectional Accuracy

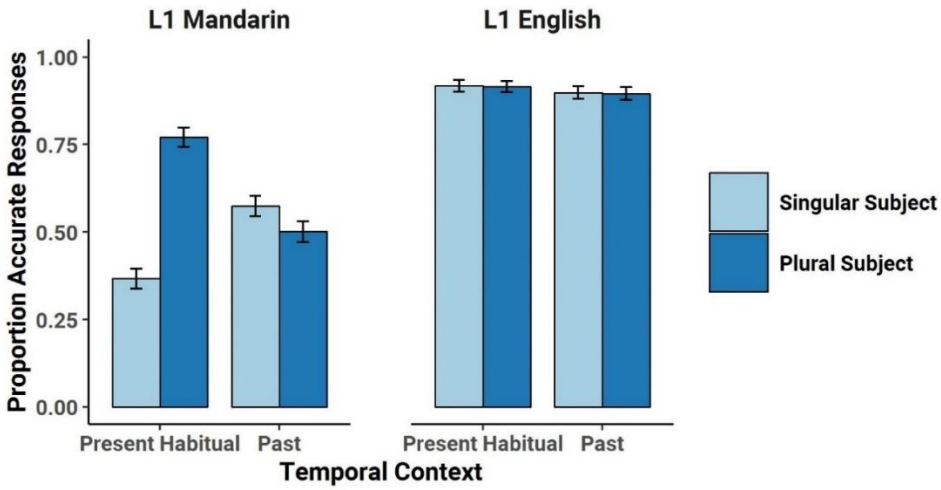


Figure 10. Experiment 2: Average proportion of accurate inflectional responses in Present Habitual and Past temporal contexts for scene description task across L1 Mandarin and L1 English groups (N=37;36). Error bars denote +/- 1 SE.

There was a significant main effect of Group and of Temporal Context, with a significant three-way interaction between Group, Temporal Context and Subject Number (Table 5). Inflectional accuracy was more variable across conditions in the L1 Mandarin group than in the L1 English group, with the L1 Mandarin group producing most accurate responses in the Present Habitual Plural Subject condition and fewest accurate responses in the Present Habitual Singular Subject condition (M= 0.77 vs. M=0.37; L1 English: M=0.92 vs. M=0.92; Figure 10).

Subgroup analyses revealed that in the L1 Mandarin group, there was a significant interaction between Temporal Context and Subject Number; in the L1 English group, there was no such interaction.

Inflectional Type

3rd person singular -s (3SG -s) responses

Group and Temporal Context were used as fixed effects predictors for the 3SG -*s* analysis BLME model. Subject Number was dropped due to a missing category problem in the L1 English group (no response for Past Plural Subject condition; Figure 12).

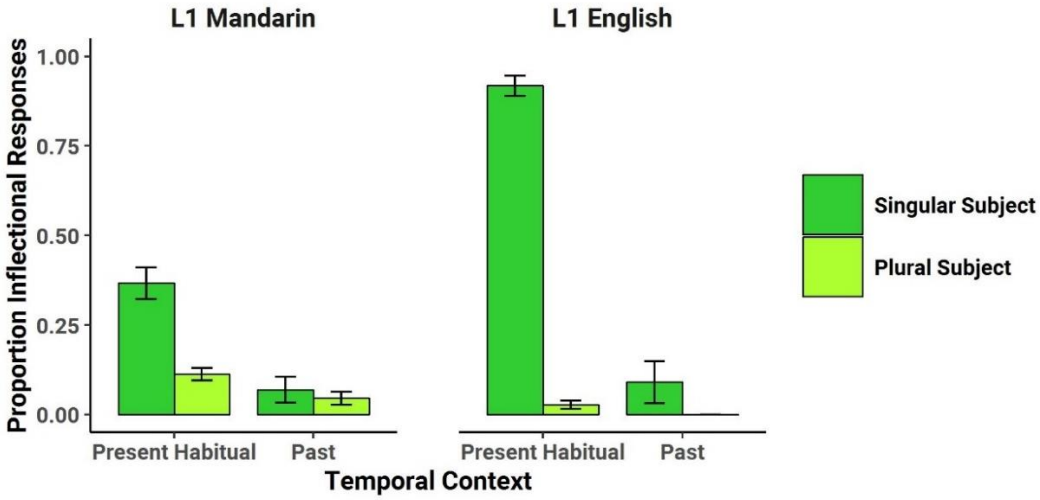


Figure 11. Experiment 2: Average proportion of 3SG -*s* inflectional production across Present Habitual and Past temporal contexts for the scene description task across L1 Mandarin and L1 English groups (N=37;36). Error bars denote +/- 1 SE.

There was a significant main effect of Group and of Subject Number, with a significant interaction between Group and Temporal Context (Table 6): Although the L1 Mandarin group produced more 3SG -*s* inflections in the Present Habitual conditions (M=0.24) than in the Past conditions (M=0.06), they did so to a lesser extent than the L1 English group (M=0.45 vs. M=0.05). Subgroup analyses revealed that in the L1 Mandarin group, Subject Number was a significant predictor, with participants being more likely to produce 3SG -*s* inflections following a singular subject than a plural subject. In the L1 English group, Subject Number was also a significant predictor.

Past –ed responses

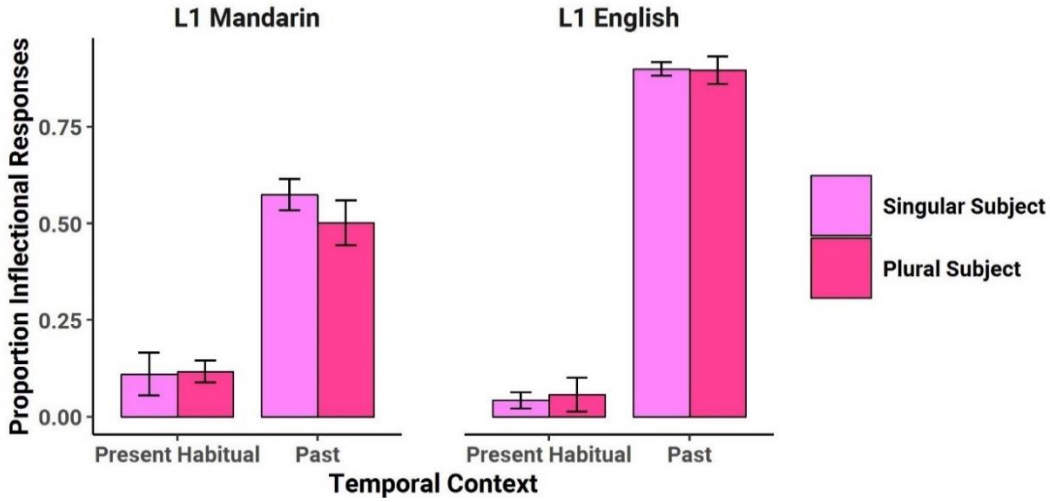


Figure 12. Experiment 2: Average proportion of past *-ed* inflectional production across Present Habitual and Past temporal contexts for the scene description task across L1 Mandarin and L1 English groups (N=48;46). Error bars denote +/- 1 SE.

There was a significant main effect of Group and of Temporal Context, with a significant two-way interaction between Group and Temporal Context (Table 7): Although the L1 Mandarin group produced more past *-ed* inflections in the Past conditions (M=0.54) than in the Present Habitual conditions (M=0.12), they did so to a lesser extent than the L1 English group (M=0.90 vs. M=0.05; Figure 12). Subgroup analyses revealed that in the L1 Mandarin group, there was a significant effect of Temporal Context but no other significant effects; likewise, in the L1 English group, there was a significant effect of Temporal Context but no other significant effects.

Inflectional Omission responses

Table 9.

Experiment 2: Number of inflectional omission responses out of all inflectional errors (in each condition) for L1 Mandarin and L1 English groups across Present Habitual and Past temporal contexts.

	L1 Mandarin	L1 English
Present Habitual Singular Subject	151/183 (83%)	11/23 (48%)
Present Habitual Plural Subject	0/55 (0%)	0/25 (0%)
Past Singular Subject	103/123 (84%)	3/28 (11%)
Past Plural Subject	129/142 (91%)	30/30 (100%)
Total	*383/503 (76%)*	*44/106 (42%)*

There was a significant main effect of Group (Table 6): The L1 Mandarin group was significantly more likely to produce inflection omission responses than the L1 English group (Table 9). There was no main effect of Temporal Context: Participants across L1 Mandarin and L1 English groups were no more likely to make omission errors in the Present Habitual contexts than in the Past contexts. There was no significant interaction between Group and Temporal Context, indicating that the effect of Temporal Context did not differ significantly between the L1 Mandarin and L1 English groups. Subgroup analyses revealed that there was no significant effect of Temporal Context in neither the L1 Mandarin nor the L1 English group.

2.3.3. Interim discussion

Experiment 2 replicated the finding that although L1 Mandarin participants made errors when producing temporal inflections, they nevertheless showed sensitivity to temporal context. As in Experiment 1, they showed particularly low accuracy in the Present Habitual Singular Subject condition (requiring 3SG *-s*), relative to L1 English speakers' performance in the same condition, and relative to their own performance in the Past Tense conditions (requiring *–ed*).

These results provide further evidence that L1 Mandarin speakers are able to conceptualise and linguistically encode relevant tense distinctions, but are not able to

produce them consistently. They also replicate the pattern whereby the (featurally complex) 3SG *–s* inflection is more susceptible to error than the (featurally less complex) Past *–ed* inflection. However, whether this difference was due to inconsistent retrieval of inflectional forms or errors in oral articulation could not be determined.

In Experiment 3, I therefore examined whether these patterns of inflectional error would remain when participants did not orally articulate their responses. To do this, I used the same task as Experiment 2, but asked participants to produce typed responses on a computer keyboard instead. If L1 Mandarin participants' inflectional errors in Experiments 1 and 2 resulted from oral articulatory failures alone, we should see significantly higher inflectional accuracy in Experiment 3 compared to Experiment 2. On the other hand, if retrieval failures accounted for the inflectional errors previously observed, similar patterns of inflectional production should remain even with the articulatory component of the task removed.

2.4. Experiment 3

2.4.1. Methods

Participants

48 L1 Mandarin speakers of L2 English aged 18-31 (M=22.88; SD=2.26) and 46 monolingual L1 English speakers aged 17-20 (M=18.20; SD=0.74) participated in Experiment 3. Participants were recruited based on identical criteria as Experiment 2 with no additional requirements.

Materials

24 experimental items and 24 filler items were used from Experiment 2 (retaining 12 of the 18 verbs: six experimental + six filler verbs) in order to shorten the experimental session (as participants were considerably slower to produce typed than spoken responses). The trial structure, experimental legend and illustrative trial examples were identical to Experiment 2. Individual images of animal, place, food, activity etc. were labelled with their corresponding names (e.g. dog, park etc.) were created as JPGs as part of a vocabulary training session (Appendix D).

Procedure

Prior to the formal experimental session, participants passively viewed images with their corresponding names as part of a vocabulary training session in order to familiarise themselves with the trial images. The instructions for the scene description task were identical to Experiment 2 except that participants were told that during each action scene presentation, they must type out their descriptions on a keyboard, with no option to edit their responses, i.e., written scene description task. The duration of each action scene was increased to 15000 ms to reflect the response modality. Afterwards, participants were paid £5 for their time.

Coding and Scoring

The coding and scoring procedures for the written scene description task were identical to Experiment 1 and 2.

2.4.2. Results

Overall Inflectional Accuracy

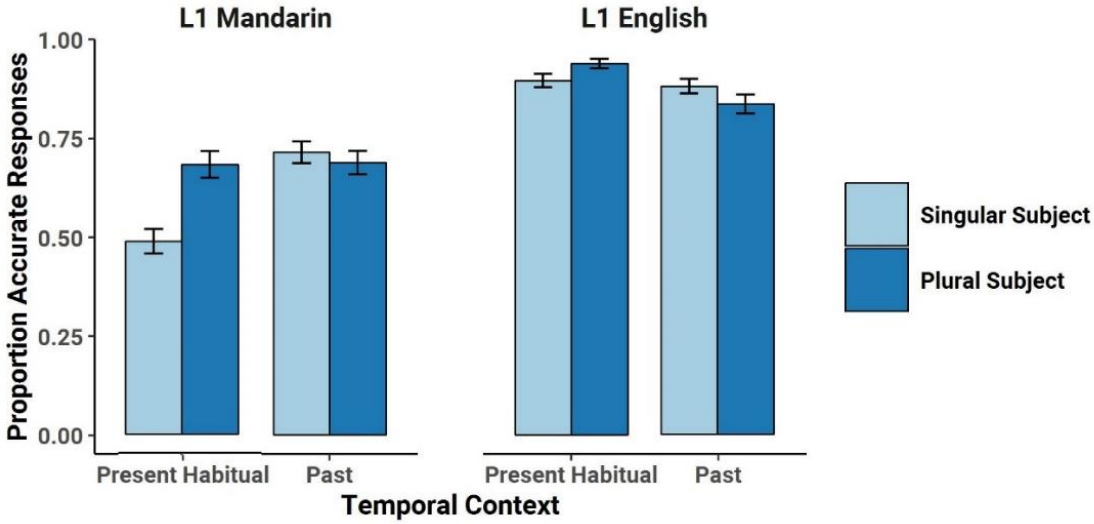


Figure 13. Experiment 3: Average proportion of accurate inflectional responses in Present Habitual and Past temporal contexts for the scene description task across L1 Mandarin and L1 English groups (N=48;46). Error bars denote +/- 1 SE.

There was a significant main effect of Group, with a significant interaction between Group and Temporal Context (Table 5). Inflectional accuracy was more variable across temporal conditions in the L1 Mandarin group than in the L1 English group, with the L1 Mandarin group showing a greater disparity between performance in the Past and Present Habitual conditions than the L1 English group (L1 Mandarin M= 0.72 vs. M=0.60; L1 English: M=0.88 vs. M= 0.93; Figure 13). Notably, however, there was not a significant three-way interaction between Group, Temporal Context, and Subject Number.

Subgroup analyses revealed that in the L1 Mandarin group, there were significant effects of Temporal Context and Subject Number, and a significant interaction between Temporal Context and Subject Number. In the L1 English group, there was a significant effect of Temporal Context and a significant interaction between Temporal Context and Subject Number interaction; however, there was not a significant effect of Subject Number,

Inflectional Type

3rd Person Singular -s responses

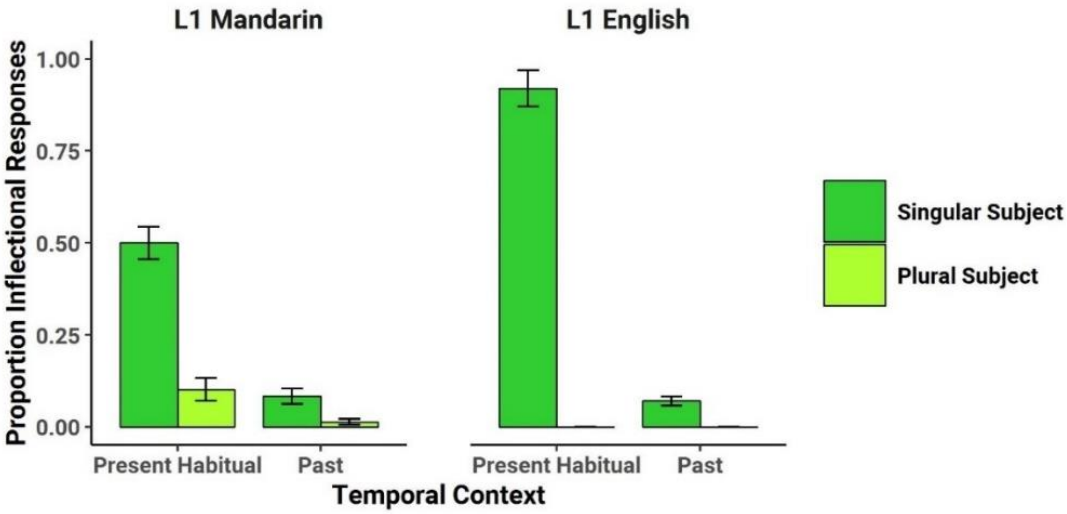


Figure 14. Experiment 3: Average proportional production of 3SG *-s* inflection across Present Habitual and Past temporal contexts for the scene description task across L1 Mandarin and L1 English groups. (N=48;46) Error bars denote +/- 1 SE.

There was a significant main effect of Group and of Temporal Context, with a significant interaction between Group and Temporal Context (Table 6): Although the L1 Mandarin group produced more 3SG *-s* inflections in the Present Habitual conditions (M=0.30) than in the Past conditions (M=0.05), they did so to a lesser extent than the L1 English group (M=0.46 vs. M=0.04; Figure 14).

Subgroup analyses revealed that in the L1 Mandarin group, there was a significant effect of Subject Number, with participants more likely to produce 3SG *-s* inflections following a singular subject than a plural subject; there was also a

significant interaction between Temporal Context and Subject Number, with participants most likely to produce 3SG *-s* inflections in the Present Habitual Singular Subject condition. In the L1 English group, there was a significant effect of Temporal Context.

Past –ed responses

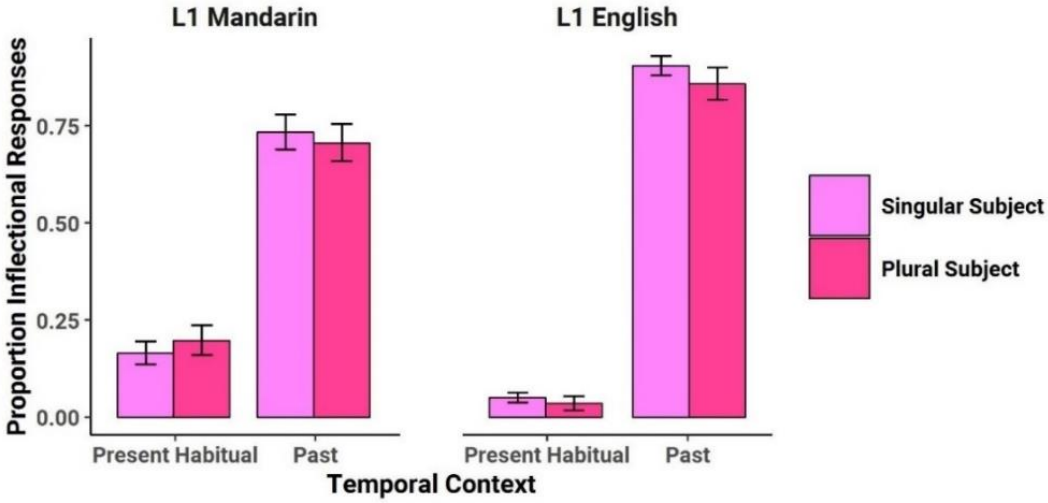


Figure 15. Experiment 3: Average proportional production of past *-ed* inflection across Present Habitual and Past temporal contexts for the scene description task across L1 Mandarin and L1 English groups. (N=48;46) Error bars denote +/- 1 SE.

There was a significant main effect of Temporal Context, with a significant two-way interaction between Group and Temporal Context (Table 7): Although the L1 Mandarin group produced more past *-ed* inflections in the Past conditions (M=0.72) than in the Present Habitual conditions (M=0.19), they did so to a lesser extent than the L1 English group (M=0.88 vs. M=0.05; Figure 15). Subgroup analyses revealed that in the L1 Mandarin group, there was a significant effect of Temporal Context but no other significant effects; likewise, in the L1 English group, there was a significant effect of Temporal Context but no other significant effects.

Inflectional Omission responses

Table 10.

Experiment 3: Number of inflectional omission responses out of all inflectional errors (in each condition) for L1 Mandarin and L1 English groups across Present Habitual and Past temporal contexts.

	L1 Mandarin	L1 English
Present Habitual Singular Subject	83/124 (67%)	7/19 (37%)
Present Habitual Plural Subject	0/53 (0%)	0/8 (0%)
Past Singular Subject	46/67 (69%)	6/23 (26%)
Past Plural Subject	63/66 (95%)	29/29 (100%)
Total	*192/410 (47%)*	*42/79 (53%)*

There were no significant effects of Group but there was a marginal effect of Temporal Context in the main analysis (Table 8). There was a marginal effect of Temporal Context in the L1 Mandarin group but not the L1 English group in the subgroup analysis (Table 10).

Between Experiment Comparisons

Three sets of analyses were conducted concerning the effect of production modality (spoken vs. written) on inflectional accuracy, inflectional type (3SG *-s* and past *-ed*), and inflectional omission (including existing predictors Group, Temporal Context and Subject Number). Data from Experiment 2 and Experiment 3 were combined, including only verbs which were common across the two experiments (verbs which were used in Experiment 2 but not Experiment 3 were excluded). For full statistics, see Tables 11-14.

There was no significant main effect of Modality on inflectional accuracy overall. Participants overall were not more likely to produce an accurate response in the written modality (M=0.79) compared with the spoken modality (M=0.73). Interestingly, there was a two-way interaction between Group and Subject Number irrespective of Modality. There were greater differences between singular and plural subjects in the L1 Mandarin group than the L1 English group (L1 Mandarin: M=0.57

vs. 0.67; L1 English: M= 0.91 vs. 0.91). There was a three-way interaction between Group, Temporal Context and Modality and a four-way interaction also including Subject Number (Table 11). Subgroup analyses reveal a similar picture. Different from within-experiment analyses previously, there were significant effects of Temporal Context for both L1 Mandarin and L1 English groups. However, two groups show different effects of temporal context. Whilst L1 Mandarin speakers were less likely to produce accurate inflections in the Present Habitual than the Past Context irrespective of production modality (M = 0.59 vs. M = 0.63), L1 English were more likely to produce accurate responses in the Present Habitual Context than the Past Context (L1 English: M= 0.93 vs. M = 0.89). Critically, a significant main effect of Modality was not found in neither the L1 Mandarin nor the L1 English group. Interestingly, whilst there was a two-way interaction between Temporal Context and Modality, and a three-way interaction between Temporal Context, Subject Number and Modality for the L1 Mandarin group, there were no such interactions for the L1 English group.

For 3SG *-s* production, there was no significant main effect of Modality overall. Participants were not more likely to produce 3SG *-s* in the written modality (M=0.21) compared with the spoken modality (M=0.21). Modality did not interact with any other predictors (Group, Temporal Context and Subject Number). Subgroup analyses did not reveal any significant effects of Modality, nor any interactions (Table 12).

For past *-ed* production, there was no significant main effect of Modality. Similar to 3SG *-s*, participants were not more likely to produce past *-ed* in the written modality (M=0.46) compared with the spoken modality (M=0.40). The interaction between Group and Modality was close to significance (Table 13). Subgroup analyses revealed a significant effect of Modality for the L1 Mandarin group for past *-ed* production, but not for the L1 English group. No other interactions were found involving Modality in either group.

For inflectional omissions, there was a marginal main effect of Modality overall (Table 14): Numerically, participants omitted fewer inflections in the written modality than the spoken modality (Tables 5 and 11). There was also a marginal

interaction between Group and Modality. Subgroup analyses revealed a significant main effect of Modality on inflectional omission for the L1 Mandarin group, but not the L1 English Group: L1 Mandarin participants were more likely to make omission errors in the spoken modality than in the written modality, but the L1 English participants made very few errors overall and were close to ceiling levels in terms of accuracy in both modalities.

Table 11.

Experiments 2 and 3: Between-experiment analyses on the effect of production modality on inflectional accuracy.

		B (SE)	***p***
Main Model			
	Intercept	1.73 (0.11)	**< .001**
	Group ***(L1 Mandarin** vs. L1 English)*	-2.27 (0.21)	**<.001**
	Temporal Context ***(Present Habitual** vs Past)*	0.23 (0.11)	**.039**
	Subject Number ***(Singular** vs Plural)*	0.33 (0.11)	**.004**
	Modality ***(Spoken** vs Written)*	0.24 (0.21)	.246
	Group × Temporal Context	-1.09 (0.23)	**<.001**
	Group × Subject Number	-0.44 (0.23)	**.048**
	Group × Modality	-0.40 (0.41)	.324
	Temporal Context × Subject Number	-1.22 (0.23)	**<.001**
	Temporal Context × Modality	0.18 (0.23)	.422
	Subject Number × Modality	-0.07 (0.23)	.749
	Group × Temporal Context × Subject Number	0.74 (0.46)	.104
	Group × Temporal Context × Modality	-1.06 (0.46)	**.020**
	Group × Subject Number × Modality	0.43 (0.46)	.341
	Temporal Context × Modality × Subject Number	-0.20 (0.46)	.652
	Group × Temporal Context × Subject Number × Modality	-2.43 (0.92)	**.008**

(Table 11 continued)

L1 Mandarin			
	Intercept	0.57 (0.11)	**<.001**
	Temporal Context	0.31 (0.12)	**.008**
	Subject Number	0.54 (0.12)	**<.001**
	Modality	0.43 (0.23)	.056
	Temporal Context × Subject Number	-1.56 (0.23)	**<.001**
	Temporal Context × Modality	0.71 (0.23)	**.002**
	Subject Number × Modality	-0.28 (0.23)	.226
	Temporal Context × Subject Number × Modality	1.01 (0.47)	**.031**
L1 English			
	Intercept	3.03 (0.22)	**<.001**
	Temporal Context	-0.80 (0.20)	**<.001**
	Subject Number	0.11 (0.20)	.582
	Modality	0.05 (0.39)	.901
	Temporal Context × Subject Number	-0.87 (0.40)	**.029**
	Temporal Context × Modality	-0.35 (0.40)	.380
	Subject Number × Modality	0.13 (0.40)	.752
	Temporal Context × Subject Number × Modality	-1.45 (0.80)	.070

Table 12.

Experiments 2 and 3: Between-experiment analyses on the effect of production modality on 3SG -s production.

		B (SE)	***p***
Main Model			
	Intercept	-1.83 (0.08)	**<.001**
	Group ***(L1 Mandarin** vs. L1 English)*	0.24 0(.15)	.122
	Temporal Context ***(Present Habitual** vs. Past)*	-2.64 (0.13)	**<.001**
	Modality ***(Spoken** vs. Written)*	-0.01 (0.15)	.941
	Group × Temporal Context	-1.01 (0.26)	**<.001**
	Group × Modality	-0.05 (0.31)	.882
	Temporal Context × Modality	-0.25 (0.26)	.342
	Group × Temporal Context × Modality	0.20 (0.52)	.695
L1 Mandarin	Intercept	-2.11 (0.14)	**<.001**
	Temporal Context	-2.26 (0.18)	**<.001**
	Modality	0.06 (0.27)	.817
	Temporal Context × Modality	-0.31 (0.35)	.373
L1 English	Intercept	-1.67 (0.10)	**<.001**
	Temporal Context	-3.05 (0.19)	**<.001**
	Modality	-0.06 (0.19)	.752
	Temporal Context × Modality	-0.14 (0.38)	.705

Table 13.

Experiments 2 and 3: Between-experiment analyses on the effect of production modality on past -ed production.

		B (SE)	*p*
Main Model			
	Intercept	-0.68 (0.15)	**<.001**
	Group ***(L1 Mandarin** vs. L1 English)*	0.35 (0.30)	.251
	Temporal Context ***(Present Habitual** vs Past)*	5.29 (0.20)	**<.001**
	Subject Number ***(Singular** vs Plural)*	-0.12 (0.14)	.393
	Modality ***(Spoken** vs Written)*	0.39 (0.30)	.199
	Group × Temporal Context	3.76 (0.37)	**<.001**
	Group × Subject Number	-0.17 (0.27)	.543
	Group × Modality	-1.05 (0.61)	.098
	Temporal Context × Subject Number	-0.46 (0.28)	.086
	Temporal Context × Modality	-0.24 (0.36)	.495
	Subject Number × Modality	-0.29 (0.28)	.296
	Group × Temporal Context × Subject Number	0.12 (0.55)	.822
	Group × Temporal Context × Modality	-0.82 (0.71)	.248
	Group × Subject Number × Modality	0.84 (0.55)	.130
	Temporal Context × Subject Number × Modality	0.22 (0.56)	.689
	Group × Temporal Context × Subject Number × Modality	-0.01 (1.11)	.993

(Table 13 continued)

L1 Mandarin			
	Intercept	-0.85 (0.20)	**<.001**
	Temporal Context	3.38 (0.18)	**<.001**
	Subject Number	-0.03 (0.15	.824
	Modality	0.91 (0.39)	**.021**
	Temporal Context × Subject Number	-0.52 (0.30)	.080
	Temporal Context × Modality	0.17 (0.34)	.621
	Subject Number × Modality	0.13 (0.30)	.660
	Temporal Context × Subject Number × Modality	0.23 (0.60)	.706
L1 English			
	Intercept	-0.51 (0.23)	**.029**
	Temporal Context	7.26 (0.39)	**<.001**
	Subject Number	-0.20 (0.23)	.383
	Modality	-0.13 (0.47)	.774
	Temporal Context × Subject Number	-0.40 (0.47)	.389
	Temporal Context × Modality	-0.68 (0.64)	.289
	Subject Number × Modality	-0.71 (0.47)	.129
	Temporal Context × Subject Number ×Modality	0.21 (0.94)	.820

Table 14.

Experiments 2 and 3: Between-experiment analyses on the effect of production modality on inflectional omissions.

		B (SE)	***p***
Main Model			
	Intercept	0.80 (0.17)	**<.001**
	Group *(**L1 Mandarin** vs. L1 English)*	-1.33 (0.36)	**<.001**
	Temporal Context *(**Present Habitual** vs. Past)*	1.53 (0.22)	**<.001**
	Modality *(**Spoken** vs. Written)*	-0.63 (0.33)	.060
	Group × Temporal Context	0.74 (0.59)	.208
	Group × Modality	1.18 (0.73)	.104
	Temporal Context × Modality	0.19 (0.44)	.673
	Group × Temporal Context × Modality	0.28 (1.17)	.811
L1 Mandarin	Intercept	1.07 (0.21)	**<.001**
	Temporal Context	1.40 (0.25)	**<.001**
	Modality	-0.88 (0.41)	**.035**
	Temporal Context × Modality	0.13 (0.50)	.791
L1 English	Intercept	-0.24 (0.25)	.330
	Temporal Context	1.85 (0.49)	**<.001**
	Modality	0.24 (0.50)	.633
	Temporal Context × Modality	0.38 (0.91)	.679

2.4.3. Interim discussion

Experiment 3 replicated the key findings of Experiments 1 and 2 in the written modality (which did not require articulation): L1 Mandarin speakers showed sensitivity to temporal context, but exhibited particularly low accuracy in the Present Habitual Singular Subject condition (requiring 3SG *-s*), relative to L1 English speakers' performance in the same condition, and relative to their own performance in the Past Tense conditions (requiring *–ed*). Critically, although L1 Mandarin speakers were not statistically less likely to be accurate in the spoken modality (Experiment 2) than in the written modality (Experiment 3), they were more likely to make omission errors in the spoken modality than in the written modality. L1 English speakers did not show such effects. These findings are consistent with a processing account of inflectional errors, based on inconsistent retrieval of inflectional forms; they are not compatible with an account that attributes inflectional errors purely to articulatory difficulties.

2.5. General Discussion

Previous research has established that L2 speakers frequently produce inflectional errors but has not reached consensus over the loci of such errors. Specifically, it is unclear whether erroneous inflectional production arises from deficits in representation or processing, and where within the production system such deficits might be located.

In Experiments 1 and 2, both L1 Mandarin and L1 English participants produced spoken descriptions, and in Experiment 3, they produced written descriptions. Predictably, in all three experiments, L1 Mandarin speakers produced less accurate inflections than L1 English speakers in both Present Habitual and Past temporal contexts. However, like L1 English speakers, L1 Mandarin speakers were also more likely to produce the correct inflectional markings under appropriate contexts than inappropriate contexts. This pattern held for both 3SG *-s* and past *-ed*, with a higher proportion of past *-ed* produced across all three experiments. Particularly, this pattern

also held across spoken and written production, with higher inflectional accuracy for written production, though this was not statistically significant.

2.5.1. The Locus of L2 Inflectional Errors

These results are informative about the nature of L2 speakers' erroneous inflectional production within a processing model of language production and cast light on previous accounts that have been proposed from a theoretical linguistic perspective. Taking these results as a whole, our spoken and written L2 production data provide compelling evidence that errors in L2 inflectional production more likely reflect processing breakdowns rather than representational deficits. At the start of this paper, I outlined possible sources of error in L2 inflectional production within current models of language production (Levelt, 1989; Levelt et al., 1999), together with linguistic accounts of L2 inflectional errors (Hawkins & Chan,1997; Prevost & White, 2000; Goad et al., 2003). Representational deficits and processing breakdowns are implicated at multiple stages of language production. These include conceptualization failures, missing or inconsistent activation of lemma level diacritic features, missing or inconsistent association between syntactic functions, inconsistent lexical retrieval and articulation failures. Current findings are consistent with some but not all of these accounts.

We first consider possible representational deficits at multiple stages of language production and evaluate the implications of our data. First, we consider the possibility of conceptualization failures as a potential source of error during inflectional production. Under this account, if an L1 Mandarin speaker did not have conceptual distinctions necessary for inflectional morphology, they would omit L2 inflections across the board regardless of modality. Our findings contradict this claim. L1 Mandarin speakers produced inflections with 55% (Exp. 2) and 66% (Exp. 3) accuracy in spoken and written modality across conditions, and were more likely to produce both 3SG *–s* and past *-ed* inflections in appropriate temporal contexts than in inappropriate temporal contexts. This indicates that L1 Mandarin speakers were sensitive to L2 temporal distinctions at the level of conceptualization, refuting the idea of representational and processing deficits at the conceptual level.

Second, we turn to the possibility that inflectional errors are the consequence of missing diacritic features (e.g. tense) at the lemma level. If this were true, speakers without relevant diacritic representations at the lemma level in their L1 would be unable to make the syntactic distinctions for producing inflectional morphology entirely. This would again predict that L1 Mandarin speakers of English would omit inflections across the board. Current findings suggest otherwise: Consistent with previous accounts of 'optional' inflectional production in second language acquisition research (i.e., sometimes producing and sometimes omitting the appropriate inflection), our participants' inflectional production was systematically variable. L1 Mandarin speakers of English systematically produced both 3SG *-s* and past *-ed* consistent with temporal context, indicating that they had not only acquired the underlying temporal distinctions, but also the syntactic distinctions for subsequent retrieval of inflectional forms.

Third, an alternative possibility would be that representational deficits at the lemma level could lead to random production of inflections, whereby L2 speakers would fail to associate syntactic functions with appropriate diacritic features (e.g., activating the values 3rd and **SINGULAR** for a verb lemma's **PERSON** and **NUMBER** diacritic features respectively, following a 3rd person singular subject). This account would predict no significant differences in the production of inflections across temporal contexts and subject number. Again, our data clearly refute this assumption. It is also clear from the appropriate use of 3SG *-s* in particular that L1 Mandarin participants were able to carry out appropriate syntactic assignment for subject number, even though 3SG *-s* production was poorer overall.

Hence our data clearly demonstrate that erroneous inflectional production was not the result of failure to acquire relevant diacritic representations or syntactic associations. As such, they argue against Hawkins and Chan's (1997) *Failed Functional Feature Hypothesis*, which claimed that it was not possible for L2 speakers to acquire grammatical features which do not exist in the speaker's L1. Our findings demonstrate that L2 speakers of English whose L1 does not use inflectional morphology were capable of acquiring L2 temporal distinctions and inflectional features after the critical period (all our participants acquired L2 English after age 5).

Instead, our results are in line with accounts which attribute inflectional error to processing breakdowns. Within a psycholinguistic model of production, inflectional errors could be caused by a processing breakdown which failed to activate the relevant diacritic features at the lemma level and the appropriate syntactic associations, which in turn would lead to failure to activate the corresponding inflectional forms (in the same way as speech errors can arise in L1 production; Dell et al., 1997). This account would predict that speakers' production of production of specific inflectional forms would be sensitive to temporal context, but that it would be susceptible to error especially under processing load (e.g., time constraints), and would show an effect of featural complexity. Particularly, considering the number of links between lemma level representations and inflectional forms, inflections involving more complex features (e.g., distinctions based on both subject number and tense) would rely on accurate activation of multiple feature nodes, making successful retrieval less likely. This stands in contrast with inflection markings involving singular or less complex features (e.g. tense only), which only require activation from one feature node, making successful retrieval more likely.

Our findings are compatible with this account. Our L2 speakers were sensitive to temporal context, but nevertheless produced errors in terms of sometimes omitting to produce inflections required (in linguistic terms, optionality). Moreover, 3SG *-s*, requiring both subject number and tense information, was more frequently omitted than past *-ed*. These findings therefore support Hawkins' (2007) account of featural complexity, and are consistent with data from Chondrogianni and Marinis (2012), where 3SG *-s* was found to be more difficult to produce accurately than past *-ed*. This finding can be viewed in conjunction with Dell et al.'s (1997) theory of L1 speech errors, where speech production errors in aphasic patients can be explained by inappropriate weights between connections during transmission of activation. If the same principle applies in the case of L2 production, the speaker may have inappropriately weighted connections between feature nodes for activating the correct inflectional form where context requires it. Such inappropriate weights between node connections might be the result of L1 transfer.

Our findings are also compatible with Prevost and White's (2000) *Missing Surface Inflection Hypothesis*. Under this account, inaccurate or optional production

of inflections was attributed to difficulties in morphological encoding and activating the relevant inflectional forms rather than representational deficits. By implication, this indicates fundamentally a processing difficulty where inflections containing more complex features (i.e., 3SG -*s*) should be more susceptible to this difficulty. In our study, L1 Mandarin participants still processed L2 temporal and subject number information during L2 inflectional production (more 3SG -*s* responses than any other context). This suggested difficulties in activation and integration during retrieval of inflectional forms rather than the lack of representations. Note that the current data cannot tease apart activation of features and retrieval of inflectional forms.

Turning to an account locating L2 speakers' inflectional errors in articulation failures, production data across spoken (Exp. 2) and written (Exp. 3) modalities were especially revealing on the role of articulation in inflectional production. Despite the overall increase in inflectional accuracy by L1 Mandarin speakers of English in written compared with spoken production, inflectional error patterns from spoken production persisted in written production even when no overt articulation was involved. This clearly indicated that articulation difficulties alone were not the primary cause of inflectional errors and cannot solely account for erroneous inflectional production. The source of inflectional error must primarily occur earlier on in the production process. However, this does not preclude potential phonological processing difficulties in the L2 that might contribute to higher incidence of errors in spoken production. Additionally, the higher inflectional accuracy in the written modality (i.e. *'writing'* on a keyboard) might be linked to the increased response time permitted in Experiment 3 (Experiments 1 and 2: 7000ms; Experiment 3: 15000ms), which gave L1 Mandarin speakers more time to activate morphological representations and retrieve corresponding lexical forms.

2.5.2. Limitations and Future Directions

Experiments 1, 2 and 3 provide convincing evidence that patterns of inflectional errors are likely to be down to processing breakdowns, but is unable to tease apart different types of processing breakdowns (e.g. activation of diacritic features and

retrieval failures). Moreover, current evidence cannot tease apart processing and articulatory difficulties in the current data.

Assuming that phonological mediation occurs in both spoken and written production (Chenoweth & Hayes, 2003; Friederici, Schoenle, & Goodglass, 1981; Zhang & Damian, 2010), it remains plausible that discrepancies in L1 and L2 phonological properties constrained the speaker's ability to encode relevant phonemes correctly. In Levelt's terms, difficulties in phonological and phonetic processing (perhaps due to L1 phonotactics) could restrict native-like formation of the phonetic plan (or inner speech), resulting in difficulties in the execution of articulatory or orthographic motor gestures. In other words, even if the message is not intended for oral articulation, the generation of the phonological word and phonetic plan would still be necessary for written production. In the context of our study, neither 3SG *-s* nor past *-ed* in the word final position are plausible phoneme combinations in Mandarin Chinese. One may speculate whether all L2 phoneme combinations, especially those which are not permitted, can be effectively planned during phonological and phonetic encoding, and in turn executed during inflectional production.

As L1 Mandarin speakers of English in the current study have all acquired English after the first critical period (AoA > 5 years), one additional consideration could be given to the role of explicit or metalinguistic knowledge in real-time production. In Levelt's terms, explicit knowledge could be a way for post critical period learners to establish lemma level representations (diacritic features) and their associated morphological forms. However, this does not necessarily mean L2 learners can activate these representations consistently during real-time production. In other words, explicit knowledge enables 'competence' at a representational level, but does not necessarily enable proficient 'performance' at a processing level. Though explicit knowledge may not be critical for the accurate inflectional production of 3SG *-s* and past *-ed* for all learners, but given the age of L2 acquisition of our participants, the application of explicit metalinguistic knowledge during production is likely to be crucial, especially for less proficient L2 speakers.

One last question concerns how L2 knowledge could be acquired for late L2 learners. One may speculate whether L1 Mandarin speakers initially viewed tense inflections as functionally equivalents to Mandarin aspectual markers. Specifically, L1 Mandarin speakers might map past *-ed* onto the Mandarin aspectual marker *le* for functional use. This would be consistent with the core principle of the *Feature Reassembly Hypothesis* (Lardiere, 2008), which could explain the high proportion of past *-ed* responses to past perfective aspect events.

Taking these results as a whole, they provide compelling evidence through both spoken and written L2 production, that erroneous L2 inflectional production is more likely a processing problem, rather than a representational one. More importantly, these findings have been interpreted in terms of both psycholinguistic framework of language production and linguistic theories of L2 inflectional error. What is most valuable in the current context is the attempt to reconcile these two perspectives in their theoretical assumptions and predictions, highlighting areas where the two perspectives complement each other, as well as areas where the two sets of theories fall short.

Chapter 3

The effect of comprehension modality on L2 inflectional processing in L1 Mandarin learners of L2 English

Second language (L2) comprehension is difficult for L2 learners, which may be exacerbated when the learner's L1 does not draw information from the same semantic or morphosyntactic cues for meaning as the L2. Additionally, L2 learners may find comprehension more difficult under greater cognitive load. Two self-paced comprehension experiments investigated whether L1 Mandarin learners of L2 English could show sensitivity to semantic and morphosyntactic mismatches from temporal adverbials and inflectional morphemes (which do not exist in Mandarin) during real-time sentence processing, and whether this sensitivity is affected by comprehension modality. Advanced L1 Mandarin learners of L2 English and L1 English controls either listened to (Experiment 4) or read (Experiment 5) English sentences in a self-paced moving-window paradigm. Results showed that L1 Mandarin learners of L2 English exhibited non-native like sensitivity to omission of inflectional morphemes compared with L1 English speakers, suggesting that L2 learners are sensitive to lexical and morphosyntactic mismatches during L2 comprehension, even if similar morphosyntactic features do not exist in the learners' L1. Critically, whilst L1 Mandarin learners of L2 English showed sensitivity to omission of inflectional morphemes during auditory (listening) comprehension, they did not during visual (reading) comprehension. These results suggest that auditory comprehension is not invariably more difficult for L2 learners; rather, sensitivity to grammatical violations (i.e. omission of inflections) can in some contexts be facilitated by perceptually salient auditory cues.

3.1. Introduction

Second language (L2) comprehension is a cognitively demanding task for L2 learners, especially for those who acquired the L2 during or after puberty (Johnson & Newport, 1989; Segalowitz & Segalowitz, 1993). Not only does L2 comprehension require the learner to have broad L2 lexical and grammatical knowledge, but it also requires the learner to use L2 lexical and grammatical cues to understand L2 sentences in real-time. Whilst L2 vocabulary and grammatical knowledge can be explicitly learnt in the classroom, native-like comprehension mechanisms - which allows the learner to implicitly assimilate information from linguistic cues in real-time - can be much more difficult for L2 learners to acquire. This is especially the case when the L2 contains features that do not exist in the speaker's first language (L1). For example, the acquisition and processing of English inflectional morphology for L1 Mandarin speakers of L2 English.

Inflectional morphology marks both semantic and syntactic information (e.g., person, number, tense, aspect etc.), and its use is reflective of the syntactic structure and semantic information contained in the surrounding sentence or discourse (Marslen-Wilson, 2007). In order to understand morphosyntactic information represented by inflectional markings, the listener or reader must not only have a good command of grammatical knowledge, but must also be able to readily assimilate information within the grammatical context. For example, in a sentential context, native-like processing of inflectional morphology requires the listener or reader to know the conditions upon which the use of an inflectional marking (e.g. past *-ed*) is appropriate, as well as the ability to assimilate lexical (e.g. subject, temporal adverbial) with morphosyntactic cues (e.g. inflectional morphology) incrementally in real-time. If the listener or reader is able to do this, then any mismatches between these cues which violates L2 learners' grammatical knowledge will result in processing difficulties.

How do learners use L2 linguistic features for L2 comprehension when similar features do not exist in the learner's L1? Two possibilities could be considered. On the one hand, learners might use their existing L1 comprehension mechanisms (or L1 implicit knowledge), so that they extract limited information from L2 input. On the other hand, advanced L2 learners might develop a new set of comprehension mechanisms (or L2 implicit knowledge) as part of the L2 acquisition process, so that they become sensitive to lexical and morphosyntactic mismatches from L2 input in a native-like manner, though they may be substantially slower than L1 speakers. Whilst considerable L2 processing research has focused on the parsing of ambiguous sentences, syntactic dependencies and agreement mismatches for evidence of native-like sentence processing (e.g. Jiang, 2004; 2007; Juffs & Harrington, 1995; 1996; Marinis, Roberts, Felser, & Clahsen, 2005; Papadopoulou & Clahsen, 2003; Roberts & Felser, 2011 etc.), not a great deal of attention has been paid to L2 learners' real-time sensitivity to mismatches between lexical and morphosyntactic cues relating to temporal information in sentential contexts (but see Roberts & Liszka, 2013). Moreover, direct comparisons focusing on how comprehension across auditory and visual modalities affect this process has not been made.

In this chapter, I focus on how L1 Mandarin learners of L2 English comprehend English inflectional morphology (3rd person *-s* or past *-ed*) across auditory (listening) and visual (reading) modalities. I test whether L1 Mandarin speakers are sensitive to mismatches involving these inflectional morphemes during L2 English comprehension, given that the tense feature underlying inflectional morphology is absent (and therefore not grammaticalized) in Mandarin but obligatory in English. Previous research has shown that inflections containing more complex information (e.g. tense and number for 3rd person singular *-s*) are more difficult for L2 learners to produce consistently than inflections containing less complex information (e.g. tense for past *-ed*; Chondrogianni & Marinis, 2012), but it is not yet clear whether information complexity would affect the use of morphological cues during comprehension. Hence, I investigate whether L1 Mandarin learners experience different levels of processing difficulties depending the amount of information contained within the inflectional morpheme. Moreover, previous research has shown that L2 auditory comprehension is disadvantaged compared with L2 visual

comprehension in grammaticality judgement tasks (Haig, 1991; Johnson, 1992; Murphy, 1997), as it involves additional speech segmentation (Anderson, 1980) and time pressure (Johnson, 1992). It is unclear if this disadvantage would persist if speech is readily segmented. It is also unclear whether this disadvantage would still apply during 'normal' comprehension, i.e., with the goal of determining a semantic interpretation without explicit grammaticality judgement (as previously seen in Jackson & Bobb, 2009; Jackson & Dussias, 2009). Therefore, I also seek to examine cross-modality differences during morphological processing in L1 and L2 English groups in a semantic-oriented comprehension task.

To summarise, the current study investigates whether L1 Mandarin speakers are sensitive to lexical and morphosyntactic mismatches between temporal adverbials and inflectional morphology during real-time L2 comprehension, and whether they exhibit different levels of sensitivity to inflectional morphemes contingent on the complexity of morphosyntactic features. Most significantly, I examine whether processing modality (auditory or visual) modulates L2 learners' sensitivity to inflectional omissions.

3.1.1. Fundamental differences between L1 and L2 morphosyntactic processing

A key prerequisite to discussing the nature of real-time L2 morphosyntactic processing is whether there exists a qualitatively or quantitatively difference between how native L1 speakers and non-native L2 learners process morphosyntactic cues in real time. In keeping with the Shallow Structure Hypothesis (Clahsen & Felser, 2006), numerous empirical studies have demonstrated clear differences between native L1 speakers and L2 learners in their neurological and behavioural responses to grammatical violations during real-time comprehension.

Past ERP studies have revealed dedicated brain regions for the processing of specific language features in L1 speakers. Comparatively, L2 learners exhibit different sensitivities towards grammatical violations in these regions during comprehension. Whilst proficient L2 learners show L1-like event-related potentials

(N400 responses) to semantic violations in L2 speech, they do not show the same level of sensitivity towards L2 syntactic violations (P600 responses). This pattern has been found across L2 learners from different L1 backgrounds (Hahne, 2001; Hahne & Federici, 2001), and across different comprehension modalities (Weber-Fox & Neville, 1996). Focusing on Chinese learners of English specifically, Chen et al. (2007) found that unlike L1 English speakers, who exhibited sensitivity to subject-verb agreement violations in the form of ERP responses, L1 Chinese learners of English did not show such responses, despite showing highly accurate offline grammatical knowledge. These findings suggest that L2 learners' morphosyntactic processing differs qualitatively from native L1 users, in ways that are also mediated by L2 proficiency (VanPatten, Keating & Leeser, 2012).

Using a self-paced reading paradigm, Jiang (2004) found that even proficient L1 Mandarin learners of L2 English showed little sensitivity towards plural marking violations. Jiang found that unlike L1 English speakers who showed significant differences in reaction time between sentence segments with grammatical and ungrammatical number marking (e.g. *The child was watching some of the rabbit(s) in the room**), L1 Mandarin learners of L2 English did not show any significant differences between the two conditions (i.e. *rabbit* or *rabbits*), even though they exhibited offline knowledge of appropriate number marking. Similar findings were observed for subject-verb agreement violations among L1 Mandarin learners of L2 English (e.g. *The bridges to the island was about ten miles away**), where they did not show native-like sensitivity towards the ungrammatical segment (i.e. *was*) during online-comprehension (Jiang, 2007).

Examining the processing of temporal agreement specifically, Roberts and Liszka (2013) found that L2 English learners from L1 French and German backgrounds, whilst demonstrating proficient offline L2 grammatical knowledge, responded differently to L1-English speakers when encountering past simple and present perfect temporal mismatches (e.g. *When / Since she first started her job, Emma loved / has loved the work very much*). Whilst L1 English speakers experienced selective processing difficulty with temporal mismatches between a fronted temporal adverbial (at the beginning of the sentence) and an inflected verb in the present perfect condition (e.g. *Last year, James has gone swimming every day.*

Now he's getting bored of it.), they did not in the past simple condition (e.g. *Since last week, James went swimming every day. Now he's getting bored of it.*). In contrast, L1 French learners of English experienced significant processing difficulties to temporal in both present perfect and past simple conditions, whilst L1 German learners of English did not exhibit such processing difficulties in either condition.

These findings are significant in several ways. Consistent with previous research, Roberts and Liszka (2013) demonstrated non-native-like morphosyntactic processing in L2 learners from different L1 backgrounds. At the same time, the authors pointed towards language specific L1-effects in real-time L2 temporal processing. Specifically, French and German both encode tense, but only French grammaticalizes aspect whilst German lacks any overt aspectual morphemes (Comrie, 1976; Schilder, 1997). This stands in contrast with English, where both tense and aspect are grammaticalized using either an inflected verb (e.g. *wanted*) or an auxiliary with a perfect form (e.g. *has wanted*). Thus, the apparent absence of processing difficulty to mismatches among L1 German learners could be attributable to the lack of overt aspectual markers in their L1. This has important implications in the context of the current study, as Mandarin lacks overt markings for tense, which could affect sensitivity to L2 mismatches between the temporal adverbial and the inflected verb in L1 Mandarin learners of L2 English.

To summarise, behavioural and neurological evidence has repeatedly shown via explicit and implicit measures that L2 morphosyntactic processing is fundamentally different to L1 morphosyntactic processing. Importantly, despite having proficient offline L2 grammatical knowledge, evidence has shown that L2 learners are not sensitive to morphosyntactic violations in a native-like way during real-time sentence processing. In 3.1.2. and 3.1.3, real-time processing of temporal information from morphosyntactic cues will be discussed in relation to theories of monolingual and bilingual sentence processing. This is particularly important to our discussion as we focus on the role of the L1 on L2 learners' ability to process temporal information from inflectional morphology and detect potential mismatches between lexical and morphosyntactic cues.

3.1.2. Theories of L2 sentence processing

Real-time sentence processing is a fast-paced event which requires individuals to retrieve the semantics of lexical words as well as incrementally establishing the grammatical structure of sentences (Rueschemeyer & Gaskell, 2007). Under time pressure, the task of assimilating and interpreting lexical and morphosyntactic cues can require significant cognitive resources in L2 learners, affecting automaticity of L2 processing (Segalowitz & Segalowitz, 1993). The theoretical discussion surrounding the processing of L2 morphosyntactic mismatches in sentential contexts in this study centre around two main questions: 1) how do L2 learners handle two sets of grammatical knowledge and acquire the ability to assimilate information from L2 grammatical features when such features (or cues) are absent in the L1, and 2) how L2 learners handle these differences to comprehend sentences in real-time.

How does L2 learners' comprehension mechanism deal with two sets of grammatical knowledge in their language systems? According to The Competition Model (Bates & MacWhinney, 1989), comprehension is led by a series of interactive activations based on form-meaning probabilistic mappings. Grammatical cues compete with each other during language processing, with the strongest activations converging on the most fitting interpretation of the sentence. Two factors are important to the competition of grammatical cues, *cue validity* (the value of cues extracted from linguistic input) and *cue strength* (priority or preference assigned to cues as determined by reliability). The Competition Model utilises the connectionist assumption which states that all mental processes (including language) share the same cognitive structures and principles (MacWhinney, 1987). As such, L1 and L2 would share the same set of processing mechanisms. This means that the mechanisms which had previously been adapted to process L1 grammar would inevitably transfer onto the L2, resulting in interference. As the two sets of grammar compete, the amount of interference would depend on the degree of overlap between L1 and L2 grammatical properties. If the two grammatical systems share a number of similar properties, the value of grammatical cues (cue validity) would be transferred and strengthened from L1 to L2, and receive little interference from the L1.

However, if the two sets of grammar are dissimilar and have different valid cues, L1 cue validity could (inappropriately) transfer from L1 to L2, causing interference.

Returning to the first aim of the current study, how could L2 learners acquire the ability for processing temporal agreement between temporal adverbials and inflectional morphology when such features are absent in the learners' L1? The Competition Model would argue that L2 learners must adjust their processing priorities contingent on the validity and reliability of L2 grammatical features (e.g. inflectional morphemes) as cues to meaning. As Mandarin does not have inflectional morphology, we cannot assume inflectional morphemes carry high cue validity for L1 Mandarin learners of English by default, and therefore it is highly probable that they do not initially assign hight processing priority to inflectional morphemes in order to interpret the temporal context of the sentence. However, if L1 Mandarin learners of English were to process inflectional morphemes consistently (evident in the form of sensitivity to adverbial-inflection mismatches) much like L1 English speakers do, this would be evidence for L1 Mandarin learners of English adopting L2 cue validity during real-time L2 comprehension.

The second aim of the study concerns whether L2 learners make processing distinctions between inflections containing different numbers of features. In other words, inflectional markings can require agreement with more than one cue depending on context, which necessitates the L2 learner to carry out context-specific cue processing. For example, (temporal) inflectional morphology requires obligatory agreement with temporal adverbials if present. However, in some cases, inflectional morphology must also account for subject number (e.g. 3SG *-s*) if presented in a specific temporal context (e.g. present habitual). These two scenarios require different priorities over linguistic cue processing. For example, L2 English learners would only need to refer to temporal cues in a past tense context during morphological processing, but would also need to refer to subject number information if a singular subject is involved in a present tense (habitual) context, which could be extremely challenging in real time. If L2 learners exhibit non-native-like processing behaviour, and do not refer to subject number information, then they would not be sensitive if subject number agreement is violated (e.g. if 3SG *-s* was omitted).

Although the Competition Model outlines the principles behind acquiring new processing priorities for comprehending L2 input, as Bates and MacWhinney (1989) pointed out, its sole purpose is not to account for real-time processing of sentences in bilinguals. Importantly, it does not make a comprehensive distinction between language competence and language performance. In other words, whether L2 learners could in principle assimilate information from inflectional morphology based on explicit grammatical knowledge and be sensitive to mismatches between lexical and morphosyntactic cues does not necessarily mean that they will consistently do so in real-time. Hence, further theories which account for this crucial distinction are necessary for this discussion.

Theories in second language research make distinctions between explicit and implicit knowledge in language acquisition (R. Ellis, 2005; 2006), which parallels the competence vs. performance distinction. Specifically, explicit knowledge reflects conscious, metalinguistic knowledge of grammar which can be accessed and measured via language tests, whereas implicit knowledge reflects intuitive, automatised processes which apply grammatical knowledge during real-time L2 comprehension. Though the two sets of knowledge are theoretically related, the former does not necessarily predict the latter. In other words, acquiring explicit grammatical knowledge does not necessarily mean this knowledge will be applied in real-time during L2 comprehension.

In the context of the current study, assuming that L2 English learners have acquired the grammatical (or explicit) knowledge for morphosyntactic agreement between temporal adverbials and inflectional morphology despite its absence in the L1, native-like processing would also require learners to have the implicit knowledge of how inflectional morphemes should be consistent with the temporal adverbial in real-time. If they do, then L2 learners should be sensitive to any potential mismatches between the temporal adverbials and inflectional morphology (*Yesterday she walk a mile**). If they do not, then we would assume implicit knowledge is missing or not fully acquired. This would be consistent with previous studies where L2 learners exhibited non-native-like grammatical processing despite having proficient offline knowledge (Jiang, 2004; 2007; Marinis, Roberts, Felser & Clahsen, 2005; Roberts & Liszka, 2013).

Accounts of second language acquisition also make claims about cue saliency and redundancy during L2 acquisition. Under the usage-based approach, speakers will prefer to direct their attention to the most salient and effective cue during L2 comprehension (*learned attention*; Ellis & Wulff, 2008). If a grammatical feature is not an effective and unique cue to the overall semantic interpretation of the message, it will often be considered redundant by the speaker. For example, as temporal morphology is most frequently used alongside temporal adverbials (e.g. *every morning*), inflectional morpheme on the verb can often be considered redundant in understanding the overall meaning of the sentence. In fact, research evidence has shown that L2 learners are faster to comprehend the temporality of events when sentences included both temporal adverbials and verb morphology than verb morphology alone (e.g. Lee, Cardierno, Glass & VanPatten, 1997; Boatwright, 1999), indicating that temporal adverbials are more powerful during processing of temporal information. This difficulty is compounded by knowledge of existing mappings between words and functions, which overshadows the acquisition of additional cues (i.e., the blocking phenomenon; N. Ellis, 2006). For example, knowing that temporal adverbials indicate temporal properties of events (e.g. *yesterday*) could make it harder for L2 learner to acquire another cue which also indicates temporal properties (e.g. inflectional morphology such as past *-ed*). However, for languages where inflectional morphology is obligatory, they have to be consistent with other temporal cues such as temporal adverbials. Therefore, even though inflectional morphology may not be critical for the overall interpretation of the message, if an L2 speaker has an adopted native-L1 like processing mechanism, agreement processing of both temporal adverbial and inflectional morphology would be an essential part of successful L2 comprehension.

To summarise, theories in L2 sentence processing have in their own terms explained: 1) how L2 learners may in principle acquire a comprehension mechanism which adjusts processing priorities depending on the validity of cues to meaning in the L2, 2) how the ability to apply grammatical knowledge in real-time is necessary for L2 native-like sentence comprehension, and 3) why the ability to process inflectional morphology as temporal marking may be hard to acquire. As noted by Slabakova (2015), it is possible for L2 learners to acquire temporal meaning without

morphology. Therefore, the key question we ask in this chapter is not whether L2 learners of English can acquire temporal concepts in the L2, nor whether they possess the relevant grammatical knowledge, but rather whether L2 learners can acquire a native-like comprehension mechanism to apply their explicit grammatical knowledge in real-time. Sensitivity to mismatches between linguistic cues is therefore indicative of whether L2 learners have a native-like comprehension mechanism or implicit knowledge for real-time L2 comprehension.

3.1.3. The effect of comprehension modality on grammatical sensitivity

The final key point of consideration for the current study concerns the effect comprehension modality on L2 learners' ability to detect potential ungrammaticalities, specifically mismatches between temporal adverbials and inflectional morphology during auditory (listening) and visual (reading) comprehension.

Past research has revealed an effect of comprehension modality on grammatical sensitivity by presenting identical experimental stimuli to participants in auditory and visual forms. Using identical stimuli from Johnson and Newport (1989), Johnson (1992) showed that visual presentations of stimuli revealed significantly greater levels of accuracy and sensitivity than auditory presentations on English grammaticality judgement tasks in L2 learners. This was shown for English morphemes (Johnson, 1992) as well as subjacency violations (Haig, 1991; Murphy, 1997). Aside from methodological differences which may have confounded experimental findings (longer time given to visual (text) presentations), Anderson (1980) also pointed out natural auditory stimuli require L2 learners to actively segment continuous streams of speech, making it more cognitively demanding for L2 learners to process compared with L2 text. L2 listeners would also have to carry out more complex processing in the auditory modality (sound-to-form-to-meaning) than in the visual modality (form-to-meaning), potentially resulting in slower and less accurate reaction on grammaticality judgement.

Interaction between task-specific demands and comprehension modality also has important implications for real-time L2 processing. Specifically, grammaticality judgement tasks could induce the L2 learner to strategically and intentionally monitor grammatical violations, for which visual stimuli could be more efficiently processed, even if these grammatical violations do not hinder the correct interpretation of the message. In contrast, meaning-oriented comprehension without grammaticality judgement is closer to natural L2 comprehension, where grammatical violations are only critical if they hinder the interpretation of the message. As shown by Jackson and Bobb (2009) and Jackson and Dussias (2009), L2 learners tended to show greater resemblance to native-like processing in grammaticality judgement tasks than in tasks which assess L2 learners' understanding of the experimental sentences. These findings point towards the notion that L2 learners' real-time processing of L2 sentences could be significantly affected by the task they are asked to perform.

3.1.4. The current study

Current review of existing literature and models indicates that: 1) Successful L2 comprehension requires the L2 learner to assimilate information from multiple linguistic cues. However, it is not clear whether L2 learners could acquire the comprehension mechanism (or implicit knowledge) to consistently and incrementally assimilate the relevant cues in real-time L2 sentence processing, especially when the relevant grammatical features (i.e. inflectional morphology) are absent in the L1; 2) The comprehension of L2 temporal morphology requires context-specific processing with different cues (e.g. for 3SG *-s* vs. past *-ed*), but it is not clear whether L2 learners would make such distinctions in real-time L2 processing; 3) Auditory comprehension is significantly less accurate for L2 learners as it requires additional speech segmentation. However, it is not clear whether auditory processing would still be disadvantaged compared with visual processing if L2 learners no longer have to segment continuous speech, and with the intention of carrying out meaning-oriented comprehension instead of monitoring for grammatical violations.

This chapter presents two comprehension experiments examining the processing of English temporal morphology 3SG *-s* (e.g., *walks*) and past *-ed* (e.g., *walked*) using self-paced listening and self-paced reading paradigms (Ferreira, Henderson, Anes, Weeks & McFarlane, 1996; Just, Carpenter & Woolley, 1982). In each paradigm, participants were presented with grammatical and ungrammatical sentences where ungrammatical constructions were associated with missing inflectional morphemes in obligatory contexts. L2 learners' reaction time (RT) at each segment of the sentence was compared against L1 English controls, where longer RTs at ungrammatical verb segments indicated processing difficulty during corresponding grammatical verb segments.

In two experiments, L1 Mandarin and L1 English participants either listened to (Experiment 4) or read (Experiment 5) English sentences involving different temporal contexts. Experimental sentences uniformly contained a temporal adverbial, a singular subject, a transitive verb, an object and a prepositional phrase in this order. Temporal context (Present Habitual, Past) was manipulated via the temporal adverbial (e.g. *every weekend, yesterday*), and Grammaticality was manipulated via the omission of inflectional morphology (3SG *-s* or past *-ed*). Participant reaction time (RT) was recorded for each segment of the sentence, focusing on the critical verb segment (where inflectional omission takes place).

Given current accounts of L2 sentence processing, there are two possibilities. If L1 Mandarin learners of L2 English acquired the grammatical knowledge regarding inflectional morphology as a cue to temporal information, and have the ability to apply this knowledge in real-time in native-like way, they would be sensitive to mismatches between temporal adverbial and the omission of corresponding 3SG *-s* and past *-ed* inflections (e.g. ***every day / yesterday*** *the girl* ***paint*** *sunflowers in the park*). This would result in significantly slower RTs in critical verb segments with omitted morphology compared with those without (i.e. a significant effect of Grammaticality on verb segment RTs). On the other hand, if L1 Mandarin learners of L2 English have acquired the explicit grammatical knowledge regarding inflectional morphology as a cue to temporal information, but have not acquired the implicit knowledge for applying grammatical knowledge in real time, one would not expect significant RT differences between critical verb segments with and without 3SG *-s*

and past *-ed* omissions (i.e. no significant effect of Grammaticality on verb segment RTs). Moreover, it remains unclear to what extent L1 Mandarin learners of L2 English would resemble native-like sensitivity to inflectional omissions. If they do, then there would not be a significant effect of Group on verb segment RTs. If they exhibit weaker levels of sensitivity to inflectional omissions, then one would expect a significant effect of Group on verb segment RTs.

Additionally, I examine whether there are significant differences between L1 English speakers and L2 English learners' sensitivity to the omission of 3SG *-s* and past *-ed* inflectional morphemes. As stated previously, these two temporal markings require agreement to different cues depending on context. Whereas 3SG *-s* denotes agreement with both tense and subject number, past *-ed* denotes agreement only with tense. It is noted that as subject number and tense are both marked using 3SG *-s* in English, teasing the use of subject number cue from tense cues in L2 learners in isolation is difficult. However, by comparing response RTs to past *-ed* omissions against 3SG *-s* omissions, one could examine whether the addition of subject number cue in 3SG *-s* facilitates or hinders the detection of inflectional omissions in L2 learners. In other words, one could observe whether having two agreement features (tense and subject number) would make the detection of missing inflections easier or more difficult for L2 learners compared with having only one agreement feature. If additional features affect participants' sensitivity towards 3SG *-s* compared with past *-ed* omissions, then one would see a significant effect of Temporal Context (i.e. 3SG *-s* vs. past *-ed* inflectional marking) with a Temporal Context × Grammaticality interaction.

Finally, as noted by Johnson (1992), inaccurate auditory perception of stimuli could significantly confound the result of grammaticality judgements. Therefore, I carried out experiments examining both auditory and visual comprehension, placing significant emphasis on cross modality variations during L2 comprehension. If auditory modality significantly disadvantages comprehension due to inaccurate or slower perception of auditory stimuli compared with visual stimuli, then L1 Mandarin learners of L2 English should exhibit weaker sensitivity to inflectional omissions in the auditory than in the visual modality. However, if auditory cues facilitate comprehension in the auditory modality, then L1 Mandarin learners of L2

English should exhibit stronger sensitivity in the auditory compared with the visual modality. In statistical terms, one would expect differences in effect sizes between auditory and visual statistical models if comprehension modality does in fact affect sensitivity to inflectional omissions.

To sum up, the current study examines: 1) whether L2 learners, with no inflection in their L1, could acquire a native-like comprehension mechanism (or implicit knowledge) to apply explicit grammatical knowledge relating to inflectional use during real-time L2 comprehension; 2) whether L2 learners' sensitivity to inflectional omissions is facilitated or reduced by additional agreement features (i.e. subject number in 3SG *-s*) during L2 comprehension; 3) whether L2 learners exhibit weaker sensitivity to inflectional omissions during auditory than in visual L2 comprehension.

3.2. Experiment 4

3.2.1. Method

Participants

61 L1 Mandarin learners of L2 English aged 19-34 (M=23.79, SD=2.48) and 56 L1 English speakers aged 17-31 (M=20.48, SD=5.11) participated in this experiment. All L1 Mandarin participants were late learners of English (AoA > 5 years) and had an IELTS (International English Language Testing System) score of 6.5 or above with 6 or above in the listening component of the IELTS. Their length of stay (in months) and daily exposure to L2 English (in hours) were also recorded (see Appendix G). All L1 English speakers had no exposure to any other languages before the age of five. An additional measure of morphological proficiency was used as part of the experiment for both L1 Mandarin and L1 English groups to show that they have the appropriate offline grammatical knowledge of inflectional morphology under different temporal contexts[9].

[9] See Appendix J for a sample copy of the Morphological Proficiency Test, and Appendix K for descriptive and inferential statistics on this test across L1 Mandarin and L1 English groups.

Materials

Nine regular (experimental) and nine irregular (filler) transitive verbs were chosen for the listening experiment. Four different sentences were created around each verb, with each sentence having four versions corresponding to the four experimental conditions (see Table 15 for examples). All 288 sentences[10] included a temporal adverbial, a subject, a verb, an object and a prepositional phrase.

Table 15.

Experiment 4: Example of a stimuli sentence across temporal contexts and grammatiaclity. Forward slashes (/) denote segment boundaries.

Temp. Context	Grammaticality	temp adv. / subject / verb / object / prep. phrase
Present Habitual	Grammatical	Every Saturday / the girl / paint**s** / sunflowers / in the park.
Present Habitual	Ungrammatical	Every Saturday / the girl / paint / sunflowers / in the park.*
Past	Grammatical	Yesterday / the girl / paint**ed** / sunflowers / in the park.
Past	Ungrammatical	Yesterday / the girl / paint / sunflowers / in the park.*
Question:		Do / did the girl paint sunflowers in the gallery?

* indicates ungrammaticality.

For experimental sentences, I used singular subjects and manipulated temporal context (Present Habitual vs. Past) and grammaticality of the inflectional form (grammatical: without omission vs. ungrammatical: with omission). Two grammatical versions of each sentence containing verbs with 3SG *-s* and past *-ed* inflectional endings were generated and two ungrammatical versions with these inflections omitted. Temporal context was also indicated by temporal adverbials for Present or Past temporal contexts e.g. *Every weekend* (Present Habitual) vs. *Yesterday* (Past). For filler sentences, location prepositional phrases were used instead of temporal adverbials, and non-inflectional grammatical errors, such as the incorrect use of articles, determiners and prepositions were used instead of inflectional omissions. Different versions of the same sentence were assigned across

[10] See Appendix H and I for the full list of experimental and filler sentences used in Experiments 4 and 5.

four different participant groups using a Latin square design, such that each participant would hear each sentence under only one experimental condition. Frequency of nouns was tallied to ensure no word was overly repetitive across sentences. Closed comprehension questions were created for a quarter of the sentences based on the non-verb content of each sentence (see Table 15). The tense of the auxiliary verb 'do' was always consistent with the temporal context of the sentence. This was to avoid participants' attention being drawn to intentionally monitor the temporal contexts of sentences and corresponding verb inflections.

All sentences were recorded in the University of Edinburgh PPLS recording studio with a male RP English speaker with a sampling rate of 44.1 kHz (16-bit) in .wav format. The speaker took natural pauses between phrases to avoid co-articulation. Every iteration of each sentence was recorded separately and edited the recordings by dividing each sentence into five audio segments (see Table 12). All audio files were programmed by trial and condition in E-Studio 2.0 for stimulus presentation. Subsequently, a list of audio file durations (in milliseconds) was compiled using Praat (version 6.0, Boersma & Weenink, 2015) and scripts provided by the UCLA Phonetics Lab.

An original Morphological Proficiency Test was used to assess participants' offline knowledge of temporal inflectional morphemes. The test is targeted at L2 learners of English with intermediate to advanced proficiency (see Appendix K). The test contains two sections, consisting of 30 multiple choice questions and 20 gap-filling exercises.

Design

This experiment used a 2 x 2 x 2 mixed design. The between-subject variable was Participant Group (L1 Mandarin vs. L1 English), and the within-subject variables were Temporal Context (Present Habitual vs. Past) and Grammaticality (Grammatical vs. Ungrammatical).

Procedure

The experiments took place in a quiet lab with a computer and a pair of stereo headphones. Before commencing, participants provided demographic details including language background information and gave consent for their data to be used. Each participant was introduced to the experimental set-up by reading written instructions in English. The experimenter repeated the instructions in Mandarin if participants did not fully understand the tasks.

For the self-paced listening task, each participant listened to 72 sentences (36 experimental + 36 filler) presented via E-Studio 2.0 and a pair of headphones. For each trial, participants first viewed the phrase **[READY?]** on a standard-sized 1920 x 1080 computer screen. Then, participants initiated the presentation of each sentence by pressing the **[SPACE BAR]**. Each segment of the sentence was then played sequentially at each press. At the end of each trial, participants either answered a comprehension question by pressing one of two number keys (**1** for **YES**; **2** for **NO**) based on the sentence they just heard, or pressed the **[SPACE BAR]** to continue with the next trial. Participants completed five practice trials containing sentences with and without comprehension questions (to reflect selective presentation of comprehension questions in the task) before starting the experiment. Presentation order was randomised to prevent trial order effect. Participants had an optional break after every 12 trials to prevent fatigue. They were reminded that they should progress through the sentences at a steady pace, and not press the [**SPACE BAR**] before each segment ended.

Following the self-paced listening task, each participant completed the Morphological Proficiency Test. They were asked complete it as quickly as possible and hand it back to the experimenter. Participants received 0.5 hours course credit or £5 cash for their time.

Coding and scoring

The self-paced listening task produced cumulative reaction times (RT) from the start of every audio segment to the point of response. RTs for each segment was calculated by deducting the duration of audio files (calculated using Praat) from the cumulative RTs (recorded via E-Prime), and responses to comprehension questions were scored as binary data (0 or 1). 7% of trial data were excluded based on the following criteria: 1) temporal adverbial and verb segments with negative raw RTs, where participants responded before the end of the segment, 2) extreme raw RTs outside +/- 2 SD, and 3) trials with incorrect comprehension question responses.

3.2.2. Results

Self-paced Listening (SPL) Task

For SPL reaction time analyses, a forward model building strategy was used with a maximal random effects structure (Barr et al., 2013). If the addition of a predictor significantly improved model fit, then it was kept as part of the final model. In order to analyse L1 Mandarin speakers' auditory sensitivity to L2 English inflectional omissions on the critical verb in a given temporal context, a general linear mixed-effects models (GLMMs) was used with Group (between-subject), Temporal Context and Grammaticality (within-subject) as main effect predictors, and Participant, Item and Trial Order as random intercepts if they significantly improved model fit. Fixed-effects predictors were contrast-coded, and the outcome variable (RT) was centred before being added to the model.

For the purposes of this study, descriptive figures for all five segments across both temporal contexts are presented, but GLMM models are only reported for RT data from the critical verb segment.

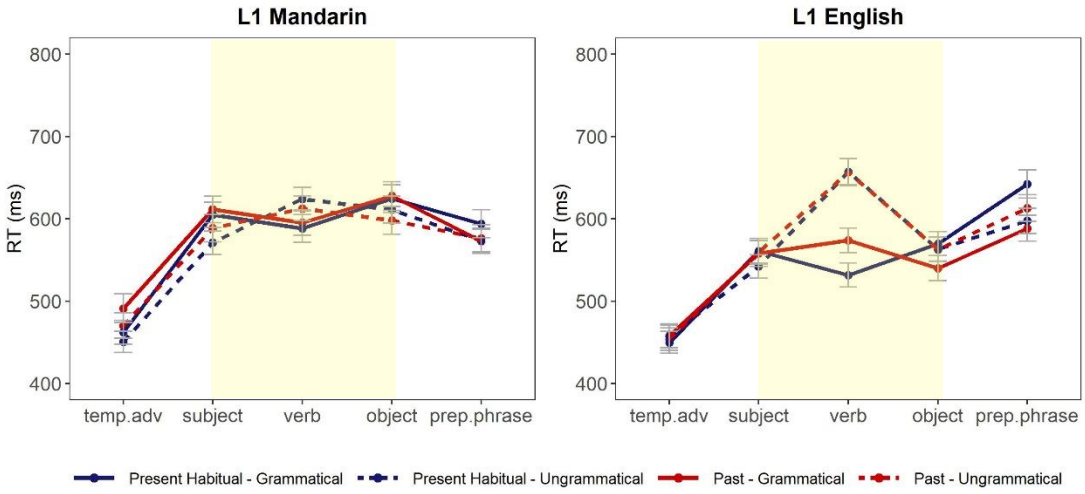


Figure 16. Mean RTs for temporal adverbial, subject, verb, object and prepositional phrase segments for L1 Mandarin and L1 English groups (N=61;56). Error bars denote +/- 1 SE.

Figure 16 shows the mean RTs for each of the five segments across Present Habitual (3SG *-s*) and Past (*-ed*) temporal contexts for L1 Mandarin and L1 English groups. Highlighted regions contain the pre-critical, critical and post-critical segments.

Overall, there was no significant main effect of Group. The L1 Mandarin group did not have significantly longer RTs in the critical segment compared with the L1 English group (M=605.44 vs. M= 605.06). However, participants showed a significant main effect of Grammaticality irrespective of their L1: Both L1 Mandarin and L1 English groups produced shorter RTs in the grammatical condition compared with the ungrammatical condition (L1 Mandarin: M= 591.86 vs. M= 618.47; L1 English: M= 552.82 vs. M= 656.95). There were significant interactions between Group and Temporal Context and Group and Grammaticality respectively, indicating significant differences between how L1 Mandarin and L1 English speakers responded to inflectional omissions as a whole, and to 3SG *-s* and past *-ed* omissions separately (Table 16). Interestingly, there was also a two-way interaction between Temporal Context and Grammaticality, indicating sensitivity to inflectional omission was different for 3SG *-s* and past *-ed*.

Subgroup analyses confirmed the significant main effect of Grammaticality for both L1 Mandarin and L1 English groups, indicating sensitivity to inflectional omissions across groups. Temporal Context however, did not produce a significant main effect for the L1 Mandarin group (Present Habitual 3SG *-s*: M = 606.18 vs. Past *-ed*: M = 603.99), but did for the L1 English group (Present Habitual 3SG *-s*: M = 594.48 vs. Past *-ed*: M = 615.29). Similarly, the interaction between Temporal Context and Grammaticality was also not significant for the L1 Mandarin group but was for the L1 English group. These results indicated that the L1 Mandarin group did not process 3SG *-s* and past *-ed* omissions differently, but the L1 English group did.

Table 16.

Experiment 4: Generalised linear mixed-effects model (GLMM) statistics for RT on critical verb segment in self-paced listening task for L1 Mandarin and L1 English groups (N=61;56).

	B (SE)	*p*
Intercept	609.60 (29.27)	**<.001**
Group (*L1 Mandarin* vs. *L1 English*)	16.28 (43.07)	.706
Temporal Context (*Present Habitual* vs. *Past*)	11.77 (7.32)	.108
Grammaticality (*Grammatical* vs. *Ungrammatical*)	69.85 (7.33)	**<.001**
Group × Temporal Context	30.16 (14.66)	**.040**
Group × Grammaticality	67.13 (14.64)	**<.001**
Temporal Context × Grammaticality	-39.15 (14.65)	**.008**
Group × Temporal Context × Grammaticality	-16.83 (29.31)	.566
L1 Mandarin		
Intercept	602.00 (34.52)	**<.001**
Temporal Context	-3.09 (10.90)	.777
Grammaticality	37.30 (10.91)	**.001**
Temporal Context × Grammaticality	-29.54 (21.85)	.176
L1 English		
Intercept	617.21 (38.66)	**<.001**
Temporal Context	25.99 (9.73)	**.008**
Grammaticality	102.95 (9.74)	**<.001**
Temporal Context × Grammaticality	-46.18 (19.46)	**.018**

3.2.3. Interim Discussion

In Experiment 4, I examined L2 temporal processing during auditory comprehension in L1 Mandarin learners of L2 English and L1 English controls via a self-paced listening task. There were several findings of interest. First, L1 Mandarin participants showed significantly slower RTs on ungrammatical trials (where inflections were omitted) compared with grammatical trials (where inflections were attached), much like L1 English participants. This critically showed that L1 Mandarin participants were sensitive to the omission of inflectional markings where contexts required them. However, it was also clear that L1 Mandarin and L1 English participants responded differently to inflectional omissions depending on temporal context. Whereas L1 Mandarin participants did not show differential sensitivity towards 3SG *-s* and past *-ed* omissions, L1 English exhibited superior sensitivity to 3SG *-s* omissions than past *-ed* omissions, which indicated integral differences in 3SG *-s* and past *-ed* processing in native-like comprehension.

As noted in Johnson (1992) and Murphy (1997), auditory presentation of stimuli can impose problems in comprehension tasks, resulting in low performance accuracy. Specifically, erroneous phonological processing can confound measures of higher-level processing (i.e. grammaticality judgement). In this case, one cannot be sure whether the phonological properties of 3SG *-s* or past *-ed* would be harder to 'hear' for a L1 Mandarin participant on a perceptual level. Therefore, in the next experiment, the current experiment was administered in a non-auditory modality, i.e. self-paced reading, eliminating the element of auditory processing from sentence comprehension.

3.3. Experiment 5

3.3.1. Methods

Participants

Two new groups of participants, including 61 L1 Mandarin (L2 English) aged 21-28 (M=22.72, SD=1.32) and 57 L1 English speakers aged 18-43 (M= 22.14, SD=4.13) participated in this experiment. L1 Mandarin speakers were required to have a score of 6.5 overall as well as a score of 6 on the reading section of the IELTS exam. All other recruitment criteria were identical to Experiment 4. The same morphological proficiency test from Experiment 4 was used in Experiment 5.

Materials

Identical sentences from the self-paced listening task in Experiment 4 were used, but they were prepared in the written form. Each sentence again contained five segments (temporal adverbial / subject / verb / object / prepositional phrase) and closed comprehension questions were again created for a quarter of the sentences (Table 17). All sentences used identical font size and style (font size: 24, font style: Courier New) for presentation in E-Studio 2.0.

Table 17.

Experiment 5: Illustration of stimuli sentence presented using a visual moving-window paradigm for the self-paced reading task.

	Temp. Adverbial	Subject	Verb	Object	Prep. Phrase
Slide 1	**Yesterday**	--- ----	-------	----------	-- --- ----
Slide 2	---------	**the girl**	-------	----------	-- --- ----
Slide 3	---------	--- ----	**painted**	----------	-- --- ----
Slide 4	---------	--- ----	-------	**sunflowers**	-- --- ----
Slide 5	---------	--- ----	-------	----------	**in the park**

Design

The design was identical to Experiment 4.

Procedure

The experimenter introduced participants to the set-up of the experiment via the same procedures as Experiment 4. All aspects of the self-paced reading task were identical to the self-paced listening task except for the modality of presentation. For the self-paced reading task, a visual moving-window paradigm (Ferreira et al., 1996), was used where participants silently read 36 experimental and 36 filler sentences one segment at a time by pressing the [**SPACE BAR**] (Table 17). At every press, all other non-target segments became dashes to prevent interference. At the end of each trial, participants either answered a comprehension question or continued with the next trial as per the listening experiment. Participants had an optional break after every 12 trials to prevent fatigue.

Following the self-paced reading task, participants again completed the Morphological Proficiency Test and were paid £5 for their time.

Coding and Scoring

The self-paced reading task produced RTs from the start of presentation to the point of response for each segment. 2% of trial data were removed based on the following exclusion criteria: 1) All trials with extreme RTs exceeding 3000 ms (assumed to reflect a lack of concentration) and below 100 ms (assumed to be an non-intentional response) in the temporal adverbial and verb segments. 2) Trials with incorrect comprehension responses. Residualised RTs for each segment were calculated using the word length (number of letters per segment; Ferreira & Clifton, 1986).

3.3.2. Results

Self-Paced Reading (SPR) Task

In order to analyse L1 Mandarin participants visual sensitivity to L2 English inflectional omissions in different temporal contexts, GLMMs were again used with Group (between-subjects), Temporal Context and Grammaticality (within-subjects) as fixed-effect predictors. Identical to the SPL analyses in Experiment 4, Participant, Item and Trial Order were included as random effects if they significantly improved model fit. Prior to the construction of the GLMMs, fixed-effects predictors were contrast-coded, and residualised RTs were centred around a mean of 0. I considered log-transformations inappropriate for the current RT data, as a logarithmic scale may obscure between-group differences, especially their interactions with key predictors in the analyses (see Lo & Andrews, 2015, for discussion).

For the SPR task, I focused on the differences between RTs as affected by Temporal Context and Grammaticality across L1 Mandarin and L1 English groups on the critical (verb) and on the spill-over (object) segments. Assuming that L2 learners generally have slower reading times (e.g. Fraser, 2007), sensitivity to grammatical violations at the critical (verb) segment could potentially be delayed and reflected in the post-critical spill-over (object) segment.

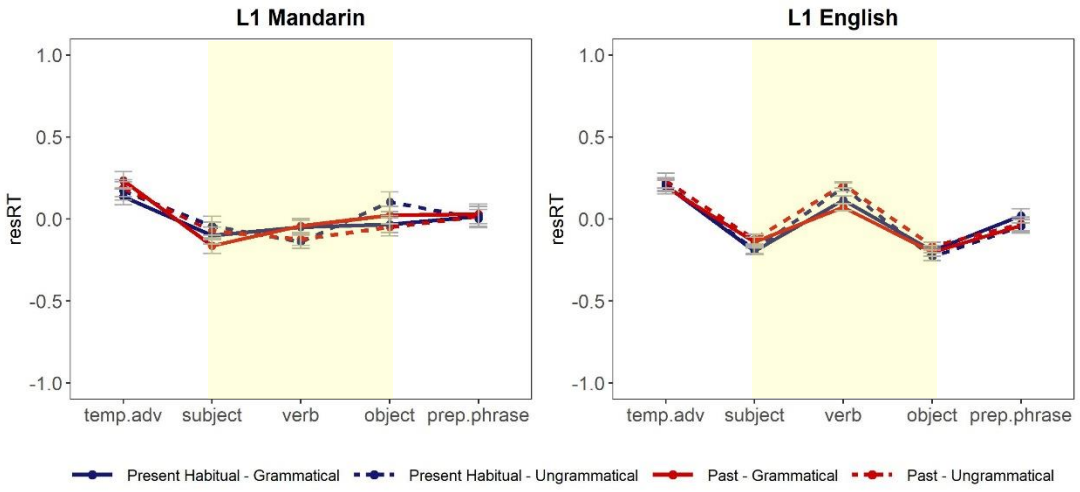


Figure 17. Experiment 5: Mean residualised RTs for temporal adverbial, subject, verb, object and prepositional phrase segments in the self-paced reading task for L1 Mandarin and L1 English groups (N=61;57). Errors bars denote +/- 1 SE.

Figure 17 shows the residualised RTs for each of the five segments across Present Habitual (3SG *-s*) and Past (*-ed*) temporal contexts for L1 Mandarin and L1 English groups. Highlighted regions contain the pre-critical, critical and post-critical (spill-over) segments.

Critical (verb) segment

Overall, there was a significant main effect of Group on the critical verb segment. The L1 Mandarin group produced significantly shorter RTs than the L1 English group after accounting for word length (M = -0.09 vs. M = 0.15). However, there were no effects of Temporal Context (Present Habitual: M = 0.02 vs. Past: M = 0.02) nor Grammaticality (Grammatical: M = 0.02 vs. Ungrammatical: M = 0.02). Importantly, there was a significant two-way interaction between Group and Grammaticality, indicating that L1 Mandarin and L1 English groups responded to inflectional omissions differently, also prompting subgroup analyses (Table 18). Subgroup analyses revealed a marginal main effect of Grammaticality for the L1 Mandarin group, and a significant effect of Grammaticality for the L1 English group. There was no significant main effect of Temporal Context, nor any interactions between Temporal Context and Grammaticality in either group. This indicated that within each group, participants did not process 3SG *-s* and past *-ed* omissions differently.

Spill-over (object) segment

Examining the spill-over (object) segment, there was a significant main effect of Group (Table 18). Unlike the critical verb segment, the L1 Mandarin group produced longer RTs compared than the L1 English group, after accounting for word length (M = 0.01 vs. M = -0.20). The main model did not show significant main effects of Temporality nor Grammaticality, but did show a significant three-way interaction between Group, Temporal Context and Grammaticality. Upon closer examination, subgroup analyses revealed no significant main effects of Temporal Context nor Grammaticality for either group, restricting the significant three-way interaction to group differences alone.

Table 18.

Experiment 5: General linear mixed-effects model (GLMM) statistics for residualised RTs in the critical (verb) segment and spill-over (object) segment in the self-paced reading task for L1 Mandarin and L1 English groups (N=61;57).

	Verb Segment		Spill-over Segment	
	B (SE)	*p*	B (SE)	*p*
Intercept	0.02 (0.02)	.223	-0.09 (0.03)	**.002**
Group (***L1 Mandarin*** vs. *L1 English*)	0.24 (0.04)	**<.001**	-0.21(0.04)	**<.001**
Temporal Context (***Present Habitual*** vs. *Past*)	-0.00 (0.02)	.985	-0.01 (0.05)	.772
Grammaticality (***Grammatical*** vs. *Ungrammatical*)	0.01 (0.02)	.829	0.01 (0.05)	.771
Group × Temporal Context	-0.03 (0.05)	.574	0.07 (0.06)	.238
Group × Grammaticality	0.20 (0.05)	**<.001**	-0.03 (0.06)	.596
Temporal Context × Grammaticality	0.03 (0.05)	.518	-0.07 (0.10)	.453
Group × Temporal Context × Grammaticality	0.05 (0.10)	.578	0.28 (0.12)	**.026**
L1 Mandarin				
Intercept	-0.09 (0.03)	**.009**	0.01 (0.04)	.749
Temporal Context	0.01 (0.04)	.786	-0.05 (0.08)	.519
Grammaticality	-0.09 (0.04)	.056	0.03 (0.08)	.695
Temporal Context × Grammaticality	0.01 (0.09)	.940	-0.20 (0.15)	.187
L1 English				
Intercept	0.15 (0.02)	**<.001**	-0.20 (0.03)	**<.001**
Temporal Context	-0.02 (0.03)	.521	0.02 (0.05)	.700
Grammaticality	0.11 (0.03)	**<.001**	-0.00 (0.05)	.969
Temporal Context × Grammaticality	0.05 (0.05)	.318	0.07 (0.09)	.464

Between-experiment (Modality) Comparisons

As auditory (Experiment 4) and visual (Experiment 5) comprehension were measured on different scales (RT for auditory comprehension and residualised RT based on word length for visual / reading comprehension), direct model fitting using Modality as a fixed effects predictor was not possible. Instead, an effect size measure (*Cohen's d*) was used as an indicator of cross-modality effects (Table 19). Crucially, data from self-paced comprehension tasks showed a greater effect of Grammaticality in the auditory (Experiment 4) than in the visual (Experiment 5) modality, indicating that auditory stimuli elicited stronger sensitivity to inflectional omissions. Interestingly, there was a greater between-group difference in the visual compared with the auditory modality, with L1 Mandarin participants showing shorter response RTs overall compared with L1 English participants in the visual modality.

Table 19.

Cohen's d effect size statistics across Experiment 4 and Experiment 5.

	Cohen's d	
	Experiment 4 (N=61;57)	Experiment 5 (N=61;56)
Group	0.07	1.16
Temporal Context	0.05	-0.00
Grammaticality	0.32	0.01
Group × Temporal Context	0.07	-0.02
Group × Grammaticality	0.15	0.13
Temporal Context × Grammaticality	-0.09	0.02
Group × Temporal Context × Grammaticality	-0.02	0.02

3.3.3. Interim discussion

Experiment 5 examined L2 temporal comprehension in L1 Mandarin learners of L2 English in the visual modality. There were several findings of interest: Surprisingly, the L1 Mandarin group did not show sensitivity to inflectional

omissions at a statistically significant level in the critical verb segment in the visual modality, unlike the L1 English group who showed such sensitivity. The spill-over region did not show any delayed Grammaticality effects. Similar to Experiment 4, we did not see any effects of Temporal Context or its interaction with Grammaticality for the L1 Mandarin group, indicating no differential sensitivity to 3SG *-s* and past *-ed* omissions in the visual modality. Interestingly, unlike their performance in the self-paced listening task in Experiment 4, the L1 English group did not show a significant main effect of Temporal Context nor an interaction with Grammaticality, indicating no differential sensitivity to 3SG *-s* and past *-ed* omissions.

Comparing across modalities, the L1 Mandarin group was not sensitive to inflectional omissions to a statistically significant level in the visual modality compared with the auditory modality, irrespective of inflectional type, unlike the L1 English group who did for both auditory and visual modalities.

3.4. General Discussion

Previous research has shown that L2 learners generally do not process L2 sentences in a native-like way. Given current evidence on L2 sentence processing, it is unclear 1) whether L2 learners can consistently assimilate information from L1-absent linguistic cues during real-time L2 comprehension, and therefore exhibit sensitivity (or experience processing difficulties) when they encounter mismatches between lexical and morphosyntactic cues; 2) whether processing of cues is recognisably context dependent; 3) whether sensitivity to mismatches between lexical and morphosyntactic cues during L2 sentence processing is affected by comprehension modality in a significant way.

In Experiments 4 and 5, L1 Mandarin and L1 English participants either listened to or read sentences with and without inflectional omissions on the main verb in a self-paced moving-window paradigm (in which inflectional omissions were always associated with ungrammaticality). Unsurprisingly, L1 Mandarin participants

exhibited non-native-like sensitivity towards inflectional omissions on the critical verb segment in L2 comprehension. In auditory comprehension, whilst L1 Mandarin participants clearly exhibited sensitivity towards inflectional omissions like L1 English participants, they did not show stronger sensitivity towards 3SG *-s* omissions compared with past *-ed* omissions, which was evident among L1 English participants. In visual (reading) comprehension, L1 Mandarin participants did not exhibit sensitivity towards inflectional omissions on the critical verb segment at a statistically significant level compared with L1 English participants who did. There were no spill-over effects in the object segment either. Effect size measures for Grammaticality were larger in the auditory modality compared with the visual modality, which indicated that an auditory presentation of stimuli gave rise to stronger sensitivity in detecting inflectional omissions.

3.4.1. L2 comprehension mechanism and application of implicit knowledge

Revisiting the aims of the current study, one key aspect of our investigation was to see if L2 learners could acquire a native-like comprehension mechanism which and apply L2 grammatical knowledge in real time despite grammatical properties of the L1. In other words, whether L2 learners could exhibit real-time sensitivity if mismatches between lexical and morphosyntactic cues occur (when the relevant grammatical rules are violated). The theoretical question lies not with whether L2 learners understood the intended message (demonstrated via performance on comprehension questions), nor whether they know the grammatical features on an explicit level (demonstrated via performance on the morphological proficiency test), but rather whether L2 learners incrementally assimilate information from multiple linguistic cues and implicitly apply relevant grammatical knowledge in a native-like way during L2 comprehension. If so, L2 learners should be sensitive to mismatches between cues in a way similar to that in native-L1 speakers.

Our findings were mixed. Results from Experiment 4 provided convincing evidence that L2 learners do have auditory sensitivity to missing inflections which affected their processing of L2 sentences (as indicated by longer reaction times for

ungrammatical trials), indicating that they could incrementally assimilate information from both lexical and morphosyntactic cues, and were able to apply grammatical knowledge in real time. This evidence seemingly suggests that L1 Mandarin learners of L2 English, with no inflectional morphology in their L1, can acquire a comprehension mechanism (or implicit knowledge) that applies L2 grammatical knowledge during real-time sentence processing. Contrary to Roberts and Liszka (2013), the absence of the grammatical feature in the learners' L1 did not prohibit them from processing it in the L2. However, this did not necessarily mean that their performance and their processing of L2 sentences were native-like. Note that whilst L1 Mandarin participants exhibited sensitivity to inflectional omissions in general, they did not exhibit stronger sensitivity when 3SG *-s* was omitted than when past *-ed* was omitted in experimental sentences, which was evident in L1 English participants. It is clear that L1 Mandarin participants did not process these inflections in a strictly native-like fashion, and that the fact that 3SG *-s* requires more than one type of agreement did not facilitate or hinder their sensitivity to its omission. Though it could be argued that current findings are in favour of a fundamental difference interpretation of L1 and L2 processing, current evidence does not conclusively rule out a quantitative difference interpretation, especially when L2 learners are found to be sensitive to both 3SG *-s* and past *-ed* inflectional omissions in the auditory modality overall.

Let us return to Bates and MacWhinney's (1989) claim of cue validity and cue strength, that L2 learners must adjust processing priority when L2 grammar has a different hierarchy of form-to-function mappings. We hypothesised if L1 Mandarin learners of L2 English could acquire new grammatical features, and assign value and processing priority to these newly acquired L2 grammatical features as linguistic cues, then they should in principle experience processing difficulties if these cues gave inconsistent or contradictory information. It is clear from Experiment 4, that L2 learners were indeed sensitive to inflectional omissions, indicating that L2 learners have assigned value and processing priority to inflectional morphology as a linguistic cue for temporal information, even if it does not exist in the L1. Importantly, this pattern occurred when the task did not explicitly require participants to monitor the

grammatical acceptability of the L2 stimuli, which showed that this is an implicitly driven process.

Let us also reconsider the concept of *learned attention* under the associative learning theory (Ellis & Wulff, 2008), which claimed that L2 learners direct their attention to the most salient cues to meaning during initial acquisition. Findings from Experiment 4 showed that at the current proficiency level (intermediate to advanced), L2 learners no longer prioritised cues based on surface level saliency, even when experimental sentences had fronted temporal adverbials and inflections occurred later in the sentence. Instead, they carried out incremental parsing using all relevant cues as required by L2 grammar, including less salient cues such as inflectional morphology.

One shouldn't ignore one interesting finding in Experiment 4, that sensitivity to inflectional omissions not only differed across inflectional endings in the L1 English controls, but was stronger for 3SG *-s* than for past *-ed*. This asymmetry indicated that native-like processing is different for 3SG *-s* and past *-ed* inflections. One interpretation of this difference could be down to the number of features (or the number of agreement) contained within the inflection. Specifically, the inflection requiring more than one type of agreement (i.e. 3SG *-s*) was more salient when absent during real-time sentence processing than the inflection requiring only one type of agreement (i.e. past *-ed*), resulting in increased sensitivity for the former in L1 English participants. It is possible that as subject number is an important cue for grammaticality in addition to temporal context for 3SG *-s*, the shorter distance between the subject and inflectional morpheme compared with the temporal adverbial contributed to stronger sensitivity for 3SG *-s* omission on the critical verb segment.

Interestingly, this finding shows resemblance to findings by Roberts and Liszka (2013), where L1 English controls showed sensitivity to temporal mismatches in the present perfect condition but not in the past simple condition. Roberts and Liszka suggested that different degrees of grammaticality could be at play (i.e. past simple ungrammatical trials were more acceptable than present perfect ungrammatical trials). In the context of the current study, omitting 3SG *-s* could be considered 'more

ungrammatical' than the omitting past *-ed*, giving rise to stronger 3SG *-s* sensitivity in L1 English learners.

3.4.2. Modality effects in L2 comprehension

Let us now examine the most interesting finding from the current study. According to previous research, there is an auditory disadvantage in L2 comprehension imposed by additional speech segmentation (Johnson, 1992; Murphy, 1997). Specifically, L2 English learners have been found to show superior performance in grammaticality judgement when the L2 stimuli is presented in the visual rather than the auditory form. Findings from Experiment 5 seemingly contradicted this claim. With identical stimuli to Experiment 4, the L1 Mandarin group did not exhibit visual sensitivity to inflectional omissions at a statistically significant level. This showed that the auditory nature of stimuli did not invariably make L2 comprehension more difficult. In fact, phonological saliency facilitated assimilation and integration of L2 linguistic cues.

How could we explain the different modality effects found in previous studies and in the current study? It is possible that during real-time comprehension, visual text could take longer to process compared with auditory stimuli. However, it should be noted that as both stimuli from self-paced listening and self-paced reading tasks are readily segmented, the argument of additional speech segmentation increasing processing difficulty does not apply here (Anderson, 1980). Instead, current data seem to suggest greater perceptual saliency for auditory stimuli in the context of L2 sentence comprehension, facilitating sensitivity to L2 inflectional omissions. With regard to the facilitatory effect of auditory cues, L1 Mandarin participants might have been facilitated by the presence of additional syllables created by inflectional morphemes. However, given the fact that the verbs in these experiments contained alveolar endings, they would only facilitate comprehension in the past *-ed* context (syllabic endings, as in *shouted*), and not in the 3SG *-s* context (consonant cluster endings, as in *kicks*). If phonological saliency was the only contributor, there should have been significant differences between sensitivity to syllabic endings for past *-ed*

and consonant cluster endings for 3SG *-s* in L1 Mandarin participants. However, this was not the case, hence we could not attribute the observed effects solely to syllabic features in the auditory stimuli. Moreover, I argue that given the semantically driven nature of the current experiments, it is also possible that L2 learners have adopted a processing strategy to prioritise semantic information (i.e. verbs) over syntactic features (i.e. inflectional morphemes) when L2 input is not perceptually salient (i.e. in the visual modality). In other words, L2 learners could, implicitly or explicitly, exhibit different levels of grammatical sensitivity depending on the purpose of L2 comprehension.

3.4.3. Limitations and remaining issues

These experiments provide clear evidence for the integration of linguistic cues during temporal processing in auditory L2 comprehension, and that phonological saliency could facilitate integration of linguistic cues compared with visual / reading comprehension. However, it is not clear how phonological features facilitate the detection of grammatical violations in the auditory modality. Do L2 learners find auditory cues more salient across-the-board? Or do they show perceptual bias towards phonological features which exists in the L1 (syllabic endings, as in [tɪd] in *shouted*) compared with those which do not (consonant clusters, as in [ks] in *kicks*)? The extent of phonological influence will be addressed in Chapter 4.

Given that multiple studies have shown L2 learners possess visual sensitivity to L2 grammatical violations, I do not dismiss that this sensitivity exists amongst L2 learners. Rather, I propose that task demands play an important role in measures of L2 learners' grammatical sensitivity. In a semantically driven task without perceptually salient cues, or under cognitive stress, L2 learners could prioritise semantic over syntactic cues during real-time sentence processing. However, in a syntactically driven task, where the primary aim is to monitor for grammatical violations, L2 learners could exhibit superior sensitivity towards syntactic cues. This possibility could be confirmed by repeating the current experiments where comprehension questions are replaced with a grammaticality judgement task (e.g. Jackson & Bobb, 2009; Jackson & Dussias, 2009). Taking the findings of the current

experiments, it is clear that L2 learners can assign processing priority to novel L2 grammatical features and integrate multiple linguistic cues during L2 comprehension, even if these cues do not exist in the learner's L1. Differences across auditory and visual modalities raise question about the level of uniformity in L2 grammatical processing, particularly, whether L2 learners' sensitivity to grammatical violations change, depending on the nature of stimuli and task demands.

Let us return to the point about the nativelikeness of grammatical (or morphology) processing in L2 learners during L2 sentence processing and the extent of L1 effects. Unlike previous studies which contrasted L2 learners from multiple L1 groups (Marinis et al., 2005; Papadopoulou & Clahsen, 2006; Roberts & Liszka, 2013 etc.), the current study only used a single group of L2 learners when investigating L2 sentence processing. Whilst it is clear that sensitivity to inflectional omissions was evident in the auditory modality, without other L1 groups for comparison, the extent to which L1 effects affect real-time L2 sentence processing cannot be comprehensively discussed.

To summarise, this chapter addressed the question of cue processing during real-time L2 sentence processing, specifically, whether L2 learners could acquire an L2 comprehension mechanism to incrementally apply explicit grammatical knowledge to linguistic cues when such features are absent in the L1. Current evidence in auditory comprehension suggests that this is possible. However, L2 learners did not behave like native-L1 speakers and process inflections with different numbers of features differently. Critically, their sensitivity was not uniform across comprehension modalities. In the current semantic-oriented task where both auditory speech and visual text are readily segmented, auditory cues had a facilitatory effect on L2 learners' sensitivity to inflectional omissions.

Chapter 4

L1 phonological influence on L2 comprehension and production

Phonological influence has been implicated as one of the key factors affecting L2 comprehension and production accuracy (Best, 1995; Flege, 1995; Bayley, 1996; Hawkins & Liszka, 2003). Specifically, L2 comprehension is contingent on the accurate perception of L2 phonological features, and L2 production relies on the correct generation of phoneme sequences for articulation. The current study seeks to examine the extent of phonological influence on L1 Mandarin speakers acquiring English inflectional morphology, a grammatical feature which is absent in Mandarin and is phonologically variable in English. This study tested the following predictions: 1) Perceiving distinctions in L2 speech sounds is more difficult if L1 experience induces perceptual biases which favour L1 over L2 phonological features; 2) Production of selective L2 speech sounds is more difficult if the learner's L1 does not allow such phoneme sequences. Using English 3rd person singular *-s* (3SG *-s*) and past *-ed* inflectional morphemes, the findings revealed that L1 Mandarin learners of L2 English did not show consistent perceptual biases towards 3SG -s and past *-ed* inflections which were significantly different to native-L1 speakers under different phonological contexts. Moreover, they processed information from inflectional markings in in the absence of additional cues, just like native-L1 speakers. However, L1 Mandarin learners of L2 English exhibited significantly less accuracy in the production task (CTOPP-2; Phoneme Elision Task) where omission and adjunction of L2 phonemes were required, indicating strong L1 phonological influence on production. Overall, given the absence of certain L2 phonological features in the L1, L1 phonological influence has been found to affect L2 production more than L2 comprehension.

4.1. Introduction

L1 phonological influence is an overarching factor affecting L2 comprehension and production, but it is often unclear to what extent phonological factors affect perception and overt articulation of L2 speech. In L2 comprehension, in order to understand and interpret L2 grammatical features, L2 learners must perceive L2 phonological features correctly, as well as acquire the underlying grammatical distinctions associated with these phonological features. The absence of grammatical distinctions (e.g. tense for L1 Mandarin learners of L2 English) and / or phonological features (e.g. consonant clusters) in the learner's L1 may hinder L2 learners' ability to effectively comprehend L2 speech. Previous research has shown mixed findings regarding the facilitatory effect of auditory cues in detecting L2 grammatical violations (Johnson, 1992; Murphy, 1997; Chapter 3). This brings in the question of whether differences between L1 and L2 phonological properties could affect L2 learners' sensitivity to L2 grammatical features. Could L2 learners be more sensitive to L2 speech sounds that are shared by their L1 than those which are not? If so, to what extent does this sensitivity affect comprehension of novel L2 grammatical features (e.g. inflectional morphology)?

In order to produce L2 grammatical features, L2 learners not only have to acquire the underlying grammatical distinctions in the L2, but must also be able to create the correct phonological structures to articulate these features. It is also well-known that L2 learners often find it difficult to produce grammatical features which do not exist in their L1 even after years of L2 immersion (Lardiere, 1998; 2000). Previous research has attributed variations in L2 grammatical production to L1 phonological influences, where phonological structures not permissible in the L1 are more likely to fail in production (see Goad, White & Steele, 2003 for a linguistic explanation). I argue that in order to draw conclusions about L1 phonological influences, one should also examine L1 phonological constraints outside of specific grammatical contexts (e.g. omission of inflectional morphemes). Could L2 learners also experience phonological difficulties in L2 production without such grammatical features (e.g. in non-inflected words)?

Inflectional morphology carries both syntactic and semantic information (person, number, tense etc.) and is suffixal in English. More importantly, the phonological properties of inflectional morphemes vary depending on phonological context, especially on the phonological properties of the verb. Therefore, in order to successfully comprehend and produce L2 inflectional morphology, the L2 learner not only has to acquire L2 inflectional morphology as a grammatical feature, but also acquire the variety of L2 phonological features that realise these inflections, which may or may not be phonologically permissible in the learner's L1. Inflectional morphology is particularly relevant to our discussion as it is absent in Mandarin Chinese. Different from English, which uses inflectional morphology as well as temporal adverbials to indicate temporal properties of events, Mandarin does not use a system of inflectional morphology and relies on temporal adverbials and aspectual markers to indicate temporal information (e.g. *le*, *guo*, see Chapter 1.5.1 for detailed descriptions). Moreover, in contrast to English, which allows for word-final consonant clusters (e.g. [ks] in *kicks*), Mandarin Chinese consists of mostly monosyllabic morphemes, and word-final consonant clusters are rare.

To what extent do L1 phonological properties influence the comprehension and production of L2 inflectional morphology? On the one hand, if there is a facilitatory effect of phonological overlap between L1 and L2, then one would expect L2 learners to show superior sensitivity to phonological features shared by their L1 than phonological features which are rare or absent in the L1. In the context of comprehending L2 inflectional morphology, the implication would be that L2 learners would be more sensitive to inflectional omissions if the phonological features of the inflections are shared by the L1 than if the phonological features are rare or absent in the L1. On the other hand, if there is no facilitatory effect of L1 phonological features during L2 comprehension, L2 learners' sensitivity to L2 phonological features would be unaffected by the phonological properties of the L1. That is to say, L2 learners' sensitivity to L2 inflectional omissions would be independent of whether the phonological features of the inflections are shared by their L1. If this is the case, any behavioural differences in sensitivity between L2 learners and native-L1 speakers during online L2 comprehension would be attributable processes other than phonological overlap.

From a production perspective, there are three possibilities regarding the extent of L1 phonological influence. First, if L2 learners cannot generate L2 phoneme sequences which are not permissible in their L1, they could have problems articulating grammatical features, where such phoneme sequences are necessary (e.g. verbs with obligatory inflections; e.g. [kt] as in *yesterday she walked*). Alternatively, they could have problems generating and articulating L2 phoneme sequences across all contexts, including in non-grammatical contexts as well (e.g. adjunction of phonemes inside a non-inflected word; e.g. [kt] as in *cocktail*). However, if L2 learners do not have problems generating L2 phoneme sequences in any way, then errors in L2 inflectional production would again be attributable to problems other than L1 phonological influences.

In this chapter, I examine the extent of L1 phonological influence on English inflectional morphology in L1 Mandarin learners of L2 English. Whilst previous research has shown that L1 Mandarin learners of L2 English exhibit auditory sensitivity to inflectional omissions (Johnson & Newport, 1989; Chapter 3), it is not clear how phonological features of inflectional morphology contribute to this sensitivity. Here, I test whether L1 Mandarin learners of L2 English are more sensitive to inflectional morphology with syllabic endings (permissible in L1 Mandarin) than consonant cluster endings (rarely permissible in L1 Mandarin). Moreover, I test whether L1 Mandarin learners of L2 English exhibit sensitivity to temporal information via inflectional morphology (absent in L1 Mandarin) without other temporal cues (i.e. temporal adverbials) whilst controlling for phonological features. Previous theories of L1 phonological influence focused on the constraints the L1 imposes on the phonological hierarchy (or prosodic structure in linguistic terms; see Goad et al. 2003), and their effects on the L2 learner's ability to produce specific L2 grammatical features. Here, I test the extent of L1 phonological constraints on L2 production without implicating L2 grammatical features. Specifically, I examine whether L1 Mandarin learners of L2 English experience difficulties with phoneme adjunctions without inflectional morphemes (3SG *-s* or past *-ed*).

To summarise, this study investigates the extent of L1 phonological influence on L2 inflectional comprehension and production. This study examines not only whether L1 Mandarin learners of L2 English can exhibit sensitivity to inflectional morphemes with different types of phonological features, but also whether they exhibit superior sensitivity to inflectional morphemes with L1 phonological features. Additionally, this study examines whether phoneme adjunction affects L2 production more generally by testing whether L1 Mandarin learners of L2 English could experience production difficulties in non-inflected contexts.

4.1.1. L1 and L2 phonological development

Phonological factors play a critical role in language comprehension and production. In order to understand auditory speech, the listener must first segment auditory signals into smaller units, identify these units, and then map them onto lexical concepts. Languages contain a variety of phonological properties. Relevant to our discussion are phonological features (features of phonemes and phoneme sequences) and phonotactic constraints (rules which phoneme sequences must obey). In linguistic terms, phonological units are organised into a hierarchy, namely a prosodic structure (Selkirk, 1980; McCarthy & Prince, 1995), on which language-specific constraints are imposed.

The first step in acquiring the phonological properties of a language is learning to perceive the phonological distinctions which mark semantic differences over those which do not. With regard to the perceptual sensitivity of phonological features, early research suggests that whilst L1 infants can make phonological distinctions not present in their native language from birth (Eimas, Siqueland, Jusczyk., & Vigorito, 1971; Kuhl, 1987), they quickly lose this ability during the first year of life as they become immersed in their L1 (Werker & Tees, 1984). More specifically, researchers have found that infants exhibit stronger sensitivity to vowels which belong to their native languages than those which do not (Kuhl, Williams, Lacerda, Stevens., & Lindblom, 1992). This suggests that L1 infants' perceptual system becomes more attuned to relevant phonological distinctions as they are exposed to L1 linguistic

input. It is also well established that through immersive exposure, L1 speakers become sensitive to phonotactic information of their native language at a very young age (Friederici & Wessels, 1993). By using probabilistic information of phoneme sequences, L1 speakers can distinguish words from non-words and establish word boundaries when comprehending speech (Jusczyk et al., 1994; Mattys & Jusczyk, 2001). Later through formal language instruction, explicit knowledge of phonotactic constraints on words, including rules of permissible phoneme sequences is also applied to increase chances of successful comprehension.

As Cutler (2000) pointed out, language-specific processing requires L2 learners to acquire a degree of listening competence in order to segment L2 speech appropriately, so how do L2 learners acquire a new phonological system with different phonological properties compared with their L1? On a perceptual level, it is plausible that given the underlying principle of L1 phonological development, late L2 learners could use L1 categories to interpret L2 phonological distinctions first, and would only create new categories for the L2 after lengthy exposure (Flege, 1995). As a result, L2 learners may be insensitive to phonological distinctions which are not semantically relevant in the learner's L1. This is also consistent with the claim that L2 learners interpret unfamiliar L2 speech sounds in terms of phonetic (articulatory) similarity to their L1 (Best, 1995).

To what extent do L1 phonotactic regularities constrain the perception of L2 speech? Past research has suggested that L1 phonotactic constraints can lead to misperception of L2 phoneme sequences. For example, Dupoux, Kakehi, Hirose, Pallier and Mehler (1999) contrasted L1 French and L1 Japanese learners of English in their perceptual sensitivity to English consonant vowel sequences, and found that L1 Japanese learners are more likely to perceive 'illusory' vowels between consonants than L1 French learners (presumably so that the sequence is compatible with L1 phonotactics). Importantly, L1 Japanese learners experienced difficulties discriminating consonant sequences with and without an intermittent vowel. Such evidence suggests there is a fundamental perceptual deficit for some phoneme sequences not permitted in the learner's L1. In another study, Flege and Wang (1989) found that L1 Chinese speakers' sensitivity to English /t/ and /d/ contrasts were affected by the variety of Chinese spoken. Specifically, L1 Mandarin speakers whose

L1 does not permit word-final stops (/t/ and /d/) performed significantly worse than L1 Cantonese speakers[11] whose L1 permits unreleased obstruents (/p, t, k/), though sensitivity to /t/ - /d/ contrasts improved after training for both groups. Other findings by Cutler and colleagues also showed that L2 learners' speech segmentation strategy is heavily contingent on the phonological properties of the L1. For example, as English is not syllable based, English listeners do not use syllable structure as a segmentation strategy to perceive French (Cutler, Mehler, Norris & Segui, 1986), and similarly they do not use morae to perceive Japanese (Otake, Hatano, Cutler & Mehler, 1993). However, Weber and Cutler (2006) also showed that L2 learners could acquire L2 phonotactic probabilities when detecting embedded words in the L2, though they were not able to prevent L1 interference entirely even at high L2 proficiency.

If we take this conclusion forward, then L2 learners should primarily use the segmentation strategy of the L1 to perceive the L2, then by implication they should find some phonological features more difficult to perceive than others, depending on whether such features are permitted in the learner's L1. For example, they may divide syllables or consonant clusters into separate words when they form the suffix of the same word. The main consequence of this type of segmentation error is that L2 learners may miss important semantic information at the site of error. Take the sentence '*She performed a dance*'. If the L2 learner's L1 does not allow for [md] as a phoneme combination at the word final position, then [d] might not be interpreted as an inflectional morpheme. Instead, [d] may be misallocated to the following word, making the sentence sound more similar to '*She perform the dance*'. Consequently, the temporal interpretation of the sentence would be fundamentally different from the intended meaning (not accounting for insensitivity to 3SG *-s* omission).

If these findings are applied more extensively to consonant cluster and syllabic endings created by other inflectional morphemes, one can postulate that L2 learners could experience difficulties detecting the presence (or absence) of a phonological feature which does not fit with the phonotactic constraints of their L1. For example, in the sentence '*The girl walks in the park*', if the learner's L1 does not allow for [ks]

[11] A spoken variety of Chinese which is phonologically distinct from Standard Mandarin.

as a phoneme sequence, then it is plausible that L2 learners would fail to detect the difference between *walks* and *walk*. If we take a more lenient view, that L2 learners could at least detect the presence of an inflectional morpheme with an L2 phonological feature, L2 learners could still be more sensitive to phonological features which are more frequent in the learner's L1 than those which are rare. For example, L2 learners could exhibit more sensitivity to *shouted* (syllabic endings) than *walks* (consonant cluster endings).

An argument to the contrary would be that L2 learners, regardless of the phonotactic constraints of their L1, would show similar levels of sensitivity towards different types of phonological features. One interesting study by Solt et al. (2004) examined the L2 perception of the past *-ed* morpheme as [t], [d] and [ɪd] allophones under different phonological contexts (as determined by phonological properties of verbs). Verbs with past *-ed* morphemes were presented in a sentential context (e.g. *The girl walked in the park*), where an L1-English 'student' repeated sentences (with or without *-ed* on the verb) after an L1-English 'teacher'. L2 learners were asked to make a same vs. different response based on whether they perceived the verb repetition by the student was the same or different to the 'teacher'. Their findings showed that L2 English learners from different L1 backgrounds were generally more sensitive to *-ed* morphemes in syllabic contexts (e.g. [ɪd] in [ʃaʊtɪd] / *shouted*) than as when they appeared as part of consonant clusters (e.g. [t] in [wɔːkt] / *walked* or [d] in [kləʊzd] / *closed*). If these findings stand, that L2 learners perform similarly to each other in L2 perception regardless of their respective L1s, one may speculate whether L2 learners are fundamentally constrained by L1 phonological properties at all, and whether their performance would be significantly different to native-L1 speakers in terms of perceptual sensitivity.

In production, Solt et al. (2004) found that L2 learners of English from multiple L1 backgrounds were also most accurate in the condition with [ɪd] endings across proficiency levels compared with [t] and [d] endings. This could suggest that the ease of L2 production is determined more by intrinsic properties of L2 phonological features rather than specific phonological constraints from the learners' L1s.

To summarise, previous research commonly agree that L1 phonological properties imposes perceptual and phonotactic constraints on L2 learners' perception and production of L2 speech as a result of L1 development and maturation. L2 learners typically exhibit perceptual biases against L2 phonological features which are rare or absent in the L1. However, limited attempts have been made to explain the behavioural evidence for these constraints. Specifically, the principles of phonological acquisition and processing have not been extensively explored. In the next section, I will briefly outline a few explanations of L1 phonological influence on L2 comprehension and production from psycholinguistic and linguistic perspectives.

4.1.2. Accounts of L1 phonological influence

How do psycholinguistic models explain phonological influences in L2 comprehension and production? On the establishment of single phonemes, researchers from connectionist perspectives claim that L2 phonemes are acquired based on the saliency of phonetic features (Hancin-Bhatt, 1994). In other words, the most salient phonemes would be more easily perceived and learned. Whereas Hancin-Bhatt (1994) defined saliency in terms of frequency of occurrence, we can also consider L2 phonemes in terms of perceptual saliency. If L1 development diminishes the L2 learners' sensitivity towards phonological distinctions which do not mark semantic distinctions, then L2 learners could, as a result, exhibit perceptual biases against the relevant phonological distinctions in the L2. Alternatively, they could use L1 phonological categories to process L2 sounds by default before developing new phonological categories for the L2 (Best, 1995; Flege, 1995).

On the use of phonotactic information, connectionist models such as the Bilingual Interactive Model of Lexical Access (BIMOLA; Grosjean; 1997; Léwy & Grosjean, 2008) provides a detailed account of how bilinguals use phonotactic information to recognise and process words from each of the two languages. The model claims that whilst phonemes and words from each of the bilinguals' languages are stored as subsets of the same system, features are shared between the two

languages. Therefore, in order to identify the language of the input, the bilingual must be able to use phonotactic information to identify and activate one subset and inhibit another at phoneme and word levels. It is important to note that models such as BIMOLA do not account for 'unbalanced' bilinguals, where the L2 learner may still be acquiring the L2 phonotactic information through limited input. Given the importance of phonotactic processing in the model, the lack of L2 exposure or a lack of explicit knowledge of L2 phonotactic constraints could be detrimental to the bilinguals' ability to identify and breakdown L2 phonemes and words from auditory signals. That is, if the L2 learner does not have enough phonotactic information from the L2, he / she would have to rely on L1 phonotactics to interpret L2 phonological features, which may result in comprehension errors.

The picture is more complicated for L1 phonological influence on L2 production. Specifically, existing theories propose different principles regarding the form which L1 phonological constraints could take. Roelof's (1997) WEAVER++ is a dedicated model which details the stages of phonological encoding during speech production. Important for our discussion is the process of *syllabification*, where syllables from the *phonological word* take on the phonological context of the word or phrase and are organised in accordance with the phonological rules of the language spoken. If the same principles apply to L2 speech production, then the process of syllabification is where L1 phonotactic constraints and rules of L1 phonology are applied. This is a processing constraint where activations are facilitated or inhibited depending on the rules of the language spoken. In a way, this is comparable to Goad et al.'s (2003) *Prosodic Transfer Hypothesis* (PTH), which claimed that the L1 prosodic structure is transferred to L2 production and constrains L2 English learners' ability to consistently produce inflectional morphology. More specific than claims relating to syllabification in WEAVER++, PTH assumes that the generation of phonological representations for speech must adhere to a theoretical hierarchy imposed by the phonological rules of the language. For example, in order to produce regular English inflectional morphology, the prosodic structure must allow for adjunction to the *prosodic word* (see Figure 18).

Figure 18. Prosodic structure of Mandarin aspectual marking (3) and English inflectional marking (4). Taken from Goad and White (2006).

In the example above, whereas the Mandarin perfective aspectual marker *le* modifies the verb mai3 (to buy) inside the prosodic word to produce mai3 le5 (bought already), the English *-ed* inflection require adjunction outside the prosodic word in order to produce *helped*. If the learner's L1 (i.e. Mandarin) does not allow for the adjunction structure for attaching inflectional morphemes to the prosodic word, then the learner would not be able to generate the phonological representation for an inflected form, leading to production failures. This stands in contrast with irregular past forms where modification occurs inside the prosodic word (*drink - drank*), which were found to be easier to produce for L1 Mandarin learners of L2 English (Wolfram, 1985; Bayley, 1996; Hawkins & Lizska, 2003). Different from WEAVER++, Goad et al. (2003) stated that the transfer of L1 prosodic structures is a representational issue, and that such constraints on acquiring L2 prosodic structure originate with limited access to interlanguage representations. Note that the most recent version of the PTH claims that prosodic transfer plays a constraining role in L2 acquisition, but not a permanent one (see Goad & White, 2019, for review). Moreover, whilst Goad et al. initially claimed prosodic constraints do not necessarily affect L2 comprehension, recent evidence seems to suggest a role of L1 prosodic transfer in comprehension errors, when no production is involved (see Lieberman, 2013).

Overall, it remains unclear whether L2 learners consistently exhibit perceptual deficiency or bias for specific grammatical features as a result of L1 phonological properties. Moreover, if L1 phonological influence affects L2 production more generally, then difficulties with phoneme adjunction should be observable outside of specific grammatical contexts (i.e. inflectional morphology). However, such evidence has not yet been shown.

4.1.3. The current study

I present two experiments examining the extent of phonological influence on L2 learners' perceptual sensitivity to L2 temporal inflectional morphemes in L2 comprehension, as well as adjunction of phoneme sequences in non-inflected contexts in L2 production.

L1 Mandarin learners of L2 English (AoA > 5 years) and L1 English controls participated in two experiments, each including two tasks: a Phonological Discrimination (PD) Task using an auditory ABX paradigm (Clarks, 1982), and a Phoneme Elision task (CTOPP-2; Wagner, Torgesen, Rashotte, & Pearson, 2013). For the PD Task, participants identified test words (e.g. *kicks*) from a previous word pair (bare verb - inflected verb; e.g. *kick* - *kicks*) in an auditory ABX paradigm, a method often used to measure participants ability to discriminate between two stimuli. Phonological Endings (consonant clusters vs. syllabic) were manipulated via inflectional morpheme (3rd person singular -*s*; 3SG -*s* vs. past -*ed*) and verb. Note that in an ABX paradigm, participants must identify which of the two stimuli was presented as the test stimulus and respond (e.g. by pressing a key) as quickly as possible. This task relies on participants' ability to quickly discriminate between the two stimuli in question. Hence, participants' speed of response to the test stimulus (reaction time, or RT in milliseconds) would be a measure of their sensitivity to the differences between the two stimuli. In this paradigm, shorter RTs indicate stronger sensitivity for the phonological difference in question, and longer RTs indicate weaker, or absence of sensitivity to such differences. In this case, participants' RTs on the test words were taken as a measure of sensitivity to the phonological distinctions between the bare and inflected verbs.

For the PE Task, participants completed the standardized Phoneme Elision Task from CTOPP-2. For each of the 20 items in the test, participants deleted a specific phoneme or phoneme sequence from an English word upon instruction and articulated the post-elision word out loud.

Given current empirical evidence for the extent of L1 phonological influence, separate predictions have been made regarding the influence of L1 phonology on L2 comprehension and production.

In L2 comprehension, if L1 Mandarin learners of L2 English are constrained by L1 phonotactics and are insensitive to phonological features absent in L1 Mandarin, then it is plausible that they have a fundamental perceptual deficit with regard to temporal morphemes 3SG *-s* and past *-ed* when presented as an inflection of a verb. In which case, they should experience difficulties distinguishing inflected from non-inflected forms, especially for 3SG *-s* and past *-ed* inflections which form consonant cluster endings (e.g. *kicks* from *kick* - *kicks*, and *closed* from *close* - *closed*). That is, one would expect longer test word RTs in L1 Mandarin learners of L2 English compared to L1 English controls. If they do not have a perceptual bias regarding 3SG *-s* and past *-ed* inflectional morphemes more than their native-L1 counterparts, they should exhibit similar sensitivity to L1 English controls on test words. That is, one would expect no significant differences in test word RTs between L1 Mandarin and L1 English participants. Finally, if L1 Mandarin learners of L2 English could perceive L2 phonological features (consonant clusters vs. syllabic) created by inflectional morphemes 3SG *-s* and past *-ed*, but are still influenced by L1 phonological properties, L1 Mandarin learners could exhibit perceptual biases favouring sensitivity L1 phonological features and against L2 phonological features. That is, they may be more sensitive to syllabic endings compared to consonant cluster endings relative to L1 English controls. In which case, we should see L1 Mandarin learners exhibit significantly shorter test word RTs than L1 English controls for syllabic endings irrespective of the inflectional morpheme (3SG *-s* or past *-ed*).

In L2 production, if the constraint on phoneme adjunction is a general one extending beyond inflectional morphemes, then similar difficulties should also be found in non-inflected contexts. In the PE task, if L1 Mandarin speakers have difficulty performing phoneme adjunctions within a word, then this would provide evidence for general phonological constraint in L2 English production beyond specific grammatical features.

4.2. Experiment 6

4.2.1. Methods

Participants

55 L1 Mandarin learners of L2 English aged 19-28 (M=23.52; SD=1.72) and 41 L1 English speakers aged 19-32 (M=23.50; SD=3.60) took part in Experiment 1. L1 Mandarin speakers were postgraduate students at the University of Edinburgh who were within two years of first arrival in the UK. All L1 Mandarin participants acquired English after the age of five (AoA = 6+), and had obtained at least a score of 6.5 overall on the IELTS English proficiency exam, with no less than a score of 6 on the listening component (see Appendix L for summary). L1 English participants were monolingual speakers who did not have extensive exposure to other L2s before the age of five.

Materials

For the Phonological Discrimination (PD) Task, 20 English verbs were chosen based on their phonetic properties when attached to 3SG *-s* and past *-ed* inflectional endings (see Appendix M). Verb Set A consisted of ten verbs which formed consonant cluster endings when attached to 3SG *-s*, and syllabic endings when attached to past *-ed*; Verb Set B consisted of ten verbs which form consonant cluster endings in both cases. For this task, all bare verbs were paired with their corresponding inflected forms for each trial. Order of presentation for the two verb forms in each trial was counterbalanced for 3SG *-s* and past *-ed* endings, then rotated around two lists using a Latin square design. The verb form for the test word (bare or inflected) was also counterbalanced for different presentation order across the two lists. All verbs forms were recorded in a recording studio using the voice of a British English speaker in .wav format. E-Prime was programmed for the auditory presentation of stimuli, and a desktop computer with a 1920 x 1080 pixels screen and a pair of stereo headphones were used to deliver the recordings.

The Phoneme Elision (PE) Task was taken from the Comprehensive Test of Phonological Processing (CTOPP-2; Wagner et al., 2013) to assess adult participants' phonemic awareness (ability to manipulate phonemes) in English. The test consisted five practice items and 20 test items. Of the 20 test items, nine items required phoneme elision (or deletion) at word boundaries (the beginning or the end of words), with another eleven items requiring phoneme elision in the middle of the words (see Appendix N for details). The test was adapted for audio presentation using the voice of a British English speaker as the instructor. For each item in the test, the speaker provided instructions for each step in the task (word repetition followed by phoneme elision), with feedback on the first ten items (five practice items and five test items). Audio recordings were then edited, adding 2000 ms of silence after each instruction to allow time for participant response. All recordings were normalised for volume and stored in .wav format to preserve audio quality.

Design

The PE Task used a mixed-design with Group (L1 Mandarin vs. L1 English; between-subjects), Temporal Context (Present Habitual vs. Past; within-subjects) and Phonological Ending (consonant cluster vs. syllabic; within-subjects) as fixed-effects predictors, and response RT on the test word (ms) as the outcome variable. The PE Task used a mixed design also, with Group and Place of Elision (word boundary vs. mid-word; within-subjects) as fixed effects predictors, and response accuracy (correct vs. incorrect) as the outcome variable.

Procedure

Upon arrival, participants were first asked to read the experiment instructions and provide consent for their data to be used. They also provided demographic details and language background information, including details of L2 acquisition for the L1 Mandarin group (IELTS scores, AoA for L2, length of stay in months, and daily L2 exposure in hours). Afterwards, participants were asked to explain the experimental tasks back to the experimenter before commencing the experiment.

Participants were reminded that they must respond as soon as possible after hearing the test word.

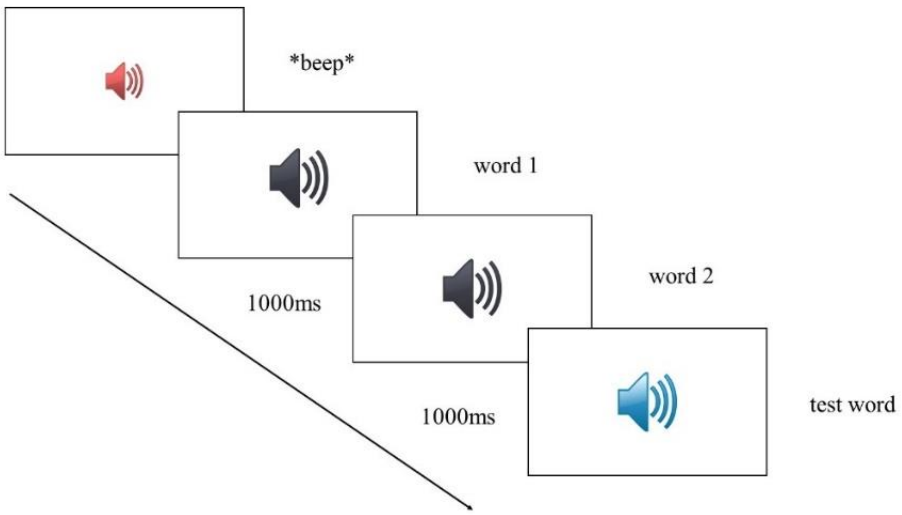


Figure 19. Experiment 6: Trial procedure for the Phonological Discrimination Task (beep - word 1 – 1000ms break – word two – 1000ms break – test word).

For each trial in the PD Task, participants first heard a beep, followed by two words. One of the two words was then played as the test word, after which participants must identify the test word by pressing one of two number keys (**[1]** for the first word, or **[2]** for the second word). Participants were given a maximum of 2500 ms to respond, after which the next trial would commence (see Figure 19). Participants listened to four blocks of 20 trials, with optional breaks between each block. Trial order was randomised, with each verb appearing only once in each block. Response RT for each test word was recorded by E-Studio 2.0 for subsequent analyses.

For the PE Task, the experimenter first explained the principle of the task to the participants with two emphases: 1) participants must focus on the pronunciation of each word, omitting sounds, not letters; 2) all words were known English words (i.e. participants are not expected to make up non-words). Participants were then given several examples of phoneme elision, none of which featured in the test items. Audio recordings were played to the participant one by one in the same order as in the original CTOPP-2 PE Task. Recordings were paused after each line of instruction to

give participants time to respond. For each item in the test, participants must first repeat an English word (e.g. instructor: s*ay 'text'*). Then, the participants must omit a specific phoneme from the given word, and pronounce the remaining parts of the word according to instruction (e.g. instructor: *say 'text' without saying /k/*). Several changes were made to the original PE test procedure: 1) participants listened to all items via audio recording in British English instead of American English; 2) all participants listened to all items regardless of response accuracy; 3) feedback was provided on the first ten items regardless of response accuracy. Participants' oral response to each item in the task was recorded in wav. format for subsequent analyses.

Each experimental session lasted 30-35 minutes. Participants were paid five pounds in cash for their time.

Coding and Scoring

Phonological Discrimination (PD) Task

E-Studio 2.0 generated raw reaction times (RTs) from the end of the test word recording to the point of response. 2% of data were excluded as participants incorrectly identified the test word on these trials. RT data above 1000ms for this task were considered as outliers, and RT data below 200ms could not be reliably attributed to intentional behavioural responses. A further 4% of data were excluded based on these criteria.

Phoneme Elision (PE) Task

Oral production data from all participants were coded using three separate coding criteria. For each item in the PE task, participants' repetition, omission and adjunction accuracy were coded as binomial data (correct, incorrect). Repetition accuracy was defined by whether the participants' repetition of the word was identifiable as the original word (accounting for non-native like pronunciations). Omission accuracy was defined by whether the target phoneme, and only the target phoneme was accurately deleted from the original word. For example, *sit* and *spit*

would both be scored as incorrect if the trial required participants to omit /p/ from *split* (*slit*). Adjunction accuracy applied only to mid-word phoneme elisions, and was defined by whether the two remaining parts of the word were blended together in oral production with no audible gaps. For example, *win* and *win - er* would both be scored as incorrect if the trial required participant to omit /t/ from *winter* (*winner*).

4.2.2. Results

Phonological Discrimination (PD) Task

For the PD Task, analyses were conducted on the effect of Group, Temporal Context and Phonological Ending on participants' reaction time (RT) on the test word. General linear mixed effects models (GLMMs) were constructed using a forward model building strategy with a maximal random effects structure (Barr et al., 2013). Group (between-subjects) was included in the model with either Temporal Context or Phonological Ending (within-subjects) as fixed-effects predictors, and Participant, (Verb) Item and Trial Order were included as random effects if they significantly improved model fit. All categorical predictors were contrast-coded and centred before they were entered into the model. Note that only data from accurate responses trials were included in these analyses (3% of response data had inaccurate responses and were excluded).

There were two parts to the analyses. First, the effect of Phonological Ending on test word RT was analysed with Group and Phonological Ending as fixed-effects predictors, also controlling for (Past) Temporal Context. As past *-ed* produced syllabic endings with Verb Set A (e.g. *shouted*) and consonant cluster endings with Verb Set B (e.g. *chased*), only trials from the Past temporal context was suited to this analysis. Second, the effect of Temporal Context on test word RT was analysed using only one set of verbs with Group and Temporal Context as fixed-effects predictors, controlling for (consonant cluster) Phonological Ending. Verb Set B contained verbs which shared consonant cluster endings for both Present Habitual (3SG *-s*) and Past (*-ed*) inflectional morphemes (e.g. *attacks*, *attacked*), and was therefore suited to this

particular analysis. From these two analyses, the effects of Temporal Context and Phonological Ending can be isolated respectively.

Phonological Ending Effects

RTs on test words with consonant cluster (Verb Set B) or syllabic endings (Verb Set A) in the Past temporal context were analysed for L1 Mandarin and L1 English groups. Note that (Verb) Item effects were controlled by adding Item as a random intercept in the GLMM.

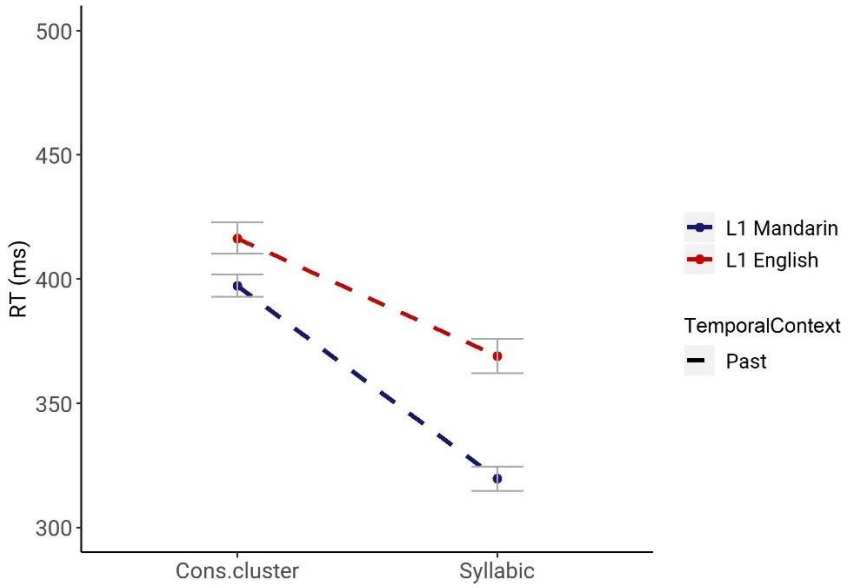


Figure 20. Experiment 6: Average reaction Time (ms) on test words across Consonant Cluster and Syllabic endings in the Past temporal context (*-ed*) for L1 Mandarin and L1 English groups (N=55;41).

There was a significant main effect of Group (Table 20). L1 Mandarin and L1 English groups differed significantly in their RTs on the test words overall (M= 360.39 vs. M= 393.13). There was also a significant main effect of Phonological Ending. Test words with consonant cluster endings in the Past temporal context produced significantly longer RTs than those with a syllabic ending in both L1 Mandarin and L1 English groups (M = 405.13 vs. M = 340.28; Figure 20). Interestingly, there was also a significant interaction between Group and Phonological Ending, indicating that L1 Mandarin and L1 English groups responded

differently to test words with consonant cluster and to words with syllabic endings. This prompted further subgroup analyses on each participant group. In addition to confirming the significant effect of Phonological Ending for both L1 Mandarin and L1 English groups (Table 20), subgroup analyses also revealed that L1 Mandarin participants exhibited greater differences in RT on tests words with a consonant cluster ending and with a syllabic ending, indicating stronger sensitivity to test words with syllabic endings (in the Past temporal context).

Table 20.

General linear-mixed effects model (GLMM) statistics for Phonological Ending Effects analysis in the Phonological Discrimination task for L1 Mandarin and L1 English groups (N=55;41).

	B (SE)	*p*
Intercept	375.92 (8.81)	<.001
Group ***(L1 Mandarin** vs L1 English)*	34.42 (14.80)	**.022**
Phonological Ending ***(Consonant Cluster** vs Syllabic)*	-69.96 (10.95)	**<.001**
Group × Phonological Ending	-30.22 (10.06)	**.003**
L1 Mandarin		
Intercept	362.16 (10.58)	<.001
Phonological Ending	-82.00 (9.98)	**<.001**
L1 English		
Intercept	396.29 (12.31)	<.001
Phonological Ending	-51.73 (13.66)	**.001**

* ***bold italic*** indicates reference levels

Temporal Context Effects

Response RTs on test words involving a consonant cluster distinction for both 3SG *-s* (Present Habitual) and past *-ed* (Past) were analysed for L1 Mandarin and L1 English groups (Figure 21).

There was no significant main effect of Group. Overall, the L1 Mandarin group had shorter RTs on the test word compared to the L1 English group (M= 386.84 vs.

M= 409.51), but the two groups did not differ significantly (Table 21). Importantly, there was a significant main effect of Temporal Context (or inflectional ending). Both L1 Mandarin and L1 English groups produced shorter RTs for 3SG *-s* (Present Habitual) than for past *-ed* (Past) (Figure 19). Group and Temporal Context did not show significant interaction, indicating Temporal Context did not affect the L1 Mandarin and L1 English groups differently.

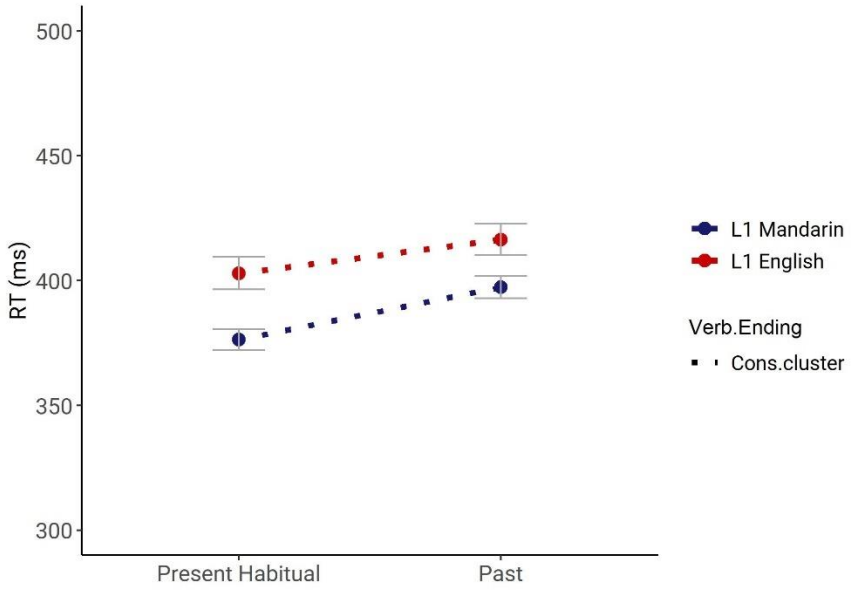


Figure 21. Experiment 6: Average reaction time (ms) on test words with Consonant Cluster endings across Present Habitual (3SG *-s*) and Past (*-ed*) temporal contexts for L1 Mandarin and L1 English groups (N=55;41).

Table 21.

Experiment 6: General linear-mixed effects model (GLMM) statistics for Temporal Context Effects analysis in the Phonological Discrimination task for L1 Mandarin and L1 English groups (N=55;41).

	B (SE)	*p*
Intercept	401.88 (9.24)	**<.001**
Group (***L1 Mandarin*** vs *L1 English*)	25.21 (16.47)	.129
Temporal Context (***Present Habitual*** vs *Past*)	18.23 (4.56)	**<.001**
Group × Temporal Context	-9.05 (9.27)	.329

* ***bold italic*** indicates reference levels

Phoneme Elision (PE) Task

For the PE Task, separate analyses were conducted for participants' accuracy on each of the three response types: repetition, elision and adjunction. Generalised logistic mixed-effects models (GLMMs) were constructed to analyse the likelihood of each type of response. For repetition accuracy, Group was used as the only fixed-effects predictor with Participant and Item as random intercepts. For omission accuracy, both Group and Place of Elision (PoE) were used as fixed-effects predictors, and Participant, Item as random intercepts if they improved model fit. Note that whilst all 20 items of the PE task required phoneme elision, only eleven out of 20 items from the PE task required phoneme adjunction. Therefore, analysis on adjunction accuracy was only run on data for these eleven items.

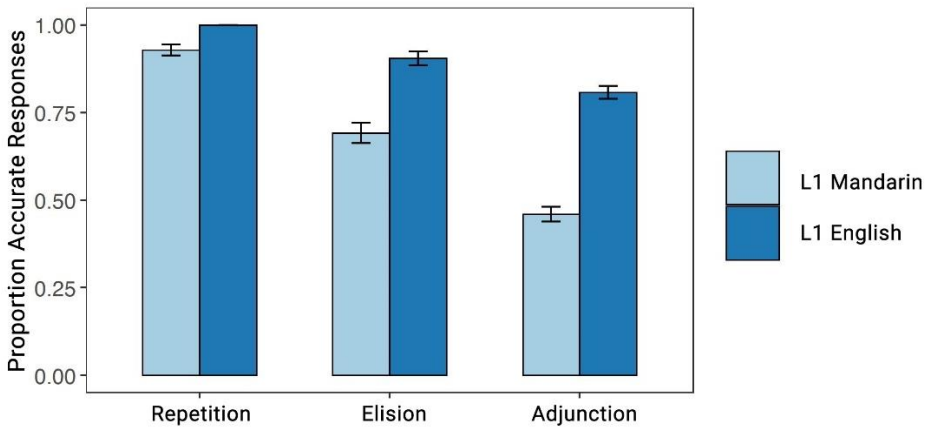


Figure 22. Experiment 6: Repetition, Elision and Adjunction accuracy in the Phoneme Elision Task for L1 Mandarin and L1 English groups (N=55;41).

For repetition accuracy, there was no main effect of Group (Table 22). Overall, the L1 Mandarin group was not significantly less likely to make an accurate response than the L1 English group when asked to repeat a word in the PE task (M= 0.93 vs. M= 1.00; Figure 22). However, there were several items which were consistently misperceived in the L1 Mandarin group. Their phonological properties will be discussed later on.

Table 22.

Experiment 6: Generalised logistic mixed-effects model (GLMM) statistics for the Phoneme Elision task across L1 Mandarin and L1 English groups (N=55;41).

	Repetition		Elision		Adjunction	
	B (SE)	*p*	B (SE)	*p*	B (SE)	*p*
Intercept	14.20 (26.94)	.598	2.38 (0.32)	**<.001**	0.75 (0.40)	.058
Group (***L1 Mandarin*** vs. *L1 English*)	21.64 (60.92)	.722	2.18 (0.28)	**<.001**	2.28 (0.26)	**<.001**
Place of Elision (***Word Boundary*** vs. *Mid-word*)	-	-	-3.01 (0.63)	<.001	-	-
Group × Place of Elision	-	-	0.21 (0.50)	.677	-	-

* ***bold italic*** indicates reference levels.

For elision accuracy, there was an effect of Group (Table 22). Overall, the L1 Mandarin group was significantly less likely to delete the correct phoneme than the L1 English group for items in the PE task (M= 0.69 vs. M= 0.90; Figure 22). Interestingly, there was also an effect of PoE. Participants were significantly more likely to produce accurate elision responses for items with word boundary elisions (at the beginning or at the end of the word) than for items with mid-word elisions (M= 0.95 vs. M= 0.65). There was no significant interaction between Group and PoE.

For adjunction accuracy, there was an effect of Group (Table 22). Overall, the L1 Mandarin group was significantly less likely to produce accurate adjunction responses than the L1 English group (M= 0.46 vs. M= 0.81; Figure 22).

4.2.3. Interim Discussion

In Experiment 6, there were two key findings regarding the effect of phonological feature on perceptual sensitivity to inflected verb forms. First, controlling for temporal context (Past), both L1 Mandarin and L1 English participants exhibited stronger sensitivity on test words with a syllabic ending than those with a consonant cluster ending, indicating that consonant clusters were more difficult to process irrespective of the listener's L1. Critically, data showed that L1 Mandarin participants exhibited superior sensitivity towards syllabic endings compared with the L1 English controls. Controlling for Phonological Ending (consonant cluster), both L1 Mandarin and L1 English participants exhibited stronger sensitivity to test words in the Present Habitual temporal context (3SG -*s*) compared with the Past (-*ed*) context with no between-group differences. This indicated that L1 Mandarin learners of L2 English assimilated temporal (and subject number) information from inflectional morphemes like L1 English controls, even when the resulting phonological feature was rarely permissible in their L1.

The PE Task showed L1 Mandarin learners of L2 English have substantial difficulties performing phoneme adjunctions within non-inflected words, pointing towards a generalised difficulty with processing and articulating L2 phoneme sequences.

Experiment 6 is not without problems. The choice of verbs for the PD Task meant that the analyses could not have a set of balanced conditions for Temporal Context and Phonological Ending. Hence, the Temporal Context effect analysis was only conducted on one set of verbs (Verb Set B) but not the other, and the Phonological Ending effect analysis was only conducted for the Past but not for the Present Habitual temporal context. For each result, a point of comparison was not available to eliminate temporal context specific or item specific effects. Consequently, for Experiment 7, Verb Set B was replaced by another set of ten verbs (Verb Set C) to counterbalance Verb Set A.

4.3. Experiment 7

4.3.1. Methods

Participants

42 newly recruited L1 Mandarin learners of L2 English aged 18-31 (M=21.69; SD=2.71) and 43 newly recruited L1 English speakers aged 18-37 (M=21.523; SD=3.84) took part in Experiment 7. All recruitment criteria were identical to those in Experiment 6.

Materials

Verb Set A was taken from Experiment 6, but Verb Set B was replaced by Verb Set C, which consisted of ten verbs which form syllabic endings when attached to 3SG *-s* inflections and consonant cluster endings when attached to past *-ed* inflections (*chases, chased*; see Appendix M for full list). Materials for the PE task were identical to those used in Experiment 6. No changes were made.

Design

Aside from the balancing of experimental conditions across Temporal Context and Phonological Ending, other aspects of experimental design were identical to that of Experiment 6.

Procedure

All aspects of the experimental procedure were identical to Experiment 6.

Coding and Scoring

All coding and scoring procedures were identical to Experiment 6 for both PD and PE Tasks.

4.3.2. Results

Phonological Discrimination (PD) Task

For the PD Task in Experiment 7, Group (between-subjects), Temporal Context and Phonological Ending (within-subjects) were used as fixed effects predictors, and Participant, Item and Trial Order as random intercepts in the main GLMM. Our model building strategy was identical to that of Experiment 6. As Experiment 7 contained a balanced experimental design, a single GLMM was constructed to examine both Temporal Context and Phonological Ending effects on response RT. Only RTs from accurate responses from the PD Task in Experiment 7 were examined.

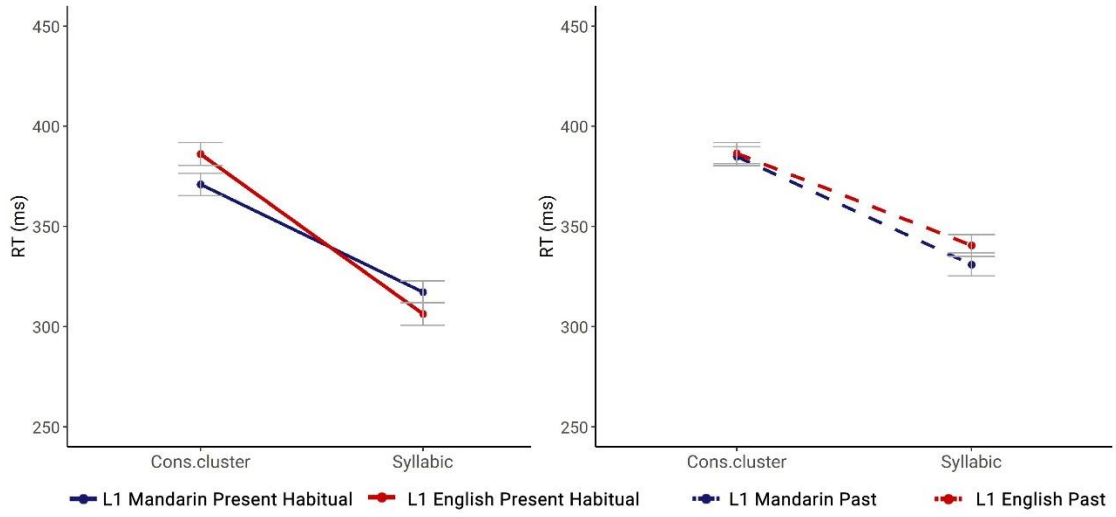


Figure 23. Experiment 7: Average reaction time (ms) for Consonant Cluster and Syllabic endings across Present Habitual (3SG *-s*) and Past (*-ed*) temporal contexts in the Phonological Discrimination Task for L1 Mandarin and L1 English groups (N=42;43).

There was no significant main effect of Group (Table 23). L1 Mandarin and L1 English groups did not significantly differ in their response RT on the test word (M= 352.52 vs. M= 356.58; Figure 23). Similar to Experiment 6, there was a significant main effect of Temporal Context (or inflectional ending). Irrespective of Group, participants produced shorter RTs in the Present Habitual (3SG *-s*) context than in the Past (*-ed*) temporal context (M= 347.18 vs. M= 361.62). Critically, similar to results from Experiment 6, there was a significant effect of Phonological Ending.

Participants from both L1 Mandarin and L1 English groups produced longer RTs on test words with consonant cluster endings compared with words with syllabic endings (Figure 23). A three-way interaction was found between Group, Temporal Context and Phonological Ending.

Table 23.

Experiment 7: General linear-mixed effects model (GLMM) statistics for test word reaction time in the Phonological Discrimination task for L1 Mandarin and L1 English groups (N=42;43).

	B (SE)	*p*
Intercept	357.954 (7.71)	**<.001**
Group *(**L1 Mandarin** vs. L1 English)*	2.596 (14.57)	.859
Temporal Context *(**Present Habitual** vs. Past)*	17.420 (3.55)	**<.001**
Phonological Ending *(**Consonant Cluster** vs. Syllabic)*	-61.72 (3.55)	**<.001**
Group × Temporal Context	3.79 (7.08)	.593
Group × Phonological Ending	-5.98 (7.09)	.399
Temporal Context × Phonological Ending	20.61 (12.33)	.112
Group × Temporal Context × Phonological Ending	28.41 (14.17)	**.045**

*** *bold italic*** indicates reference levels.

Phoneme Elision (PE) Task

Identical analyses from Experiment 6 were carried out for participants' repetition, elision and adjunction accuracy on the PE task. All fixed effects predictors and random intercepts were identical to the PE analyses in Experiment 6.

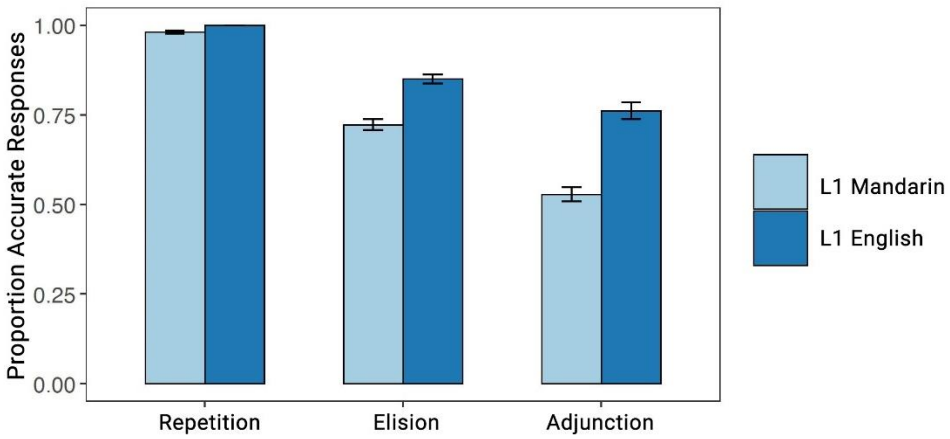


Figure 24. Experiment 6: Repetition, Elision and Adjunction accuracy in the Phoneme Elision Task for L1 Mandarin and L1 English groups (N=42;43).

For repetition accuracy, there was no significant main effect of Group (Table 24). Similar to Experiment 1, both L1 Mandarin and L1 English groups performed at ceiling levels, and the L1 Mandarin group was not significantly less likely to produce accurate responses when asked to repeat a word in the PE task (M=0.98 vs. M=1.00; Figure 24).

For elision accuracy, there was a significant main effect of Group (Table 24). The L1 Mandarin group was significantly less likely to delete the correct phoneme than the L1 English group for items in the PE task (M= 0.72 vs. M= 0.85; Figure 24). There was also an effect of PoE. Similar to Experiment 6, phonemes at word boundaries were significantly more likely to be deleted accurately compared to mid-word phonemes (M= 0.95 vs. M= 0.66).

For adjunction accuracy, there was an effect of Group (Table 24). Once more, the L1 Mandarin group was significantly less likely to produce an accurate adjunction than the L1 English group (M= 0.53 vs. M= 0.76; Figure 24)

Table 24.

Experiment 7: Generalised logistic mixed-effects model (GLMM) statistics for the Phoneme Elision task across L1 Mandarin and L1 English groups (N=42;43).

	Repetition		Elision		Adjunction	
	B (SE)	*p*	B (SE)	*p*	B (SE)	*p*
Intercept	20.23 (64.93)	.755	2.38 (0.32)	<.001	0.75 (0.40)	.058
Group (***L1 Mandarin*** vs. *L1 English*)	23.10 (128.29)	.857	2.18 (0.28)	**<.001**	2.28 (0.26)	**<.001**
Place of Elision (***Word Boundary*** vs. *Mid-word*)	-	-	-3.01 (0.63)	**<.001**	-	-
Group × Place of Elision	-	-	0.21 (0.50)	.667	-	-

**** bold italic*** indicates reference levels.

4.3.3. Interim Discussion

Experiment 7 set out to replicate the findings from Experiment 6 with a balanced design. The results were mixed. First, consistent with Experiment 6, Experiment 7 confirmed the finding that participants' perceptual sensitivity to 3SG *-s* and past *-ed* inflectional morphemes did not differ significantly, irrespective of the listener's L1 (L1 Mandarin or L1 English). However, inconsistent with Experiment 6, L1 Mandarin participants did not exhibit superior sensitivity to L1 phonological features (syllabic endings) than L1 English controls, which pointed to a lack of perceptual biases contingent on L1 phonological properties. Second, Experiment 7 showed that L1 Mandarin participants, like L1 English controls, were more sensitive to Present

Habitual 3SG *-s* than past *-ed* in syllabic phonological contexts as well as consonant cluster contexts. This indicated that the L1 Mandarin participants in particular processed temporal information via L2 inflectional morphology irrespective of phonological context. Regarding the PE Task, consistent with Experiment 6, Experiment 7 confirmed difficulties in phoneme adjunction in non-inflected contexts, indicating a generalised difficulty with articulating L2 phoneme sequences not restricted to adjunction of inflectional morphemes.

4.4. General Discussion

Previous research has proposed L1 phonological influence as a key factor during L2 comprehension and production. However, it is unclear how L1 phonological properties affect the perception and production of L2 speech. Given previous research evidence, it is unclear whether L2 learners are more sensitive to phonological features that are shared by their L1 than those that are not, and whether perceptual sensitivity interacts with the processing of grammatical features. Moreover, we do not know whether the principles involved in adjoining grammatical features in L2 production would also apply outside specific grammatical contexts.

In two experiments, L1 Mandarin learners of L2 English and L1 English controls completed Phonological Discrimination Tasks, where they differentiated bare verbs from inflected verbs (and vice versa). They also performed Phoneme Elision Tasks, where they deleted specific phoneme(s) from a non-inflected word. The findings showed that L1 Mandarin learners of L2 English performed on apar with L1 English controls when perceiving phonological features created by L2 inflectional morphemes. This indicated that L1 Mandarin learners of L2 English did not have perceptual biases for L2 phonological features that were different to L1 English controls. Although Experiment 6 showed L1 Mandarin learners of L2 English exhibited superior sensitivity on syllabic phonological endings, this was not replicated in Experiment 7 with the addition of a different set of verbs, indicating no reliable effect. In L2 production, L1 Mandarin learners of L2 English consistently performed less accurately than L1 English controls when instructed to delete specific

phonemes from an L2 English word. Importantly, L1 Mandarin learners of L2 English were significantly less accurate than L1 English controls performing phoneme adjunctions within a non-inflected word. This indicated a generalised difficulty with articulating L2 phoneme sequences among L1 Mandarin participants, which is not restricted to adjoining inflectional morphemes to verbs.

4.4.1. L2 perceptual biases and comprehension

Current findings show no reliable effect of L1 induced perceptual biases among L2 learners. More specifically, as L2 learners did not exhibit phonological sensitivity which were significantly different to their L1 counterparts on both phonological features, these findings suggest that L1 phonological properties do not fundamentally affect how L2 learners perceive L2 phonological features.

Looking back on existing theories on how L2 sounds are acquired (e.g. Best, 1995; Flege, 1995), current findings do not suggest that L2 learners interpreted L2 sounds based solely on L1 phonological distinctions. Rather, L2 learners were either not consistently affected by L1 phonological distinctions, or have acquired the ability to interpret L2 sounds in terms of L2 phonological distinctions (perhaps through L2 exposure). On a phonotactic level, L2 learners could detect the presence or absence of a phonological feature (e.g. a consonant cluster), even if it is rarely permitted in the learner's L1. Note that L1 Mandarin participants showed a greater degree of perceptual bias than L1 English participants towards syllabic *-ed* endings in Experiment 6 but not in Experiment 7. Hence, one cannot categorically rule out L1 induced perceptual biases favouring L1 over L2 phonological features, only that there was no consistent evidence for such biases.

To view the current findings in the context of psycholinguistic models of bilingual lexical access (i.e. BIMOLA, Léwy & Grosjean, 2008), current findings show that (late) L2 learners were able to appropriately use L2 phonotactic information to access higher-level representations, even if the L2 learners do not have equal mastery of L1 and L2. One of the key motivations for examining the extent of L1 phonological influence is how it affects L2 learners' perception to L2

grammatical features (i.e. inflectional morphology). One may argue that perhaps L2 learners simply detected a surface-level phonological difference without having decomposed the words in terms of verb and inflectional morpheme. However, the fact that L2 learners, like native-L1 speakers, exhibited sensitivity to temporal contexts irrespective of phonological feature in the current study, pointed towards higher-level temporal and / or syntactic information processing, indicating L2 comprehension beyond surface-level phonological sensitivity.

Moreover, current findings crucially showed that the idea of superior sensitivity towards syllabic endings over consonant cluster endings was similar across native-L1 speakers and L2 learners, indicating that this perceptual bias is independent of the listener's L1. Consistent with Solt et al. (2004), these findings not only confirmed a general processing advantage for the syllabic endings regardless of L1 background, but also extended the scope of the finding beyond a single inflectional morpheme (i.e. past *-ed*).

4.4.2. Extent of L1 phonological constraints on L2 production

How can we interpret adjunction failures within non-inflected words? The Prosodic Transfer Hypothesis claimed that L1 prosodic structure constrains L2 learners' ability to produce the phonological representations for inflected words (Goad et al., 2003; Goad & White, 2009). According to PTH, inflectional omissions are caused not by an absence of L2 grammatical representations among L1 Mandarin learners of L2 English, but rather an inability to adjoin inflectional morphemes to the prosodic word (according to L1 prosodic structure), which results in difficulties forming phonological representations for production. Current evidence suggests the problem with adjunction extends beyond adjunction to the prosodic word. However, the generalisability of this claim is a theoretically tricky issue to resolve. In particular, as PTH makes specific claims about how the phonological representation of a word is structured, and psycholinguistic frameworks (e.g. WEAVER++, Roelofs, 1997) have not made clear how language specific syllabification rules could

be applied in L2 learners, direct comparisons are not currently possible across theories. Unfortunately, resolving this issue is beyond the scope of this paper.

One long-lasting issue with interpreting language production data has been the task of disentangling representational from processing problems. In other words, it is unclear whether production errors are due to representational or processing failures. The same issue applies here. Although the current study was only concerned with how L1 Mandarin learners of L2 English could perform phoneme adjunctions in a non-inflected context, one should not ignore the fact that adjunction accuracy was contingent on participants' ability to correctly isolate the target phoneme(s). Looking at one specific item in the PE Task, where L1 Mandarin participants consistently failed to produce *stain* after omitting /r/ from *strain* (see Appendix O and Appendix P), one may strongly suspect that L1 Mandarin learners of L2 English do not represent the phonological make-up of L2 words in the same way as native-L1 speakers. I argue that this lack of awareness of specific phonemes is a reflection of a representational problem, which may be compounded by processing difficulties in assembling L2 phonological segments or syllables according to L2 phonological rules. This is not to say that L1 Mandarin learners of L2 English lack the phonological category for /r/, rather it was not perceived as part of the phonological representation for *strain* during L2 perception. This interpretation would be compatible with Best (1995), where she claimed L2 learners initially use phonetically similar L1 phonological categories to interpret L2 speech (which may not include /r/ for *strain*).

One other interesting finding was that some English words were consistently misperceived across L1 Mandarin participants in the PE task. For example, the word *bold* was consistently misperceived as *boat* (therefore producing *oat* instead of *old* after omitting /b/). Misperception of /t/ and /d/ could be related to insensitivity to voicing in obstruents (see Flege & Wang, 1989). Another error frequently made by L1 Mandarin participants was the tendency to omit entire syllables from words when the omission of a single consonant was required. For example, producing *win* instead of *winner* when asked to omit /t/ from *winter*. Such tendencies also resulted in some L1 Mandarin participants producing non-words like '*pow*' when omitting /d/ from *powder*. Again, one can speculate whether this was caused by L1 Mandarin

participants misperceiving the phoneme, or simply being unable to isolate single consonants from syllable structures.

4.4.3. Limitations and remaining issues

The current study is not without problems. For example, in the PD Task, the syllabic vs. consonant cluster distinction may be considered arbitrary for categorising phonological features. The implication being that phonological variability within each category may affect perceptual saliency, and therefore perceptual sensitivity towards these features. In other words, factors other than the syllabic natures of [tɪd] and [sɪz] could confound the current results. Moreover, allophones for 3SG *-s* and past *-ed* were counterbalanced as much as possible within each verb set, but allophonic variations across verbs sets with different phonological features were difficult to control. A more detailed examination of specific allophones within each phonological feature may prove useful as an extension of the current analyses (e.g. sensitivity to variations of *-ed* as [t] in *chased* and [d] in *saved*). Note that the CTOPP-2 PE Task was a standardised test used to test phonemic awareness in children and young adults and was not designed specifically to test the adjunction of 'inflection-like' segments (e.g. [sɪz] [kt]) in non-inflected words. Therefore, the generalisability of the production data from this task should be viewed with caution. Future studies should also take a more targeted approach towards specific phoneme adjunctions in the L2 (e.g. matching phoneme sequences in inflected and non-inflected contexts), accounting for L1-L2 phonological similarities.

From a theoretical perspective, the precise mechanisms of how phonological rules or constraints are applied to L2 speech remains unclear, particularly in the psycholinguistic literature. It was therefore difficult to test specific claims about how L2 phonological segments are organised and articulated according to L2 phonological rules. This is an unresolved theoretical shortcoming. Consequently, linguistic theories on phonological structure becomes crucial to our understanding of L2 phonological processing. However, as the two approaches make different claims

about how L2 phonology is acquired, direct theoretical comparisons are not always possible.

Nonetheless, I argue that the current set of findings does make a unique contribution to the understanding of L1 phonological influence on L2 comprehension and production. Whilst plenty of research studies have examined perceptual saliency of isolated L2 sounds, L2 researchers rarely focus on the perceptual saliency of meaningful linguistic units. Findings from the current study are not only useful in examining L2 perceptual sensitivity to allophones of inflectional morphemes, but also have implications for perception of L2 grammatical features in the wider context of L2 comprehension. By showing no reliable perceptual biases in L2 learners, these findings to a degree favour accounts which point to grammatical processing errors in non-native-like L2 comprehension. In addition, current findings partly support the comprehension-production asymmetry discussed by Goad et al. (2003) and Goad and White (2006), which claimed that prosodic constraints only affect production but do not acts as a filter for comprehension and interfere with acquisition of grammatical features.

Chapter 5

Discussion and summary

Second language learners frequently exhibit errors in both production and comprehension in real-time interactions, despite having relevant grammatical knowledge. Why do they make such errors? What do these errors tell us about the state of L2 acquisition and human language processing?

In the opening chapter, I discussed in general terms the potential problems for L2 learners during L2 production and comprehension. Specifically, I first considered why they might experience difficulties producing L2 grammatical features absent in their L1. For example, why L1 Mandarin speakers of English might fail to produce English inflectional morphology (e.g. 3SG *-s* or past *-ed*) consistently according to L2 temporal context. Moreover, I also discussed whether L2 learners can go beyond knowing L2 grammatical rules in the abstract form and integrate information from new L2 grammatical features during real-time L2 comprehension. For example, L1 Mandarin learners of English could learn to extract temporal information from inflectional morphemes despite the fact that Mandarin does not have a system for inflectional morphology. Lastly, I discussed whether phonological factors, particularly perceptual deficiencies or biases could influence comprehension of L2 grammatical features. For example, L1 Mandarin learners of English could find some inflectional morphemes perceptually more salient than others depending on their phonological contexts, and whether they share phonological features with the learners' L1.

In this chapter, I will first revisit the key findings from the three sets of experiments presented in this thesis and discuss their implications with regard to theories of L2 production and comprehension. Discussion of Experiments 1, 2 and 3 will centre around sources of error underlying L2 inflectional errors, specifically, whether inconsistent L2 inflectional production is caused by representational deficits or processing breakdowns. Discussion of Experiment 4 and 5 will centre around

integration of linguistic cues during L2 comprehension, specifically, whether L2 learners could extract and integrate information from grammatical cues which are absent in their L1. Discussion of Experiments 6 and 7 will centre around effects of phonological saliency on comprehension of L2 grammatical features.

Subsequently, I will discuss some overarching themes running through explanations of L2 production and comprehension. In particular, I will discuss how psycholinguistic frameworks can be viewed in conjunction with linguistic theories in explaining issues in L2 production and comprehension, where they fall short, and ways they can complement each other. Moreover, I will discuss some general methodological issues in L2 research, including issues I have attempted to address, and remaining issues which require further research. Lastly, I will make some tentative proposals regarding further research studies which may add to the theoretical scope of current findings. To round up, I will highlight the key contributions of this thesis to second language research.

5.1. Inflectional errors in L2 production

5.1.1. Theoretical motivations and findings (Chapter 2)

Past research has shown that L2 learners frequently exhibit difficulties producing grammatical features which do not exist in their L1. Particularly, research studies have shown that L2 learners of English often experience difficulties producing L2 inflectional morphology in a consistent manner appropriate to temporal context, especially amongst learners whose L1 does not use a system of inflectional morphology (Lardiere, 1998a; 1998b; 2000; 2003; Hawkins & Liszka, 2003). However, researchers currently have not reached a consensus over the underlying cause for these errors (i.e. representational deficits or processing breakdowns). With reference to existing psycholinguistic frameworks of language production (Levelt, 1989; Levelt et al., 1999; Bock & Levelt, 1994; de Bot, 1992; 2003), and theories of L2 inflectional errors (Hawkins & Chan, 1997; Hawkins & Liszka, 2003; Haznedar & Schwartz, 1997; Prevost & White, 2000; Hawkins, 2007), I examined whether

there are consistent error patterns which could point to the nature of inflectional errors in L2 production. In addition to the debate over whether inflectional errors are caused by representational deficits or processing breakdowns, I considered whether L2 learners process relevant abstract level information during conceptualisation of utterances, as well as the effect of articulation on inflectional accuracy. In this set of production experiments, L1 Mandarin (L2 English) and L1 English participants produced event descriptions in a scene description task under distinct temporal contexts in spoken (Experiments 1 and 2) and written (Experiment 3) modalities. Using a fixed set of regular English verbs, the paradigm elicited 3SG *-s* and past *-ed* inflections in Present Habitual and Past contexts in L1 Mandarin and L1 English participants.

Overall, in keeping with previous research, the results showed that L1 Mandarin participants produced 3SG *-s* and past *-ed* inflections inconsistently across temporal contexts compared with L1 English control participants. Particularly interestingly, despite the fact that L1 Mandarin participants were significantly more likely to produce the correct inflection morphology in the appropriate temporal contexts compared with inappropriate contexts, they made substantially more errors in the temporal context which required 3SG *-s* than those which required past *-ed*. Moreover, L1 Mandarin participants produced significantly fewer inflectional omissions in the written compared with the spoken modality, unlike L1 English participants who did not show such differences.

5.1.2. Theoretical implications

Returning to the debate between representational deficits and processing breakdowns, these results demonstrated that, in psycholinguistic terms: 1) L2 learners can process temporal information relevant to L2 inflectional morphology during conceptualisation of the message, even if the learners' L1 does not use this information; 2) L2 learners can acquire the appropriate lemma level representations (diacritic features) for inflectional morphology, even if their L1 does not have such representations; 3) L2 learners can retrieve the appropriate inflectional forms from

the mental lexicon. Thus, given that L1 Mandarin learners can accurately but inconsistently produce appropriate inflections, the findings pointed towards a processing account of L2 inflectional errors. As such, the most likely explanations for the current set of L2 inflectional error data are processing breakdowns in consistently activating appropriate diacritic features or breakdowns in retrieving inflectional morphology. Moreover, consistent error patterns across spoken and written production indicated that although the absence of articulation significantly decreased the number of inflectional omissions in L1 Mandarin participants, it did not change the asymmetrical patterns of production accuracy observed for 3SG *-s* and past *-ed* inflections. Therefore, the error patterns observed could not be solely attributed to articulation errors.

5.1.3. Limitations and future directions

Current findings provide convincing evidence against representational deficits at the syntactic level, but do not tease apart different types of processing breakdowns. Particularly, current production data cannot distinguish between inconsistent activation of diacritic features and inconsistent retrieval of inflectional forms. However, given the asymmetrical pattern of error between inflections with different degrees of featural complexity (i.e. more errors for the featurally complex 3SG *-s* requiring tense and subject number, compared with past *-ed*, requiring only tense), there is a case for arguing that inappropriate activation of diacritic features is the main cause for inconsistent inflectional production.

Additionally, current data do not address possible phonological constraints on L2 inflectional production. Of the representational deficit accounts of L2 inflectional errors, the current findings do not test the notion of L1 prosodic constraints on L2 learners' ability to form the phonological word (Goad et al., 2003). One way of addressing this issue would be to contrast L2 English learners from multiple L1 backgrounds, with different degrees of overlap between L1-L2 grammatical and phonological properties. For example, Japanese has the past tense feature, but does not allow successive consonants in the word final position. Therefore, if L1 Japanese

learners of English are significantly more accurate than L1 Mandarin learners of English in producing inflections in the form of consonant clusters, then it would be a case against L1 prosodic constraints. However, as grammatical and phonological features are intrinsic in languages and often confound each other, between-group production data should be interpreted with care (see Amaro et al., 2018, for discussion).

Another way to test the extent to which L2 inflectional production is affected by L1 prosodic constraints is to examine whether L2 learners have problems producing similar phoneme sequences in non-inflectional contexts. One of the main claims of the Prosodic Transfer Hypothesis is that the phonological make-up of adjoining inflectional morphemes to verbs (adjunction of inflections to the prosodic word) is somehow 'special', and different to other forms of phonological adjunctions (Goad et al., 2003; Goad & White, 2006). If future production data show these phoneme sequences are also difficult for L2 learners to produce in non-inflectional contexts, then it could argue for a generalised difficulty with phonological processing not restricted to inflected words. On a methodological level, data coding from all three production experiments could have benefitted from triangulation across multiple coders to improve reliability.

5.2. L2 morphosyntactic processing

5.2.1. Theoretical motivations and findings (Chapter 3)

Past research has repeatedly shown non-native-like syntactic processing in L2 learners, which can manifest in the form of behavioural or neurological insensitivity to syntactic violations during real-time L2 processing (Chen et al., 2007; Jiang et al. 2004; 2007 and more). Whilst much of L2 sentence processing research has focused on whether L2 learners can make use of L2 syntactic parsing strategies (Marinis et al., 2005; Felser et al., 2005; Papadopoulou & Clahsen, 2006), very few have explicitly looked into whether L2 learners can acquire a comprehension mechanism which can make use of newly acquired L2 grammatical knowledge, specifically, those that are absent in the L2 learners' L1. In addition, it is unclear to what extent

do L2 learners process L2 temporal cues in a native-like way. Moreover, cross-modality comparisons between auditory and visual comprehension has been rare.

Using English inflectional morphology as a target, I examined how L2 learners, with no inflectional morphology in their L1, can acquire a comprehension mechanism which could apply grammatical knowledge relevant to inflectional morphology. If they can, L2 learners should be sensitive when such features are omitted in obligatory contexts during incremental sentence processing (e.g. if past *-ed* inflections were omitted after a past temporal adverbial). In addition, I focused on whether L2 learners make processing distinctions when inflections require more than one type of agreement (i.e. 3SG *-s* requires both subject number and tense agreement), and to what extent this resembles native-L1 processing. Moreover, given that previous studies have shown an auditory disadvantage for sensitivity to L2 grammatical violations (Johnson & Newport, 1989; Johnson, 1992; Murphy, 1997), I examined whether comprehension modality (auditory or visual) could affect the integration of L2 grammatical cues. Specifically, I examined whether L2 learners would find stimuli presented in the auditory modality more difficult to process than stimuli in the visual modality.

In Experiments 4 and 5, I examined whether L1 Mandarin learners of English, with no inflectional morphology in their L1, could integrate temporal information from temporal adverbials (e.g. *every day*, *last week*) and temporal inflectional morphology (3SG *-s*, past *-ed*). L1 Mandarin and L1 English participants either listened or read English sentences in a self-paced comprehension paradigm, and their sensitivity to inflectional omissions was taken as evidence for cue integration.

The findings showed that L1 Mandarin participants in general do not process L2 inflectional morphology in a native (English) like way. Specifically, in the auditory modality, whilst L1 Mandarin participants showed sensitivity to inflectional omissions in general, they did not show differential sensitivity towards 3SG *-s* and past *-ed* omissions, which was evident among L1 English participants. With regard to the effect of comprehension modality, the findings showed greater sensitivity for inflectional omissions in auditory versus visual comprehension across L1 Mandarin and L1 English participants (see effect sizes on Grammaticality), with greater

between-group differences in self-paced reading (Experiment 5) than in self-paced listening (Experiment 4). In fact, whereas L1 Mandarin participants exhibited auditory sensitivity to inflectional omissions, they did not exhibit visual sensitivity to a statistically significant level, unlike L1 English participants who did across both auditory and visual modalities.

5.2.2. Theoretical implications

These findings showed that L1 Mandarin participants, though in a non-native like way, could acquire a comprehension mechanism that applies L2 grammatical knowledge during real-time L2 comprehension, even when the relevant grammatical features are absent in the L1. In connectionist terms, these findings supported the idea that L2 learners can adopt language-specific processing priorities (or cue validity) during L2 comprehension. However, as L1 English data showed, 3SG *-s* and past *-ed* processing are inherently different, most likely due to the addition of subject number information which enhanced sensitivity for 3SG *-s*. In other words, it is possible that L1 English participants found grammatical 3SG *-s* trials easier to process due to the proximity of the subject to the verb, augmenting the reaction time difference between grammatical and ungrammatical trials (see Figure 19 in 3.2.2.). The fact that L1 Mandarin participants did not show this difference could suggest that they do not process subject number information for 3SG *-s* in a native-like way, much like the featural complexity effect found in previous production data.

Returning to the issue of comprehension modality, previous studies have shown an auditory disadvantage for L2 comprehension in the context of grammatical sensitivity. Specifically, researchers suggested difficulties in auditory comprehension could be due to additional speech segmentation (Anderson, 1980). With the element of speech segmentation removed, L1 Mandarin participants showed greater sensitivity to inflectional omissions in the auditory than in the visual modality. This seems to show that auditory comprehension is not invariably more difficult. In fact, auditory stimuli can facilitate grammatical processing (and therefore sensitivity to grammatical violations).

Another way in which the current data could explained, is by task-modality interactions. As discussed in 3.4.3, L2 learners could intentionally or unintentionally adopt comprehension strategies which suited the demands of the task, but such strategies could also be confounded by comprehension modality. For example, auditory stimuli could facilitate L2 grammatical sensitivity in a task centred around semantic interpretation, whereas visual stimuli could facilitate L2 grammatical sensitivity in a grammaticality judgement task. One could argue that the facilitatory effect of auditory stimuli among L2 learners in the current study was contingent on the fact that they were (sometimes) required to answer comprehension questions, for which inflectional morphemes (phonologically salient) were important to the interpretation of the sentence (though none of the questions concerned temporal context). On the other hand, the auditory disadvantage found in previous studies could be due to the fact that the task required L2 learners to explicitly monitor for grammatical violations. As not all grammatical features can be differentiated auditorily, one may speculate whether these grammatical violations are easier detected visually.

5.2.3. Limitations and future directions

The first potential limitation concerns the statistical reliability of cross-modality comparisons. As far as I am aware, few studies have directly contrasted sensitivities to grammatical violations across different comprehension modalities, possibly due to difficulties in standardising and comparing reaction time measures. In this case, auditory comprehension used raw reaction times (accounting for duration of audio file per segment) and visual (reading) comprehension used residualised reaction times (accounting for number of characters per segment). *Cohen's d*, a commonly used effect size measure for between-experiment comparisons (see Brysbaert, 2018, for discussion), was used for the cross-modality contrast. However, it could be argued that the reliability of this method will need further confirmation. Moreover, as the cross-modality comparison was conducted across different participant groups (using identical stimuli), it could be argued that individual differences in L2 proficiency and cognitive functioning could have confounded some of our data.

Another potential limitation is the interpretation of differential sensitivity to 3SG *-s* and past *-ed* omissions. Currently, I can only infer an effect of featural complexity given the number of features contained within 3SG *-s* and past *-ed* (i.e. L1 Mandarin participants lack subject number integration). However, in order to demonstrate this effect unambiguously, subject number violations must be isolated from temporal violations in the experimental stimuli. This could be implemented by moving the temporal adverbial to the sentence-final position so one can observe: 1) whether L2 learners (such as L1 Mandarin learners of English) would respond to subject-verb agreement errors at the verb segment, and 2) whether L2 learners would also respond to the inconsistent temporal information provided by inflectional morphemes and temporal adverbials at the post-object temporal adverbial segment (see Table 25). Moreover, contrasting the 'subject violation' condition with the 'subject + temp violation' condition in this design could potentially demonstrate a two-stage integration process for subject-verb and temporal agreements. Such a study would need pre-tests to establish the native-L1 pattern for subject number and temporal sensitivity.

Table 25.

Sample stimuli for morphological violations relating to subject number and temporal context. Critical segments are marked in red.

Error Type	Example
-	The girls / *paint* / sunflowers / *every Saturday* / in the park.
Subject violation	The girls / *paints* / sunflowers / *every Saturday* / in the park.
-	The girls / *painted* / sunflowers / *yesterday* / in the park.
Subject + Temp violation	The girls / *paints* / sunflowers / *yesterday* / in the park.

The last potential limitation of the current findings concerns the facilitatory effect of auditory stimuli. This claim lacks detail and is incomprehensive. Particularly, it is unclear whether there was a general facilitatory effect of auditory stimuli across inflections, or whether some inflections are more readily facilitated by their corresponding phonological features in the L2. In other words, could L2

learners find some L2 sounds easier to perceive, and therefore their corresponding inflections easier to detect than others? This is an important question as the phonological features of inflectional morphemes are contingent on their phonological contexts. To address this question, one could contrast L2 sounds which share L1 phonological features with L2 sounds which do not and establish if L2 learners are equally sensitive to the same inflections across phonological contexts, or if they show some degree of perceptual bias towards L1 phonological features. This question will be addressed in the next section (5.3.).

5.3. L1 phonological effects on L2 comprehension and production

5.3.1. Theoretical motivations and findings (Chapter 4)

Past research into L2 perception suggested that it is possible for L2 learners to have different perceptual biases in the L2, contingent on the phonological properties of the L1 (e.g. phonotactic restrictions; see Flege & Wang, 1989). However, this effect has rarely been examined with respect to meaningful units of language and specific phonological features. Taking the set of results from the previous comprehension experiments, it is unclear if L2 learners' sensitivity to 3SG *-s* and past *-ed* inflectional morphemes were selectively affected by the perceptual saliency of their resulting phonological features. Note that some phonological features are intrinsically more salient than others (e.g. syllabic endings are more easily perceived than consonant clusters), but perceptual saliency can also be exacerbated by experience of L1 phonological properties (e.g. Mandarin contains mostly monosyllabic morphemes, and word-final consonant clusters are rare).

For Experiment 6 and 7, I examined whether L2 learners could selectively exhibit perceptual biases toward L2 grammatical features which share L1 phonological features over those which do not. Again, using English inflectional morphemes 3SG *-s* and past *-ed*, I examined whether L1 Mandarin learners of English would be more sensitive to 3SG *-s* and past *-ed* inflectional morphemes forming syllabic endings (common in Mandarin Chinese) compared with consonant cluster endings (rare in Mandarin Chinese). L1 Mandarin and L1 English participants

discriminated between bare and inflected forms of verbs in an auditory ABX paradigm (Clark, 1982). The findings showed that, given both L1 Mandarin and L1 English participants processed temporal information from inflectional morphemes, L1 Mandarin participants showed no consistent perceptual biases toward those forming syllabic endings over consonant cluster endings compared with L1 English participants. This was true for both 3SG *-s* and past *-ed*.

As discussed in 5.1.3, it is important to establish whether there is a generalised phonological difficulty in L2 production that goes beyond the adjunction of inflectional morphemes to verbs. With reference to linguistic theories of L2 inflectional errors, I considered whether difficulties generating prosodic structure to produce inflectional morphemes could also extend to non-inflected words. For Experiments 6 and 7, L1 Mandarin and L1 English participants also performed a phoneme deletion task where they articulated English words with specific phoneme(s) taken away. This task selectively required participants to adjoin phonemes after mid-word phoneme deletions. Most distinctly, the findings showed that L1 Mandarin participants were significantly less accurate in performing phonemes adjunctions on non-inflected words compared with L1 English speakers.

5.3.2. Theoretical implications

Returning to the question of selective perceptual biases in L2 learners, these findings suggested that whilst L2 learners showed some perceptual biases towards inflectional morphemes with syllabic phonological feature, the extent of this bias was not consistently different from L1 speakers. Moreover, L2 learners processed grammatical features irrespective of the phonological contexts they appeared in. In theoretical terms, this suggested that L1 phonological properties did not constrain perception of L2 phonological features nor the underlying grammatical feature. Moreover, the fact that L1 speakers and L2 learners did not perceive L2 phonological features differently has important implications for interpreting data from comprehension experiments. Current findings pointed toward a general facilitatory effect of auditory stimuli, with no selective perceptual biases which favour L1 over

L2 phonological features. Therefore, the findings that L2 learners showed non-native-like sensitivity towards inflectional omissions in the auditory modality could not be attributed solely to phonological saliency effects.

Turning to the extent of L1 phonological effects on production, Goad et al. (2003) theorised that Mandarin prosodic structure constrains the learners' ability to adjoin inflectional morphemes to the prosodic word for regular English verbs. This process is fundamentally different for irregular verbs, where the phonological change occurs inside the prosodic word. My findings suggest that difficulties in adjoining phonemes extend beyond inflectional morphemes in L2 learners, such that they would have problems in non-inflectional contexts as well.

5.3.3. Limitations and future directions

As mentioned in 4.4.4., there may be an issue with imposing arbitrary phonological feature categories when considering phonological effects for different inflectional morphemes. L2 learners may have different levels of sensitivity towards allophones of the same morpheme. For example, consider the phonological context for 3SG *-s* in *waits* and *cooks*: whereas a digraph[12] is formed in *waits*, a strict consonant cluster is formed in *cooks*. One could argue that the perception of 3SG *-s* in these two instances could differ even though they represent the same inflectional morpheme and belong to the same category of phonological features. As allophones of 3SG *-s* and past *-ed* were counterbalanced within each set of verbs (see Appendix M), adding an allophone manipulation could be an interesting extension to the current analyses.

The other limitation concerns the items used in the Phoneme Elision task. The task was taken from a standardised test for phonological processing (i.e. CTOPP-2, Wagner et al., 2013), and was not specifically designed for L2 learners on their ability to make adjunctions inside a non-inflectional word. For this reason, I cannot make specific claims about the extent of phonological influence for 3SG *-s* and past -

[12] a combination of two letters representing one sound

ed production in Experiments 1 and 2. Conclusive evidence for this effect would require carefully designed items for the phoneme adjunction part of the task.

5.4. Further theoretical and methodological considerations

5.4.1. Theoretical considerations

Returning to the question of how L2 language data should be examined, I have taken the view that researchers should seek to take an integrated approach, accounting for explanations from multiple disciplines. Whilst theories from different areas of research take distinct perspectives and make different assumptions, they do not always have to be seen as opposing or contradictory. In fact, the production experiments showed that a cross-disciplinary approach could provide valuable insight and highlight some key common grounds in explaining L2 language production.

Whilst a psycholinguistic framework provides mechanistic explanations for how a spoken message is generated from the point of conceptualisation to articulation, linguistic theories of second language learning provide targeted explanations for why specific language phenomena might occur (i.e. inconsistent production of L2 inflectional morphology). In tackling this specific L2 phenomenon, I have taken explanations from both approaches and interpreted them in representational or processing terms, drawing comparisons where appropriate. For example, recall Levelt and colleagues had outlined the role of *diacritic features* at the lemma level in grammatical encoding. Particularly, diacritic features (e.g., tense, number) specify the syntactic content of lexical representations, based on which grammatical features relevant to inflectional morphology could be encoded for production. This can be viewed in conjunction with the concepts of *functional category* (functional roles of lexical units) and *feature* (abstract features such as number, person, tense) in linguistic terminology. Although these concepts differ in their definition, the acquisition of these theoretical constructs are acknowledged to be essential for production by both approaches. Similarly, whereas the psycholinguistic framework of language production assumes a process of spreading activation for activating

syntactic features and retrieving morphological forms, linguistic approaches refer to morphology-syntax mapping and access to morphology within the interlanguage grammar. Despite differences in their assumptions, they point to similar loci of processing breakdowns.

L2 comprehension faces a different issue. Whilst psycholinguistic explanations (connectionist theories) focus on comprehension mechanisms and real-time integration of linguistic information, linguistic theories explain language in terms of its hierarchical structure. Thus, there is an inevitable bias towards using psycholinguistic models in examining the principles of real-time information integration. This is not to say that linguistic theories do not offer insights into L2 comprehension processes. In fact, they offer detailed descriptions of states of acquisition in terms of linguistic structures, but do not offer explanations to real-time processing. Again, these approaches tackle different aspects of the language acquisition and processing and can be viewed as complementary. However, equivalences between these approaches cannot be easily drawn.

Theories of L2 phonological processing also suffer from an imbalance of theoretical explanations from psycholinguistic and linguistic approaches. As pointed out by Kormos (2006), current psycholinguistic theories do not provide enough support for the acquisition of L2 phonology beyond individual phonemes (e.g. syllables), nor the precise nature of L1 influence over L2 phonology. However, linguistic theories have provided a detailed hierarchical structure for how phonological units could be combined. For example, the Prosodic Transfer Hypothesis claims that a specific prosodic structure hindered L1 Mandarin speakers from producing inflectional morphemes, and is able to describe in structural terms how phonological properties across languages differed. Such explanations accounting for phonological rules or properties of languages are currently lacking in the psycholinguistic arena, leading to a bias towards linguistic theories when explaining phonological influences in language processing.

To summarise, I have highlighted the importance of using theories of multiple disciplines in examining L2 production and comprehension data. Unsurprisingly, both psycholinguistic frameworks and linguistic theories contain shortfalls in terms

of aspects of language representation and processing they address, which require further theoretical development.

5.4.2. Methodological considerations

Recall 1.2., where we discussed the importance of investigating real-time language processing across production and comprehension modalities, and that research studies should not generalise findings from one specific modality to another without providing convincing evidence for them. I argue that the current experiments adequately addressed possible effects of modality in L2 production and comprehension in a well-controlled manner. For L2 spoken and written production, the scene description task (Experiments 1, 2 & 3) simulated real-time production processes by imposing time restrictions on participant responses whilst controlling for content and structure of the message. This element of the task, though seemingly trivial, adds significant time pressure for what is a semantically driven task (i.e. describing an action or event), much like real-life scenarios of L2 production. Moreover, this task accommodated the slower speed of 'writing' by allowing participants more time, but not the option to edit or rewrite responses. This element was added to imitate the real-time nature of spoken production as much as possible (see Gardner et al., 2018, for further discussion). For L2 comprehension, Experiments 4 and 5 used auditory and visual moving-window paradigms for sentence presentations. The key advantage of a visual moving-window paradigm is that it parallels the listening process by not allowing participants to revisit previous segments of sentence, therefore isolating the processing target to one specific segment. The self-paced nature of these paradigms ensured controlled exposure to the experimental stimuli in both modalities.

More methodological issues remain, especially with regard to experimental design and the choice of languages for second language acquisition studies. As discussed in previous literature, it is often difficult to infer the extent of L1 influence by contrasting learner performance from L1s with different degrees of grammatical and phonological overlap with the L2. As these properties are intrinsic to each

language, it is often not possible to manipulate these aspects of language according to the research question. The other difficulty, as evident with the interpretation of current data, is the inability to isolate the processing of individual grammatical features when multiple features are marked together (e.g., in English). If one were to examine whether L1 Mandarin can integrate subject number and temporal information separately, one solution could be to use a morphologically rich L2 where these features are marked by different inflectional morphemes. Having said this, there are benefits to using a language like English, given it is one of most commonly learned languages, providing possibilities for contrasts across multiple L1s.

5.5. Further research questions

5.5.1. L2 grammatical features in L1-L2 mixed-speech

One interesting extension to the current findings on L2 production could be to investigate syntactic and morphological processing during L1-L2 mixed-speech, a frequently observed phenomenon amongst bilingual speakers. Having shown that L2 learners could acquire the relevant representations for inflectional production and (inconsistently) produce inflectional morphology in appropriate temporal contexts, it would also be valuable to examine the circumstances which facilitate or hinder the activation of L2 grammatical features in L1-L2 mixed speech. Such investigations would shed light on the way shared and unique grammatical representations in the L1 and L2 are organised and activated within the bilingual speech system.

One relevant theoretical framework which was only briefly mentioned in Chapter 1 is the Matrix Language framework (Myers-Scotton, 1993; 2006). The central claim by Myer-Scotton and colleagues is that one of the speaker's two languages would be dominant (the 'base' language) during production and provides the grammatical framework for syntactic and morphological processing. Although words from the other language ('guest' language) are 'inserted' into speech, the grammatical features of the two languages would not mix (see examples of Dutch-English code-switching in Poulisse & Bongaerts, 1994). I argue that this

phenomenon is highly language-specific and contingent on the degree of overlap between the grammar of the two languages. The question remains open whether the grammatical features from the 'guest' language would also play a part in the abstract structure of the message if the 'base' language does not have an equivalent grammatical feature (see discussions on *composite code-switching* in Myers-Scotton, 2006). For example, in a Mandarin-English mixed-speech scenario, where English verbs are inserted into Mandarin speech (where no suitable Mandarin translation exists or is not accessible by the speaker), are L1 Mandarin learners of L2 English likely to adopt the inflectional markings with the inserted English verbs (as activated by an English lemma), or do they use non-finite verb forms in English with Mandarin aspectual markers? In Levelts' terms, this would bring into question whether lemma level activation of diacritic features (e.g., for tense) for an inflectional language like English would still proceed if the 'base' language does not require such features. An additional question could be whether grammatical features in production would differ if the 'inserted' word belonged to a different word class (e.g. nouns). In which case, are grammatical markings (e.g. plural *-s*) likely to be taken from the 'base' language or the 'guest' language? Does this tendency vary depending on language-specific properties (e.g. countability of nouns), language proficiency, L1-L2 balance and exposure? To answer these questions, an elicited production paradigm can again be used, controlling for grammatical context and the content of mixed production.

5.5.2. Syllabification of L2 grammatical features

Another extension of current research briefly mentioned in 4.4.4., is whether L2 learners could consistently apply L2 syllabification rules in speech, especially regarding phonological variable grammatical features. Remember that Experiments 6 and 7 showed via the phoneme elision task, that L1 Mandarin learners of English have significant difficulty performing adjunctions within non-inflected words after a specific phoneme is taken away. I considered two possibilities which have not yet been teased apart. The first possibility was that L1 Mandarin participants did not represent the items in the task as a sequence of L2 English phonemes. Hence, they were unable to identify the correct phoneme for deletion. The second possibility was

that L1 Mandarin participants, despite the correct representations for the words, were not able to adjoin the remaining phonemes together. The latter possibility concerned the process of L2 syllabification in psycholinguistic models. Existing research claimed that L2 syllabification rules could be learned simultaneously with L2 phonological feature distinctions (Archibald, 1998). However, the precise mechanism via which this takes place is far from clear. How do phonological processing mechanisms distinguish L1 from L2 syllabification rules when they supposedly share the same (or similar) phonological representations?

In the context of L2 inflectional production, this also brings into question how knowledge of L2 syllabification rules is acquired and applied in L2 speech production, especially when inflectional morphemes can have multiple allophones depending on phonological contexts. Therefore, it would be valuable to examine the interaction between the morphology and phonology in the syllabification process. More specifically, we might consider whether higher-level linguistic knowledge drives the application of syllabification rules in L2 learners (i.e. whether L2 learners could syllabify phonemes differently depending on whether they constitute an inflectional morpheme).

5.6. Summary and conclusions

In the opening chapter of this thesis, I discussed the variety of problems an L2 learner could experience during real-time L2 production and comprehension. More specifically, having learned L2 grammar, why do L2 learners still violate grammatical rules during real-time production (e.g. omit inflectional morphemes in required contexts)? Were these errors due to representational problems, such as acquiring the abstract representation for inflectional morphology, or were they due to processing breakdowns, such as activating representations of inflectional morphology or retrieving inflectional forms. In broad terms, my findings from Experiments 1, 2 and 3 showed that a processing breakdown explanation for L2 inflectional errors is most likely, given that L2 learners not only processed temporal contexts under which inflectional morphemes are obligatory, but also activated the

necessary abstract representations to overtly produce inflectional morphemes. Moreover, my findings supported the theory of featural complexity, where the production of 3SG *-s* (containing subject number and tense features) was consistently less accurate than past *-ed* (containing tense feature only) across spoken and written modalities. Furthermore, modality affected overall accuracy but not the asymmetrical pattern of inflectional errors, thus indicating processing errors primarily occur at the grammatical level and cannot be attributed solely to articulation of speech.

The idea of language processing problems carries over to real-time L2 comprehension. The key question here was that whether L2 learners could direct their attention to and prioritise information from L2 grammatical features during L2 comprehension, even when such features do not exist in the L1. If so, they should exhibit sensitivity if these features are missing. My findings from Experiments 4 and 5 indicated that L2 learners can indeed use L2 grammatical features (i.e. inflectional morphology) as a linguistic cue to semantic information in the L2, even when such cues are not used during L1 comprehension. However, it appeared that L2 learners could not integrate information from inflectional morphemes in a native-like manner, as they did not show greater sensitivity towards inflectional morphemes with multiple features (i.e. 3SG *-s*), which was observed among L1 English participants. My findings also showed that integration of information was more successful from L2 inflectional morphemes when the stimuli were perceptually more salient (in the auditory modality). However, questions remained as to whether L2 learners experienced a general facilitatory effect of auditory stimuli, or whether the effect was selective depending on whether similar phonological features existed in the learner's L1.

For the final part of the thesis, I investigated the extent of L1 phonological influence on perception of inflectional morphemes. Specifically, whether L2 learners would have perceptual biases towards L2 grammatical features (i.e. inflectional morphemes) if they share phonological features with the learner's L1. My findings from Experiments 6 and 7 showed no consistent between-group effect in phonological sensitivity between L1 and L2 participants, indicating no reliable perceptual biases towards phonological features shared with the learner's L1.

One prominent question which remained was whether possible phonological effects played a part in L2 inflectional errors. Although I attempted to explore possible effects of L2 phonological processing in L2 production in the last set of experiments, the data were far from conclusive. Current findings from Experiments 6 and 7 seemed to indicate general difficulties with adjoining phonemes according to L2 phonological rules, rather than a specific difficulty with adjoining L2 inflectional morphemes to verbs. However, direct comparisons between phoneme adjunctions in and outside inflectional contexts were not carried out, and this finding was therefore not conclusive. Further research would also require detailed examinations of the relevant psycholinguistic accounts on L2 phonological processing. For example, one would need to examine accounts which explain the L2 syllabification processes and morphology-phonology interactions.

Overall, this thesis used a multi-disciplinary approach to examine the acquisition of L2 grammatical features and its processing during L2 production and comprehension. Using both psycholinguistic frameworks of production and comprehension and relevant linguistic accounts, I examined possible loci of inflectional errors in L2 production, and assimilation of information from L2 inflectional morphemes. Current results favour successful acquisition of grammatical representations but point to processing breakdowns, such as integration of features during production and comprehension. L1 phonological properties were not found to fundamentally bias the perception of comprehension of L2 grammatical features, but the question of L1 phonological influence on L2 production remains open.

Appendices

Appendix A.

Experiments 1, 2 and 3: L1 Mandarin (L2 English) participant language background information.

	Experiment 1 (N=16)		Experiment 2 (N=37)		Experiment 3 (N=48)	
	M	SD	M	SD	M	SD
IELTS Overall	7.22	0.41	6.93	0.43	7.05	0.42
IELTS Spoken (Exp. 1 & 2)	-	-	6.28	0.55	-	-
Written (Exp. 3)	-	-	-	-	6.92	3.07
AoA for L2 English (years)	10.81	2.32	9.51	2.39	8.75	2.43
Length of Stay (months)	4.31	2.47	8.51	1.35	6.11	3.17
L2 Contact (hours)	3.88	3.30	3.20	2.57	4.55	2.54

Appendix B.

Experiments 1, 2 and 3: Experimental and filler verbs used in the scene description task.

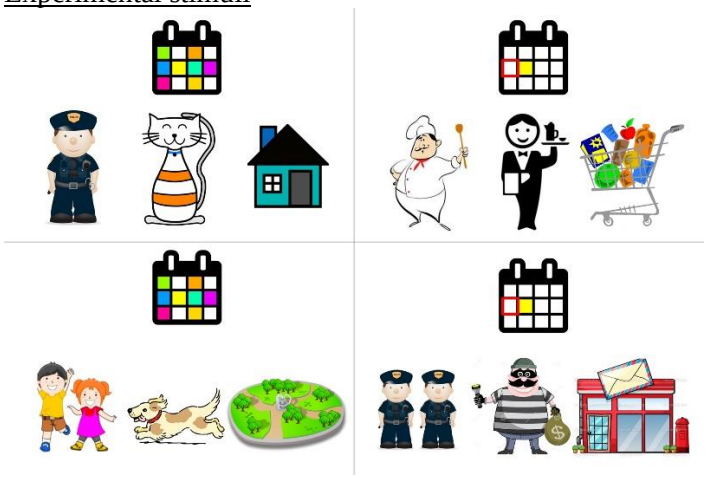
Experimental	Filler
Shout	*Watch*
Wait	*Cook*
*Load**	*Write**
Start	*Listen*
End	*Drink*
*Applaud**	*Go**
Need	*Run*
*Print**	*Speak**
Paint	*Sit*

*not included in Exp. 3

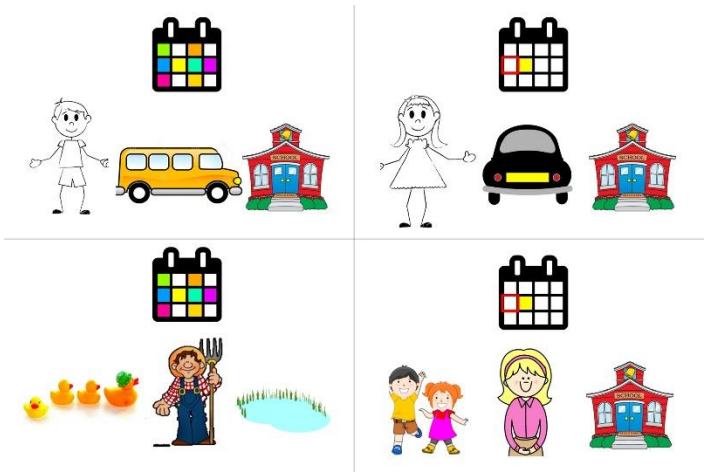
Appendix C.

Experiments 1, 2 and 3: Image stimuli for experimental and filler trials in the scene description task.

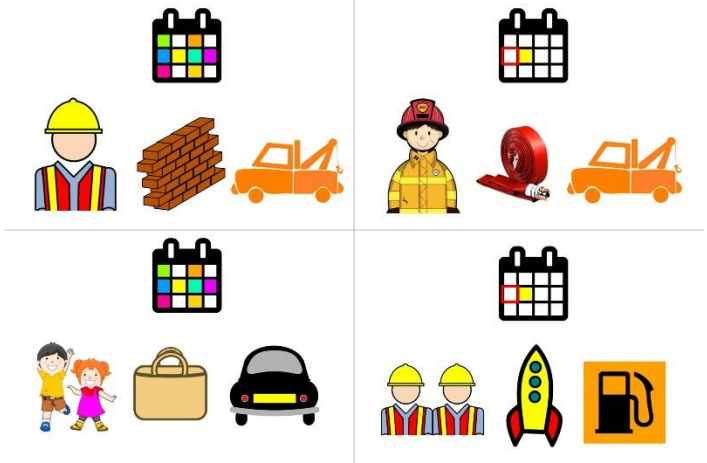
Experimental stimuli



SHOUT

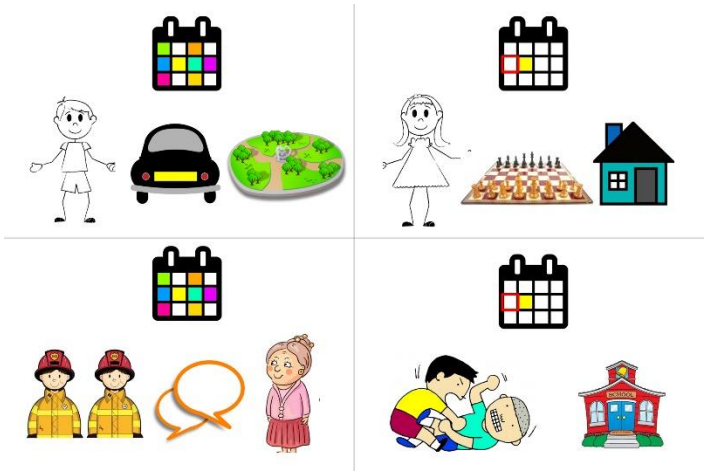


WAIT

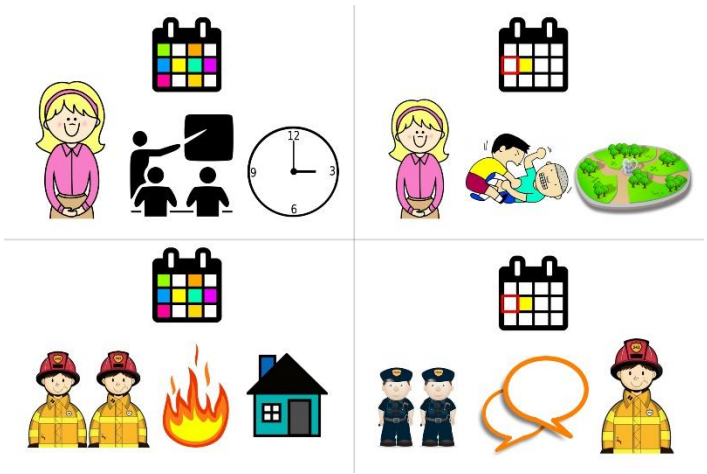


LOAD

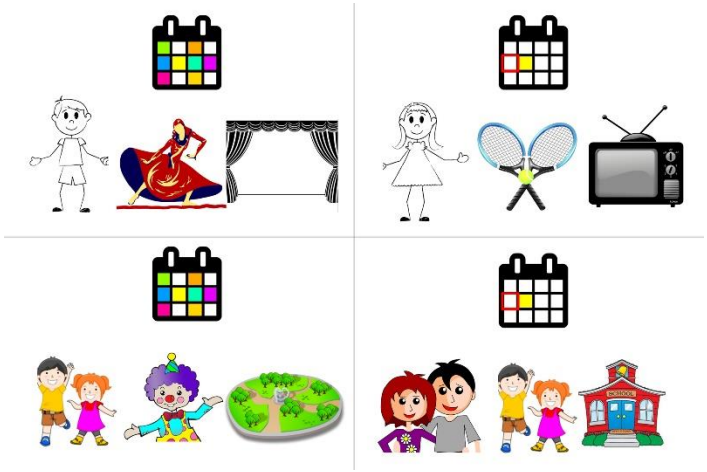
Appendix C (continued)



START

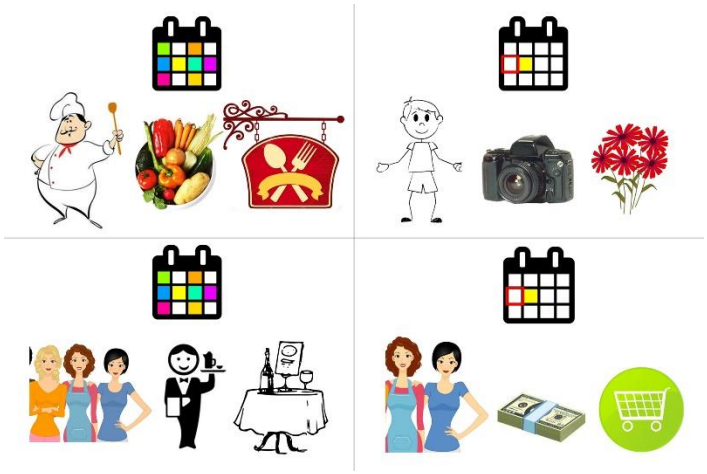


END

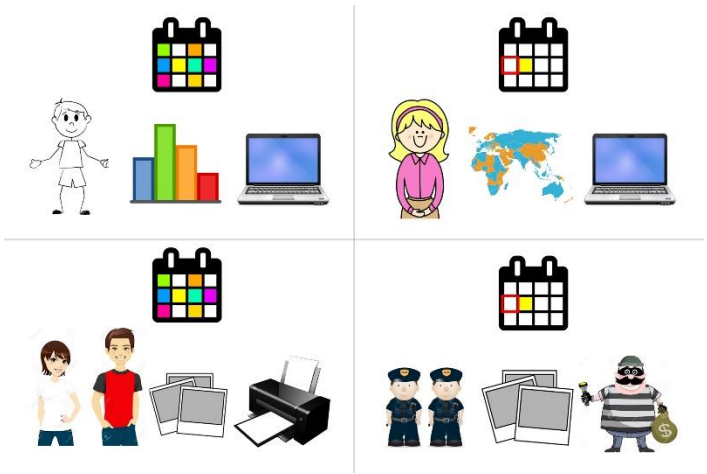


APPLAUD

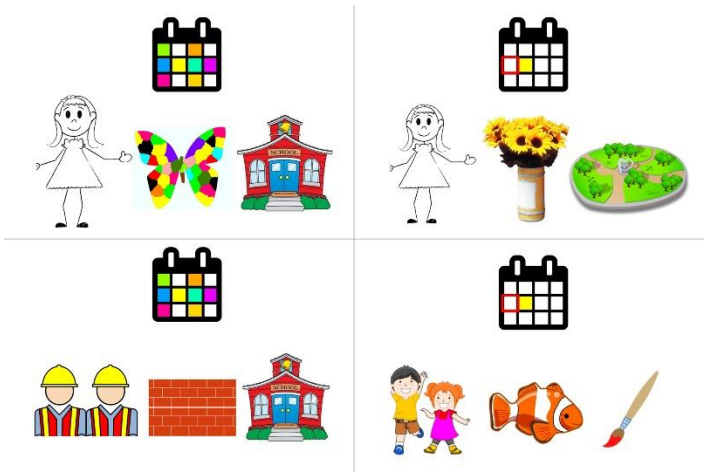
Appendix C (continued)



NEED



PRINT

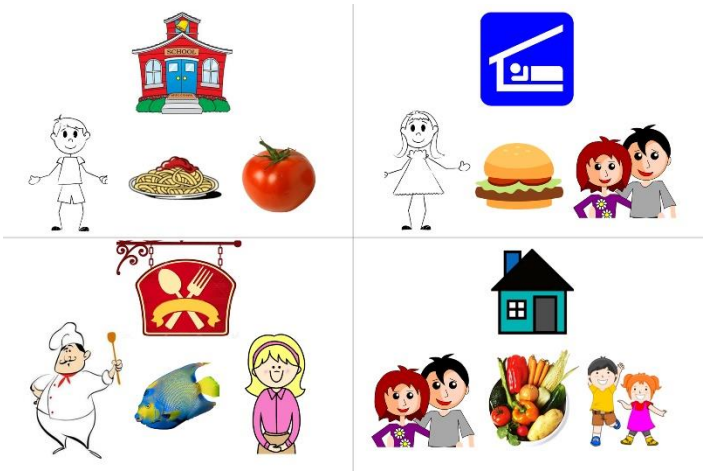


PAINT

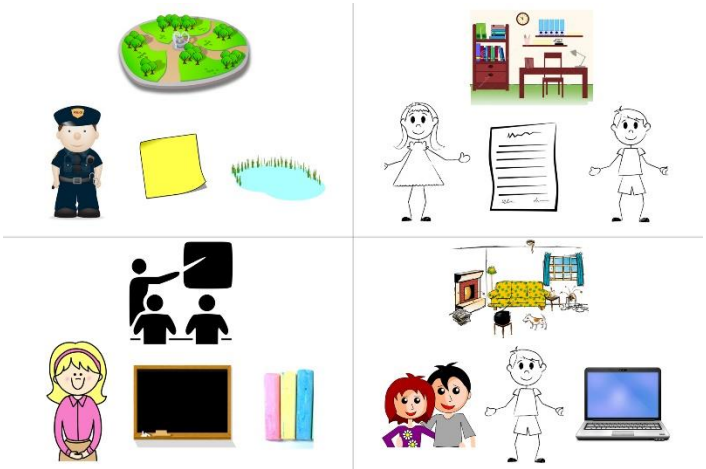
Appendix C (continued)

Filler stimuli

WATCH



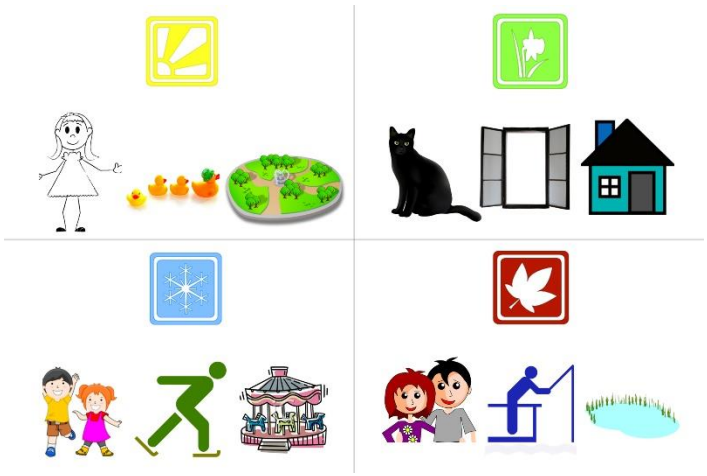
COOK



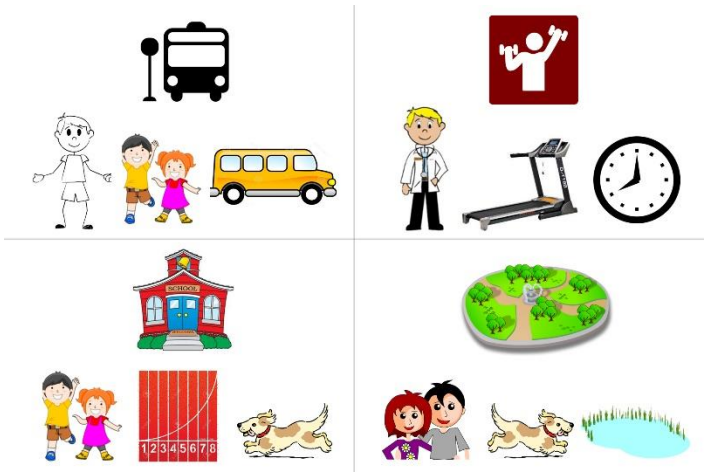
WRITE

Appendix C (continued)

LISTEN

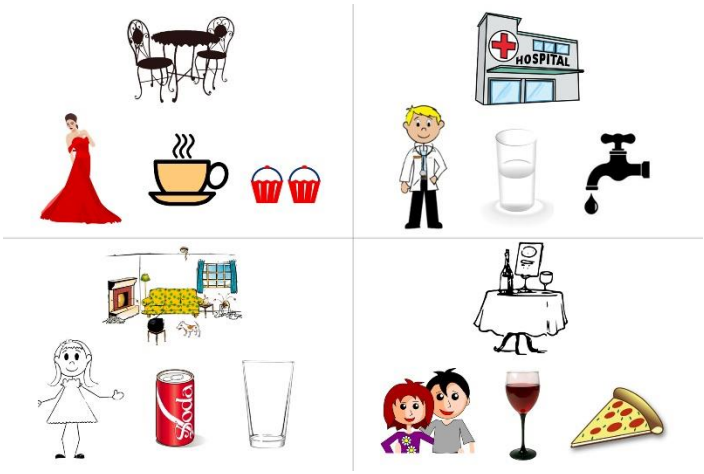


GO

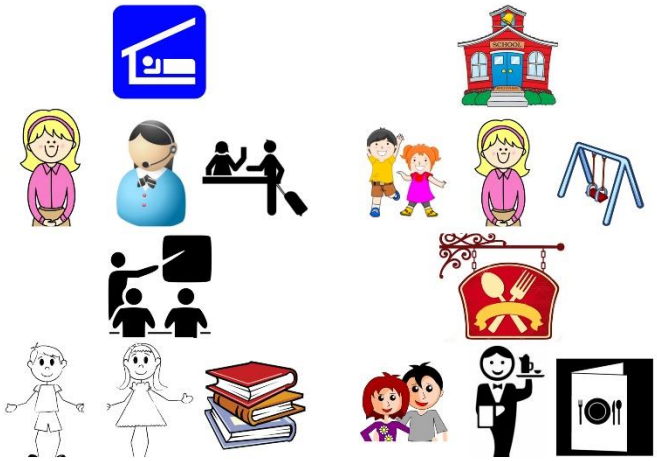


RUN

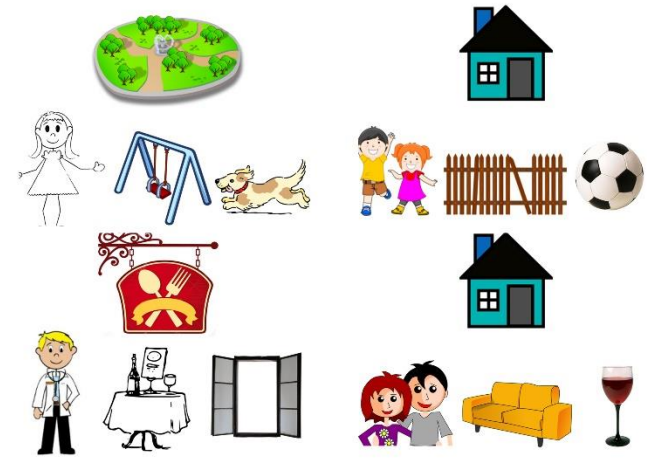
Appendix C (continued)



DRINK



SPEAK

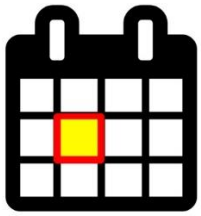


SIT

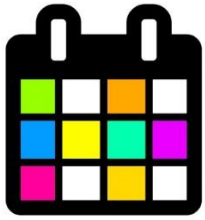
Appendix D.

Experiments 1, 2 and 3: Experimental legend and vocabulary list for the scene description task.

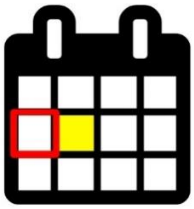
Calendar Legend



Today



Every day



Yesterday

Vocabulary List

Policeman	Farmer	Builder	Firefighter	Dancer
Clown	Waiter	Chef	Teacher	Doctor
Robber	Receptionist	Parents	Children	Fishing
Ice skating	Fair	Bird	Duck	Dog
Cat	Swan	Butterfly	Fish	Basketball
Football	Tennis	Photograph	Laptop	Printer
Vegetable	Tomato	Pizza	Hamburger	Cake
Coffee	Fire hose	Petrol	Rocket	Chess
Camera	Money	Flower	Map	Paint brush
Popcorn	Note	Letter	Chalk	Blackboard
Tap	Soda	Wine	Treadmill	Track
Swing	Sofa	Fence	Pond	Park
House	School	Restaurant	Supermarket	Post office
Stage	Bus	Truck	Car	

**Each item was presented with the corresponding images from Appendix C during vocabulary training in Exp. 3.*

Appendix E.

Experiment 1: Multiple-choice section of Oxford Placement Test with answers (Allan, 1992)

Oxford Placement Test (OPT)

The entire OPT should not take you more than 10 minutes, *i.e.* don't think too long and hard about your answers but keep a steady pace filling out the form. Now please choose the option that you think matches the sentences best in parts I to III below.

Part I of III (1-50)

Look at these examples. The correct answer is highlighted.

a In warm climates people **/ like / likes / are liking /** siting outside in the sun.

b If it is very hot, they sit **/ at / in / under /** the shade.

Circle the correct answer.

1 Water **/ is to boil / is boiling / boils /** at a temperature of 100ºC.

2 In some countries **/ it is / is / there is /** very hot all the time.

3 In cold countries people wear thick clothes **/ for keeping / to keep / for to keep /** warm.

4 In England people are always talking about **/ a weather / weather / the weather /**.

5 In some places **/ it rains / there rains / it raining /** almost every day.

6 In deserts there isn't **/ the / some / any /** grass.

7 Places near the Equator have **/ a warm / the warm / warm /** weather even in the cold season.

8 In England **/ coldest / the coldest / colder /** time of year is usually from December to February.

9 **/ The most / Most of / Most /** people don't know what it's really like in other countries.

10 Very **/ less / little / few /** people can travel abroad.

11 Mohammed Ali **/ has won / won / is winning /** his first world title fight in 1960.

12 After he **/ had won / have won / was winning /** an Olympic gold medal he became a professional boxer.

13 His religious beliefs **/ have made him / made him to / made him /** change his name when he became champion.

14 If he **/ has / would have / had /** lost his first fight with Sonny Liston, no one would have been surprised.

15 He has travelled a lot **/ both / and / or /** as a boxer and as a world-famous personality.

16 He is very well known **/ all in / all over / in all /** the world.

17 Many people **/ is believing / are believing / believe /** he was the greatest boxer of all time.

18 To be the best **/ from / in / of /** the world is not easy.

19 Like any top sportsman Ali **/ had to / must / should /** train very hard.

20 Such is his fame that people **/ would / will / did /** always remember him as a champion.

21 The history of **/ aeroplane / the aeroplane / an aeroplane /** is

22 **/ quite a / a quite / quite /** short one. For many centuries men

23 **/ are trying / try / had tried /** to fly, but with

24 **/ little / few / a little /** success. In the 19th century a few people

25 succeeded **/ to fly / in flying / into flying /** in balloons. But it wasn't until

26 the beginning of the **/ this / next / last /** century that anybody

27 **/ were / is / was /** able to fly a machine

28 **/ who / which / what /** was heavier than air, in other words, in

29 **/ who / which / what /** we now call a 'plane'. The first people to achieve

30 'powered flight' were the Wright brothers. **/ His / Their / Theirs /** was the machine which was the forerunner of the jumbo jets

31 that are **/ such / such a / so /** common sight today.

32 They **/ could / should / couldn't /** hardly have imagined that in 1969,

33 **/ not much / not many / no much /** more than half a century later,

34 a man **/ will be / had been / would be /** walking on the moon.

35 Already **/ a man / man / the man /** is taking the first step towards the stars.

36 Space satellites have now existed **/ since / during / for /** around

37 half a century and we are dependent **/ from / of / on /** them all for all

38 kinds of **/ informations / information / an information /**. Not only

39 **/ are they / they are / there are /** being used for scientific research in

40 space, but also to see what kind of weather **/ is coming / comes / coming /**.

41 By 2018 there **/ would / must / will /** have been satellites in space for sixty

42 years and the 'space superpowers' will be **/ having / making / letting /**

43 massive space stations built. When these **/ will be / are / will have been /**

44 completed it will be the first time **/ when / where / that /** astronauts will be

45 able to work in space in large numbers. **/ Apart / For / Except /** all that,

46 in many ways the most remarkable flight **/ of / above / at /** all was

47 **/ it / that / that one /** of the flying bicycle, which the world saw on television,

48 **/ flying / to fly / fly /** across the Channel from England to France, with nothing

49 **/ apart / but / than /** a man to power it. As the bicycle-flyer said,

50 'It's the first time **/ I realize / I've realized / I am realizing /** what hard work it is to be a bird!'

Part II of III (51-90)

51 Many teachers **/ say to / say / tell /** their students should learn a foreign language.

52 Learning a second language is not the same **/ as / like / than /** learning a first language.

53 It takes **/ long time / long / a long time /** to learn any language.

54 It is said that Chinese is perhaps the world's **/ harder / hardest / more hard /** language to master.

55 English is quite difficult because of all the exceptions **/ who / which / what /** have to be learnt.

56 You can learn basic structures of a language quite quickly, but only if you **/ are wanting / will to / are willing to /** make an effort.

57 A lot of people aren't used **/ to the study / to study / to studying /** grammar in their own language.

58 Many adult students of English wish they **/ would start / would have started / had started /** their language studies earlier.

59 In some countries students have to spend a lot of time working **/ on / by / in /** their own.

60 There aren't **/ no / any / some /** easy ways of learning a foreign language in your own country.

61 Some people try to improve their English by **/ hearing / listening / listening to /** the BBC World Service.

62 **/ Live / Life / Living /** with a foreign family can be a good way to learn a language.

63 It's no use **/ to try / trying / in trying /** to learn a language just by studying a dictionary.

64 Many students of English **/ would rather not / would rather prefer not / would rather not to /** take tests.

65 Some people think it's time we all **/ learn / should learn / learnt /** a single international language.

66 Charles Walker is a teacher at a comprehensive school in Norwich. He **/ has joined / joined / joins /**

67 the staff of the school in 1998 and **/ has been working / worked / works /** there ever since.

68 Before **/ move / to move / moving /** to Norwich, he taught in Italy and in Wales,

69 and before that he **/ has been / was / was being /** a student at Cambridge

70 University. So far he **/ isn't / wasn't / hasn't been /** in Norwich for as long as

71 as he was in Wales, but he likes the city a lot and **/ should / would / could /**

72 like to stay there for at least another two years, or, **/ how / which / as /** he

73 puts it, until his two children **/ have / will have / will be /** grown up a bit.

74 He met his wife, Kate, in 1992 while he **/ was to live / was living / had been living /** abroad for a while, and they got married in 1996.

75 Their two children, Mark and Susan, **/ are / were / have been /** both born in Norwich.

76 The Walkers' boy, **/ who / which / he /** is five, has just started

77 at school, but **/ his / their / her /** sister

78 **/ shall stay / stays / will be staying /** at home for another couple of years,

79 because she is nearly two years **/ younger / more young / the younger /**

80 than him. Charles and Kate Walker **/ are used / use / used /** to live in the

81 country, but now that they have children, they **/ have moved / move / moved /**

82 into the city. Charles wanted a house **/ next / near / close /** the

83 school **/ in order / for / to /** get to work easily. Unfortunately

84 **/ the / a / that /** one the two of them really wanted was too expensive,

85 so they **/ must / should / had to /** buy one a bit further away. By the time the

86 children **/ go / will go / will have gone /** to secondary school.

87 **/ that / which / what /** Charles and Kate hope will be in Norwich, the

88 Walkers **/ will have been / have been / will be /** living there for at least fifteen years.

89 They can't be sure if they **/ stay / do stay / will stay /**, but if they

90 **/ don't / didn't / won't /**, their friends won't be too surprised.

Part III of III (91-100)

Look at the following examples of question tags in English. The correct form of the tag is highlighted.

a He's getting the 9.15 train, **/ isn't he / hasn't he / wasn't he /**?

b She works in a library, **/ isn't she / doesn't she / doesn't he /**?

c Tom didn't tell you, **/ hasn't he / didn't he / did he /**?

d Someone's forgotten to switch off the gas, **/ didn't one / didn't they / haven't they /**?

Now circle the correct question tag for the following 10 items:

91 John's coming to see you, **/ hasn't he / wasn't he / isn't he /**?

92 It's been a long time since you've seen him, **/ hasn't it / isn't it / haven't you /**?

93 He's due to arrive tomorrow, **/ won't he / isn't he / will he /**?

94 He won't be getting in till about 10.30, **/ isn't he / is he / will he /**?

95 You met him while you were on holiday, **/ didn't you / weren't you / haven't you /**?

96 I think I'm expected to pick him up, **/ aren't I / don't I / are you /**?

97 No doubt you'd rather he stayed in England no, **/ didn't you / wouldn't you / shouldn't you /**?

98 Nobody else has been told he's coming, **/ is he / has he / have they /**?

99 We'd better not stay up too late tonight, **/ didn't we / have we / had we /**?

100 I suppose it's time we called it a day, **/ didn't we / isn't it / don't /**?

Answers:

1	boils	21	the aeroplane	41	will	61	listening to	81	have moved
2	it is	22	quite a	42	having	62	living	82	near
3	to keep	23	had tried	43	are	63	trying	83	to
4	the weather	24	little	44	that	64	would rather not	84	the
5	it rains	25	in flying	45	for	65	learnt	85	had to
6	any	26	last	46	of	66	joined	86	go
7	warm	27	was	47	that	67	has been working	87	which
8	the coldest	28	which	48	flying	68	moving	88	will have been
9	most	29	what	59	but	69	was	89	will stay
10	few	30	theirs	50	I've realized	70	hasn't been	90	don't
11	won	31	such a	51	say	71	would	91	isn't he
12	had won	32	could	52	as	72	as	92	hasn't it
13	made him	33	not much	53	a long time	73	have	93	isn't he
14	had	34	would be	54	hardest	74	was living	94	will he
15	both	35	man	55	which	75	were	95	didn't you
16	all over	36	for	56	are willing to	76	who	96	aren't I
17	believe	37	on	57	to studying	77	his	97	wouldn't you
18	in	38	information	58	had started	78	will be staying	98	have they
19	had to	39	are they	59	on	79	younger	99	had we
20	will	40	is coming	60	any	80	used	100	isn't it

Appendix F.

Experiment 1: Descriptive and inferential statistics (t-test) on the multiple-choice section of Oxford Placement Test for L1 Mandarin and L1 English groups (N=16;18).

	M	SD	t (df)
L1 Mandarin	71.90	8.14	-10.55 (32) ***
L1 English	94.06	3.46	

*** p <.001 sig. level against L1 English group.

Appendix G.

Experiments 4 and 5: L1 Mandarin group language background information.

	Experiment 4 (N=61)		Experiment 5 (N=61)	
	M	SD	M	SD
IELTS Overall	7.09	0.40	7.02	0.40
IELTS Listening (Exp. 4)	7.55	0.75	-	-
Reading (Exp. 5)	-	-	7.60	0.65
AoA for L2 English (years)	9.05	3.08	8.27	2.15
Length of Stay (months)	9.72	3.86	5.20	2.42
L2 Contact (hours)	3.30	2.09	4.34	2.59

Appendix H.

Experiments 4 and 5: Experimental sentences with comprehension questions for the self-paced listening and self-paced reading tasks. Forward slashes (/) denote segment boundaries. Condition labels: PH – Present Habitual. P – Past. G – Grammatical. UG – Ungrammatical.

Group A.

1. In the morning / the gardener / shouts / at the cat / in the house. (PH - G)
   Q: *Does the gardener shout at the cat in the house? (Yes)*
2. Every weekend / the food critic / shout / at the waiter / in the restaurant. (PH - UG)
3. Last weekend / the boy / shouted / at the cat / in the garden. (P - G)
4. Last night / the chef / shout / at the waiter / in the kitchen. (P - UG)
   Q: *Did the chef shout at the waiter by the bar? (No)*
5. On Mondays / the man / waits / for a flight / at the airport. (PH - G)
6. In the afternoon / the customer / wait / for the car / at the restaurant. (PH - UG)
7. Yesterday evening / the patient / waited / for the doctor / at the hospital. (P - G)
8. Yesterday afternoon / the lady / wait / for the elevator / at the shopping mall. (P - UG) Q: *Did the lady wait for the elevator at the shopping mall? (Yes)*
9. On Fridays / the builder / loads / the bricks / onto the lorry. (PH - G)
10. Every morning / the builder / load / the rocket / with fuel. (PH - UG)
11. Yesterday afternoon / the man / loaded / the washing machine / with clothes. (P - G)
    Q: *Did the man load the washing machine with clothes? (Yes)*
12. Yesterday morning / the fireman / load / the hose / onto the truck. (P - UG)
13. Every morning / the manager / starts / the meeting / with a joke. (PH - G)
14. At noon / the man / start / a conversation / with his friends. (PH - UG)
    Q: *Does the man start a conversation with his friends?(Yes)*
15. Yesterday / the girl / started / a tennis game / in the schoolyard. (P - G)
    Q: *Did the girl start a football match in the schoolyard? (No)*

16. Last Sunday / the teenager / start / a game of chess / at home. (P - UG)
17. Every week / the fireman / ends / a fire / in the café. (PH - G)
    Q: *Does the fireman end a fire in the café? (Yes)*
18. Every weekend / the waiter / end / an argument / between the customers. (PH - UG)
19. Yesterday morning / the doctor / ended / a conversation / with a patient. (P - G)
20. Last Monday / the policeman / end / a fight / in the pub. (P - UG)
21. On weekends / the director / applauds / the dancer / on the stage. (PH - G)
22. On Fridays / the woman / applaud / the girls / at school. (PH - UG)
23. Yesterday evening / the teacher / applauded / the children / on stage. (P - G)
24. Last night / the athlete / applaud / the tennis game / on tv. (P - UG)
    Q: *Did the athlete applaud the tennis game on tv? (Yes)*
25. Every day / the chef / needs / vegetables / for the restaurant. (PH - G)
26. Every month / the manager / need / leaflets / for the reception. (PH - UG)
    Q: *Does the manager need posters for the reception? (No)*
27. Last Friday / the chef / needed / glasses / for wine. (P - G)
    Q: *Did the chef need glasses for juice? (No)*
28. Last summer / the boy / need / a camera / for his trip. (P - UG)
29. Every Saturday / the woman / prints / flyers / for the concert. (PH - G)
30. On Tuesdays / the architect / print / a building plan / in the office. (PH - UG)
    Q: *Does the architect print a building plan on the building site? (No)*
31. Yesterday afternoon / the boy / printed / his homework / at school. (P - G)
32. Last week / the teacher / print / a map / of the Old Town. (P - UG)
33. Every summer / the artist / paints / butterflies / in the garden. (PH - G)
    Q: *Does the artist paint butterflies in the studio? (No)*
34. On weekends / the girl / paint / vases / at home. (PH - UG)
35. Last week / the woman / painted / swans / in the park. (P - G)
36. Last month / the girl / paint / sunflowers / at school. (P - UG)

Group B.

1. Every day / the chef / shouts / at the waiter / in the kitchen. (PH - G)
   Q: *Does the chef shout at the waiter by the bar?(No)*
2. In the morning / the gardener / shout / at the cat / in the house. (PH - UG)
3. Last night / the food critic / shouted / at the waiter / in the restaurant. (P - G)
4. Last weekend / the boy / shout / at the cat / in the garden. (P - UG)
   Q: *Does the gardener shout at the cat in the house?(Yes)*
5. Every afternoon / the lady / waits / for the elevator / at the shopping mall. (PH - G)
   Q: *Does the lady wait for the elevator at the shopping mall? (Yes)*
6. Yesterday evening / the patient / wait / for the ambulance / at the hospital. (PH - UG)
7. Yesterday afternoon / the customer / waited / for the car / at the restaurant. (P - G)
8. On Mondays / the man / wait / for a flight / at the airport. (P - UG)
9. In the morning / the fireman / loads / the hose / onto the truck. (PH - G)
10. On Fridays / the builder / load / the bricks / onto the lorry. (PH - UG)
11. Last Tuesday / the builder / loaded / the rocket / with fuel. (P - G)
12. Yesterday afternoon / the man / load / the washing machine / with clothes. (P - UG)
    Q: *Did the man load the washing machine with clothes? (Yes)*
13. Every Sunday / the teenager / starts / a game of chess / at home. (PH - G)
14. Every morning / the manager / start / the meeting / with a joke. (PH - UG)
15. Last Monday / the man / started / a conversation / with his friends. (P - G)
    Q: *Did the man start a conversation with his friends? (Yes)*
16. Yesterday / the girl / start / a tennis game / in the schoolyard. (P - UG)
    Q: *Did the girl start a football match in the schoolyard? (No)*
17. Every weekend / the policeman / ends / a fight / in the pub. (PH - G)
18. Every week / the fireman / end / a fire / in the café. (PH - UG)
    Q: *Does the fireman end a fire in the café? (Yes)*

19. Last weekend / the waiter / ended / an argument / between the customers. (P - G)
20. Yesterday morning / the doctor / end / a conversation / with a patient. (P - UG)
21. In the afternoon / the athlete / applauds / the tennis game / on tv. (PH - G)
    Q: *Does the athlete applaud the tennis game on tv? (Yes)*
22. Yesterday evening / the teacher / applaud / the children / on stage. (PH - UG)
23. Last Friday / the woman / applauded / the girls / at school. (P - G)
24. On weekends / the director / applaud / the dancer / on the stage. (P - UG)
25. Every summer / the boy / needs / a camera / for his trip. (PH - G)
26. Last Friday / the chef / need / glasses / for wine. (PH - UG)
    Q: *Did the chef need glasses for juice? (No)*
27. Last month / the manager / needed / leaflets / for the reception. (P - G)
    Q: *Did the manager need posters for the shop? (No)*
28. Every day / the chef / need / vegetables / for the restaurant. (P - UG)
29. Every year / the teacher / prints / a map / of the Old Town. (PH - G)
30. Every Saturday / The woman / print / flyers / for the concert. (PH - UG)
31. Last Tuesday / the architect / printed / a building plan / in the office. (P - G)
    Q: *Did the architect print a building plan on the building site? (No)*
32. Yesterday afternoon / the boy / print / his homework / at school. (P - UG)
33. Every week / the girl / paints / sunflowers / at school. (PH - G)
34. Last week / the woman / paint / swans / in the park. (PH - UG)
35. Last weekend / the girl / painted / vases / at home. (P - G)
36. Every summer / the artist / paint / butterflies / in the garden. (P - UG)
    Q: *Does the artist paint butterflies in the studio? (No)*

<u>Group C.</u>

1. Every afternoon / the boy / shouts / at the cat / in the garden. (PH - G)
2. Every day / the chef / shout / at the waiter / in the kitchen. (PH - UG)
3. Yesterday evening / the gardener / shouted / at the cat / in the house. (P - G)
   Q: *Did the gardener shout at the cat in the house? (Yes)*

4. Last night / the food critic / shout / at the waiter / in the restaurant. (P - UG)
5. Every morning / the patient / waits / for the doctor / at the hospital. (PH - G)
6. Every afternoon / the lady / wait / for the elevator / at the shopping mall. (PH - UG)

   Q: *Does the lady wait for the elevator at the shopping mall? (Yes)*
7. Last Monday / the man / waited / for a flight / at the airport. (P - G)
8. Yesterday afternoon / the customer / wait / for the car / at the restaurant. (P - UG)

   Q: *Did the customer wait for the car at the hotel? (No)*
9. Every day / the man / loads / the washing machine / with clothes. (PH - G)

   Q: *Does the man load the washing machine with clothes? (Yes)*
10. In the morning / the fireman / load / the hose / onto the truck. (PH - UG)
11. Last Tuesday / the builder / loaded / the bricks / onto the lorry. (P - G)
12. Last Tuesday / the builder / load / the rocket / with fuel. (P - UG)
13. In the afternoon / the girl / starts / a tennis game / in the schoolyard. (PH - G)
14. Every Sunday / the teenager / start / a game of chess / at home. (PH - UG)
15. Yesterday morning / the manager / started / the meeting / with a joke. (P - G)
16. Last Monday / the man / start / a conversation / with his friends. (P - UG)

    Q: *Did the man start a conversation with his friends? (Yes)*
17. At the end of the day / the doctor / ends / a conversation / with a patient. (PH - G)

    Q: *Does the doctor end a conversation with a nurse? (No)*
18. Every weekend / the policeman / end / a fight / in the pub. (PH - UG)
19. Last Friday / the fireman / ended / a fire / in the café. (P - G)

    Q: *Did the fireman end a fire in the café? (Yes)*
20. Last weekend / the waiter / end / an argument / between the customers. (P - UG)
21. Every week / the teacher / applauds / the children / on stage. (PH - G)
22. In the afternoon / the athlete / applaud / the tennis game / on tv. (PH - UG)

    Q: *Does the athlete applaud the tennis game on tv? (Yes)*
23. Last week / the director / applauded / the dancer / on the stage. (P - G)
24. Last Friday / the woman / applaud / the girls / at school. (P - UG)

25. Every evening / the chef / needs / glasses / for wine. (PH - G)
    Q: *Does the chef need glasses for juice? (No)*
26. Every summer / the boy / need / a camera / for his trip. (PH - UG)
27. Yesterday morning / the chef / needed / vegetables / for the restaurant. (P - G)
28. Last month / the manager / need / leaflets / for the reception. (P - UG)
29. Every term / the boy / prints / his homework / at school. (PH - G)
30. Every year / the teacher / print / a map / of the Old Town. (PH - UG)
    Q: *Does the teacher print maps of the New Town? (No)*
31. Last Saturday / The woman / printed / flyers / for the concert. (P - G)
32. Last Tuesday / the architect / print / a building plan / in the office. (P - UG)
    Q: *Did the architect print a building plan on the building site? (No)*
33. Every Sunday / the woman / paints / swans / in the park. (PH - G)
34. Every week / the girl / paint / sunflowers / at school. (PH - UG)
35. Last summer / the artist / painted / butterflies / in the garden. (P - G)
    Q: *Did the artist paint butterflies in the studio? (No)*
36. Last weekend / the girl / paint / vases / at home. (P - UG)

Group D.

1. Every weekend / the food critic / shouts / at the waiter / in the restaurant. (PH - G)
2. Every afternoon / the boy / shout / at the cat / in the garden. (PH - UG)
3. Last night / the chef / shouted / at the waiter / in the kitchen. (P - G)
4. Yesterday evening / the gardener / shout / at the cat / in the house. (P - UG)
   Q: *Did the gardener shout at the cat in the house? (Yes)*
5. In the afternoon / the customer / waits / for the car / at the restaurant. (PH - G)
6. Every morning / the patient / wait / for the doctor / at the hospital. (PH - UG)
7. Yesterday afternoon / the lady / waited / for the elevator / at the shopping mall. (P - G) Q: *Did the lady wait for the elevator at the shopping mall? (Yes)*
8. Last Monday / the man / wait / for a flight / at the airport. (P - UG)
9. Every morning / the builder / loads / the rocket / with fuel. (PH - G)
10. Every day / the man / load / the washing machine / with clothes. (PH - UG)

Q: *Does the man load the washing machine with clothes? (Yes)*

11. Yesterday morning / the fireman / loaded / the hose / onto the truck. (P - G)

    Q: *Did the fireman load the hose into the van? (No)*

12. Last Tuesday / the builder / load / the bricks / onto the lorry. (P - UG)
13. At noon / the man / starts / a conversation / with his friends. (PH - G)

    Q: D*oes the man start a conversation with his friends? (Yes)*

14. In the afternoon / the girl / start / a tennis game / in the schoolyard. (PH - UG)
15. Last Sunday / the teenager / started / a game of chess / at home. (P - G)
16. Yesterday morning / the manager / start / the meeting / with a joke. (P - UG)
17. Every weekend / the waiter / ends / an argument / between the customers. (PH - G)
18. At the end of the day / the doctor / end / a conversation / with a patient. (PH - UG)
19. Last Monday / the policeman / ended / a fight / in the pub. (P - G)
20. Last Friday / the fireman / end / a fire / in the café. (P - UG)

    Q: *Did the fireman end a fire in the café? (Yes)*

21. On Fridays / the woman / applauds / the girls / at school. (PH - G)
22. Every week / the teacher / applaud / the children / on stage. (PH - UG)

    Q: *Does the teacher applaud the children on the stage? (Yes)*

23. Last night / the athlete / applauded / the tennis game / on tv. (P - G)

    Q: *Did the athlete applaud the tennis game on tv? (Yes)*

24. Last week / the director / applaud / the dancer / on the stage. (P - UG)
25. Every month / the manager / needs / leaflets / for the reception. (PH - G)
26. Every evening / the chef / need / glasses / for wine. (PH - UG)

    Q: *Does the chef need glasses for juice? (No)*

27. Last summer / the boy / needed / a camera / for his trip. (P - G)
28. Yesterday morning / the chef / need / vegetables / for the restaurant. (P - UG)
29. On Tuesdays / the architect / prints / a building plan / in the office. (PH - G)
30. Every term / the boy / print / his homework / at school. (PH - UG)
31. Last week / the teacher / printed / a map / of the Old Town. (P - G)

    Q: *Did the teacher print maps of the New Town? (No)*

32. Last Saturday / The woman / print / flyers / for the concert. (P - UG)

33. On weekends / the girl / paints / vases / at home. (PH - G)
34. Every Sunday / the woman / paint / swans / in the park. (PH - UG)
35. Last month / the girl / painted / sunflowers / at school. (P - G)

    Q: *Did the girl paint sunflowers at school? (Yes)*
36. Last summer / the artist / paint / butterflies / in the garden. (P - UG)

    Q: *Did the artist paint butterflies in the studio? (No)*

Appendix I.

Experiments 4 and 5: Filler sentences with comprehension questions for the self-paced listening and self-paced reading tasks (same for Groups A, B, C and D). Forwards slashes (/) denote segment boundaries. Error labels: V- verb form. A – agreement. PP – preposition. D – determiner.

1. In the theatre / the boys / are watching / the clowns / perform on stage.

   Q: *Are the boys watching the clowns perform on stage? (Yes)*
2. At school / the teachers / watched / the children / to play football. (V)

   Q: *Did the teachers watch the children play basketball? (No)*
3. At the park / the children / watched / the ducks / play.
4. In the theatre / the girls / are watching / the dancers / to perform on stage. (V)
5. In the restaurant / the chefs / are cooking / fish / for the food critic.
6. At home / the boys / cooked / spaghetti / with a tomatoes. (A)

   Q: *Did the boys cook spaghetti with tomatoes? (Yes)*
7. At the park / the chefs / cooked / hamburgers / with potatoes.
8. In home / the girls / are cooking / vegetables / in the garden. (D)
9. In the car park / the policemen / are writing / parking tickets / by the cars.
10. In the library / the students / wrote / in her notebooks / with pencil. (A)
11. In the bedroom / the girls / wrote / their homework / with pen.

    Q: *Did the girls write their homework with pen?(Yes)*
12. In the library / the ladies / are writing / a letter / to her friend. (A)
13. In the car / the teenagers / are singing / to music / on their iPods.
14. At school / the children / sang / carol / by the Christmas tree. (D)
15. In the park / the clowns / sang / for the children / on the stage.

    Q: *Did the clowns sing for the children in the school hall?*

16. In the living room / the girls / are singing / music / on the sofa. (PP)
    Q: *Are the girls singing to music on the sofa? (Yes)*
17. In the emergency room / the patients / are drinking / water / from the tap.
    Q: *Are the patients drinking water from the tap? (Yes)*
18. In the kitchen / the girls / drank / glass / of orange juice. (PP)
19. In the restaurant / the chefs / drank / wine / with the waiters.
20. In the garden / the boys / are drinking / water / from glass. (PP)
21. In the kitchen / two cats / are going / out of the house / through a window.
22. At the railway station / the women / went / to the shop / buy lunch. (V)
    Q: *Did the women go to the shop at the railway station? (Yes)*
23. On the beach / the children / went / for a walk / with the dog.
24. In the restaurant / the chefs / are going / see / the guests. (V)
25. On the pavement / the children / are running / to the park / with a dog.
26. In the stadium / the athletes / ran / on the track / to win medal. (D)
27. In the park / the boys / ran / on the grass / with the teacher.
    Q: *Did the boys run on the track with the teacher? (No)*
28. In the gym / the athletes / are running / the treadmill / with weights. (PP)
    Q: *Are the athletes running on the treadmill at home? (No)*
29. In class / the boys / are speaking / to the girl / about their homework.
30. At the golf club / the guests / spoke / to the receptionist / in the phone. (PP)
31. At the restaurant / the customers / spoke / to the waiter / at the entrance.
32. At the hotel / guests / are speaking / to the chef / about the menu. (D)
    Q: *Are the guests speaking to the chef about the waiter? (No)*
33. At the park / the girls / are sitting / on the swing / with a dog.
    Q: *Are the girls sitting on the grass at the park? (No)*
34. In the café / customers / sat / at the table / for an hour. (D)
35. In the restaurant / the guests / sat / by the bar / with some wine.
36. At the hotel / the women / are sitting / at table / by the window. (D)

Appendix J.

Experiment 4 and 5: Morphological Proficiency Test (with answers)

This grammar test consists of 50 questions. Part I consists of 30 multiple choice questions (MCQs), and Part II consists of 20 gap filling exercises. For each MCQ, you must mark the most appropriate option out of the 3 that are given. For each gap-filling exercise, you must write down a suitable verb in its correct form in order to form a coherent sentence. This test should take no longer than 10 minutes overall to complete.

Part I (Multiple-choice questions - MCQs)

1. Court is in session, the lawyers **is making / are making / was making** a case for the victims on the TV broadcast.
2. The photographer often **are coming** / **come / comes** to the studio by taxi.
3. Daniel **is apologising / was apologising / were apologising** for his mistakes at work when the manager arrived.
4. The children **are running / will have run / will be running** to the buses despite being instructed to walk.
5. Sarah and her boyfriend are engaged; they **is living / are living / has lived** in Nottingham.
6. During the ceremony, the winning athletes **has stood / will have stood / will stand** on the podium.
7. Emma sees that the customer **is arguing / was arguing / argued** with the shop assistant.
8. The workers **have told / has told / was telling** the man to stay away from the crime scene.
9. Michael **expect / were expecting / expected** his train at seven o'clock last night.
10. The engineer **hold / has held / were holding** the pipe for at least an hour now.
11. Every fortnight, Benjamin **is having / has / were had** an appointment with the doctor
12. The meeting **will start / will have started / has started** by the time I get there.
13. The ferry **depart / departs / is departing** from the port right now.
14. The criminal **have shot / has shot / were shooting** the victim multiple times in the back.
15. I **were having / was having / has a shower** when she called.
16. Yesterday, the reporter **will explain / have explained / explained** her intentions at the interview.
17. John **have eaten / eats / was eating** a ham sandwich with coffee for lunch every day.

Appendix J (continued)

18. Elizabeth **is writing / were writing / was writing** a letter to her mother at the desk when Will entered.
19. The dancers **was performing / were performing / perform** at the opera house last Sunday.
20. Jane **missed / had missed / have missed** her flight to New York at 2pm yesterday.
21. Katie **are borrowing / will borrow / will have borrowed** a dress from Jane if she can't go home tonight.
22. The prime minister **has introduced / have introduced / had introduced** his secretary before the meeting started.
23. I **had seen / have seen / am seeing** her mother twice since this morning.
24. She **hid / has hidden / was hiding** behind a bush when we found her.
25. The children **buys / is buying** / **buy** sweets from the shop every weekend.
26. Sophie **was leaving / left / have left** the cat on the table before going to work.
27. The football fans **chose / choose / had chosen** their favourite team before the game had started.
28. The gentleman **are defending / is defending / were defending** his argument in a debate.
29. Will believes that he **failed / will fail / has failed** the blood test if he eats too much.
30. The judges must **decide / decided / is deciding** on the outcome of the trial.

Part II (Gap-Filling Exercise)

1. Mark _____ (**find**) his watch on the kitchen table this morning.
2. The professor _____ (**make**) his decision by the time the committee met again.
3. The passenger _____ (**appear**) 5 minutes before take-off.
4. As the girl plays with her doll, the boy _____ (**feed**) the cat some biscuits from a jar.
5. Chris _____ (**catch)** the 8.30 train if he cannot get up early tomorrow.
6. As of today, my friend and I _____ (**know**) each other for exactly ten years.
7. I _____ (**write**) a letter when my friend knocked on my door.
8. At this moment, Jessica _____ (**prepare**) for her friend's party.
9. As she sat down, the woman _____ **(remember**) her time working at the hospital.
10. The volleyball team _____ (**win**) ten games in a row by the time they were beaten.
11. The driver _____ (**spend**) 3 pounds on his lunch every day last week.
12. I _____ (**arrive**) in London by six tomorrow evening.

Appendix J (continued)

13. David wasn't sure if he _____ (**order**) already when the waiter came back.
14. The players _____ (**think**) there will be a delay to the start of the game.
15. She believes that Kevin _____ (**sing**) on his way to work every day.
16. The team _____ (**build**) a skyscraper which attracted many visitors.
17. The artist _____ (**draw**) a portrait yesterday by the sea.
18. Catherine can hear that her dog _____ (**snore**) in the living room.
19. Until you arrive, Jeremy _____ (**wait**) for you at the station.
20. I _____ (**work**) for 2 organisations since I came back from Spain.

Answers

Part I	Part II
1. are making	1. found
2. comes	2. will have made
3. was apologising	3. appeared
4. are running	4. feeds
5. are living	5. will catch
6. will stand	6. have known
7. is arguing	7. was writing
8. have told	8. is preparing
9. expected	9. remembered
10. has held	10. had won
11. has	11. spent
12. will have started	12. will have arrived
13. is departing	13. had ordered
14. has shot	14. think
15. was having	15. sings
16. explained	16. built
17. eats	17. drew
18. was writing	18. is snoring
19. were performing	19. will wait
20. missed	20. have worked
21. will borrow	
22. had introduced	
23. have seen	
24. was hiding	
25. buy	
26. left	
27. had chosen	
28. is defending	
29. will fail	
30. decide	

Appendix K.

Experiments 4 and 5: Descriptive and inferential statistics on the Morphological Proficiency Test for L1 Mandarin and L1 English groups.

	Experiment 4 (N=61;56)				Experiment 5 (N=61;57)			
	M	SD	t (df)	*p*	M	SD	t (df)	*p*
L1 Mandarin								
MCQs	27.61	1.64	-5.77 (114.95)	***	27.00	2.54	-5.48 (78.16)	***
Gap-filling	12.70	1.97	-2.83 (115.39)	**	12.15	1.92	-4.32 (108.40)	***
L1 English								
MCQs	29.04	1.08	-		28.92	0.97	-	
Gap-filling	13.73	2.05	-		13.86	2.35	-	

** p <.01 sig. level against L1 English group.
*** p <.001 sig. level against L1 English group.

Appendix L.

Experiments 6 and 7: L1 Mandarin group language background information.

	Experiment 6 (N=61)		Experiment 7 (N=61)	
	M	SD	M	SD
IELTS Overall	7.20	0.36	6.99	0.40
IELTS Listening	7.86	0.70	7.95	3.14
AoA for L2 English (years)	8.79	2.80	8.39	2.19
Length of Stay (months)	10.50	3.83	7.48	2.34
L2 Contact (hours)	3.33	2.17	3.98	2.87

Appendix M.

Experiments 6 and 7: Experimental (Sets A, B and C) and filler verbs used in Phonological Discrimination Task with phonetic properties of the final phoneme: Voicing, Place of Articulation (POA), and phonetic realisations of 3SG -s and past -ed endings (using International Phonetic Alphabet transcription).

Experimental Verbs (regular).

	Final Phoneme		**3SG *-s* ending**		***-ed* ending**	
Set A	**Voicing**	**POA**	**realisation**	**feature**	**realisation**	**feature**
Shout	voiceless	Alveolar	[s]	cons. cluster	[ɪd]	syllabic
Wait	voiceless	Alveolar	[s]	cons. cluster	[ɪd]	syllabic
Applaud	voiced	Alveolar	[z]	cons. cluster	[ɪd]	syllabic
Start	voiceless	Alveolar	[s]	cons. cluster	[ɪd]	syllabic
End	voiced	Alveolar	[z]	cons. cluster	[ɪd]	syllabic
Load	voiced	Alveolar	[z]	cons. cluster	[ɪd]	syllabic
Need	voiced	Alveolar	[z]	cons. cluster	[ɪd]	syllabic
Print	voiceless	Alveolar	[s]	cons. cluster	[ɪd]	syllabic
Paint	voiceless	Alveolar	[s]	cons. cluster	[ɪd]	syllabic
Avoid	voiced	Alveolar	[z]	cons. cluster	[ɪd]	syllabic

	Final Phoneme		**3SG *-s* ending**		***-ed* ending**	
Set B	**Voicing**	**POA**	**realisation**	**feature**	**realisation**	**feature**
Attack	voiceless	Velar	[s]	cons. cluster	[t]	cons. cluster
Arrive	voiced	Labiodental	[z]	cons. cluster	[d]	cons. cluster
Bake	voiceless	Velar	[s]	cons. cluster	[t]	cons. cluster
Pack	voiceless	Velar	[s]	cons. cluster	[t]	cons. cluster
Move	voiced	Labiodental	[z]	cons. cluster	[d]	cons. cluster
Disturb	voiced	Bilabial	[z]	cons. cluster	[d]	cons. cluster
Escape	voiceless	Bilabial	[s]	cons. cluster	[t]	cons. cluster

Kick	voiceless	Velar	[s]	cons. cluster	[t]	cons. cluster
Save	voiced	Labiodental	[s]	cons. cluster	[d]	cons. cluster
Approve	voiced	Labiodental	[z]	cons. cluster	[d]	cons. cluster

	Final Phoneme		**3SG *-s* ending**		***-ed* ending**	
Set C	**Voicing**	**POA**	**realisation**	**feature**	**realisation**	**feature**
Chase	voiceless	Alveolar	[z]	syllabic	[t]	cons. cluster
Crash	voiceless	Palatal	[z]	syllabic	[t]	cons. cluster
Damage	voiced	Palatal	[z]	syllabic	[d]	cons. cluster
Encourage	voiced	Palatal	[z]	syllabic	[d]	cons. cluster
Finish	voiceless	Palatal	[z]	syllabic	[t]	cons. cluster
Kiss	voiceless	Alveolar	[z]	syllabic	[d]	cons. cluster
Manage	voiced	Palatal	[z]	syllabic	[t]	cons. cluster
Please	voiceless	Alveolar	[z]	syllabic	[d]	cons. cluster
Stretch	voiceless	Palatal	[z]	syllabic	[t]	cons. cluster
Wish	voiceless	Palatal	[z]	syllabic	[t]	cons. cluster

Filler Verbs (irregular).

Break	**Hold**
Buy	**Make**
Choose	**Meet**
Drink	**Sleep**
Eat	**Spend**
Feed	**Stand**
Fly	**Take**
Forget	**Tell**
Give	**Wear**
Go	**Write**

Appendix N.

Experiments 6 and 7: Practice and test items from the Phoneme Elision Task in order of presentation (CTOPP-2; Wagner et al., 2013). Table includes initial word, phoneme omitted, target word and additional information: place of (phoneme) elision and task type.

	Initial word	Phoneme(s) omitted	Target word	Place of elision	Task Type
-	**airplane**	**plane**	**air**	-	-
-	**doughnut**	**dough**	**nut**	-	-
-	**cup**	**/k/**	**up**	-	-
-	**meat**	**/t/**	**me**	-	-
-	**farm**	**/f/**	**arm**	-	-
1.	*popcorn*	**corn**	*pop*	word boundary	omission
2.	*baseball*	**base**	*ball*	word boundary	omission
3.	*spider*	**der**	*spy*	word boundary	omission
4.	*bold*	**/b/**	*old*	word boundary	omission
5.	*mat*	**/m/**	*at*	word boundary	omission
6.	*tan*	**/t/**	*an*	word boundary	omission
7.	*mike*	**/k/**	*my*	word boundary	omission
8.	*time*	**/m/**	*tie*	word boundary	omission
9.	*tiger*	**/g/**	*tire*	mid-word	adjunction
10.	*powder*	**/d/**	*power*	mid-word	adjunction
11.	*winter*	**/t/**	*winner*	mid-word	adjunction
12.	*snail*	**/n/**	*sail*	mid-word	adjunction
13.	*faster*	**/s/**	*fatter*	mid-word	adjunction
14.	*sling*	**/l/**	*sing*	mid-word	adjunction
15.	*driver*	**/v/**	*dryer*	mid-word	adjunction
16.	*silk*	**/l/**	*sick*	mid-word	adjunction
17.	*flame*	**/f/**	*lame*	word boundary	omission
18.	*strain*	**/r/**	*stain*	mid-word	adjunction
19.	*split*	**/p/**	*slit*	mid-word	adjunction
20.	*fixed*	**/k/**	*fist*	mid-word	adjunction

Appendix O

Experiments 6 and 7: Sample transcription of trials from the Phoneme Elision Task (based on instructions from CTOPP-2 manual, Wagner et al., 2013) with coding examples (1- correct; 0 - incorrect).

Experimenter: *Now we are going to play a word game.*

I am going to play you some English words, and the recording will ask you to repeat the word, and then to repeat the word with a certain sound taken away.

*Take the word 'Window', it might say, say '**Window**' without saying '**ow**'. '**Window**' then becomes '**Wind**'. Is that clear?*

Participant: *Yes.*

Experiment: *Okay. I am going to record your voice for analysis. Can you try and speak as clearly as possible?*

Participant: *Okay.*

(Practice items)

Recording: *Let's play a word game: Say airplane.*

Participant: *Airplane.*

Recording: *Now, say airplane without saying plane.*

Participant: *Air.*

Recording: *It's Air.*

Experimenter: *Good, well done.*

…

Recording: *Now, let's take away smaller parts of words - say cup.*

Participant: *Cup.*

Recording: *Now, say cup without saying /k/.*

Participant: *pa-*

Recording: *It's up.*

…

(Test items)

Recording: *Say bold.*

Participant: *Boat.*

Recording: *Now say bold without saying /b/.*

Participant: *Oat.*

Coding: repetition – 0 / omission - 1.

…

Recording: *Say winter.*

Participant: *Winter.*

Recording: *Now, say winter without saying /t/.*

Participant: *Win.*

Coding: repetition – 1 / omission – 0 / adjunction - 0

…

Recording: *Say strain.*

Participant: *Strain.*

Recording: *Now, say strain without saying /r/.*

Participant: *S..rain? Sorry, I don't know.*

Coding: repetition – 1 / omission – 0 / adjunction - 0

…

Recording: *Say split.*

Participant: *Split.*

Recording: *Now, say split without saying /p/.*

Participant: *Spit?*

Coding: repetition – 1 / omission – 0 / adjunction - 0

…

Recording: *Say fixed.*

Participant: *Fixed.*

Recording: *Now, say fixed without saying /k/.*

Participant: *f.. fist?*

Coding: repetition – 1 / omission – 1 / adjunction - 1

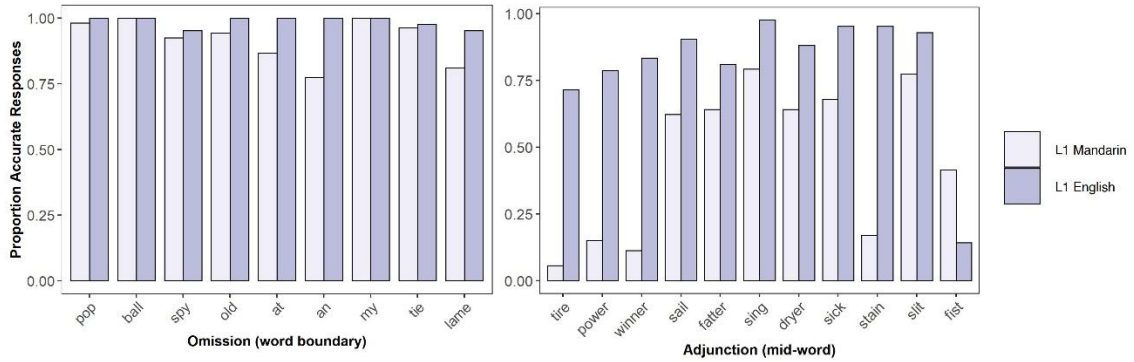
Experimenter:

That's great. Thank you.

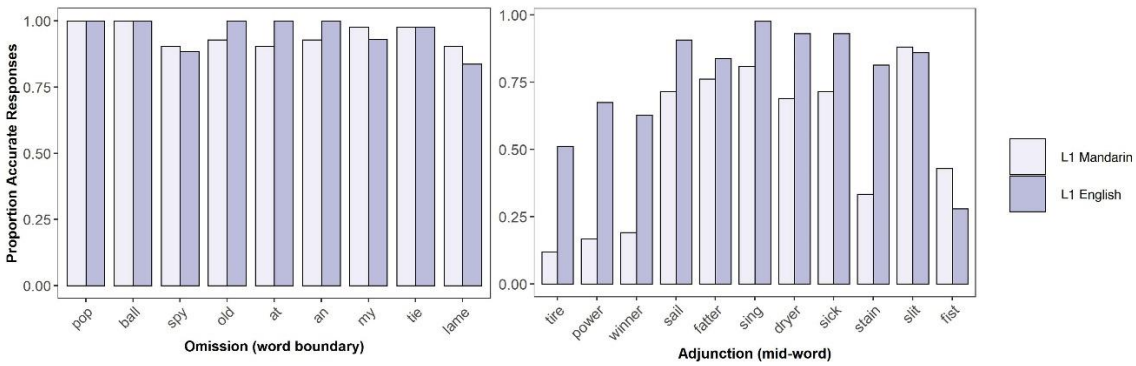
Appendix P.

Experiments 6 and 7: Average response accuracy for individual items in the Phoneme Elision Task across L1 Mandarin and L1 English groups (CTOPP-2, Wagner et al., 2013).

Experiment 6.



Experiment 7.



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