SECOND LANGUAGE PERCEPTION AND PRODUCTION OF ENGLISH REGULAR PAST TENSE: L1 INFLUENCE IN PHONOLOGY AND MORPHOSYNTAX

By

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ABSTRACT

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The goal of this study is to provide a better understanding of the influence from first language (L1) phonology and morphosyntax on second language (L2) production and perception of English regular past tense morphology. The following research questions guided the present study: 1) Do L1 phonology and morphosyntax affect L2 learners' production of the English past tense morpheme *-ed*? 2) Do L1 phonology and morphosyntax affect L2 learners' perception of the English past tense morpheme *-ed*? 3) Does the phonetic form of the regular verbs affect L2 learners' production of the English past tense morpheme *-ed*? 4) Does the phonetic form of the regular verbs affect L2 learners' perception of the English past tense morpheme *-ed*? 5) Does L2 learners' perception of the *-ed* morpheme correlate with how they produce it? To answer these questions, this study compared speakers of Turkish (a language that encodes tense morphologically and permits final consonant clusters) with speakers of Korean (a language that encodes tense morphologically but does not allow final consonant clusters) and speakers of Chinese (a language that does not mark tense and does not license final consonant clusters) on story completion, sentence repetition, self-paced listening (SPL), and perception judgment tasks.

Sixty-two L2 learners of English (18 L1 Turkish, 21 L1 Korean, 23 L1 Chinese) and 24 native English speakers participated in this study. The results from the story completion task showed that both the Turkish and Korean groups were significantly more accurate than the Chinese group, although none of the three L2 groups produced the past tense morpheme *-ed* at native-like levels. In the sentence repetition task, the three L2 groups performed alike, and they

all showed high levels of morphology suppliance (all over 90%), but only the Korean group performed in a way similar to the native control group. Moreover, in both of the oral production tasks, the learners in the three L2 groups alike were more accurate with regular verbs ending in a single consonant than regular verbs ending in consonant clusters. These results suggest that L1 morphosyntax might be an important factor in the production of English regular past tense morphology and that there seems to be a general phonological effect on final constraint clusters. The present data also indicate that the phonetic form of the regular verbs plays a role in the production of English past tense morphology.

Two tasks examined perception of past tense marking. The results from the perception judgment task revealed that none of the three L2 groups perceived the *-ed* morpheme in a native-like manner. In addition, while the Turkish group was equally accurate in perceiving the *-ed* inflection in cluster and non-cluster contexts, both the Korean and Chinese groups were less accurate with regular past forms taking non-syllabic allomorphs [t] and [d]. The results from the SPL task were somewhat inconclusive, but demonstrated that participants were most sensitive to grammatical errors targeting syllabic allomorph [əd]. These results suggest that L2 learners' perception of English past tense morphology is affected by a combination of L1 phonological constraints as well as more general properties related to the phonetic form of the regular verbs.

Finally, Spearman's correlation tests showed no statistical correlations between the perception and production of the *-ed* morpheme for any of the learner groups. While these results could be explained by differences in test materials and scoring procedures, they may also reflect a disconnect between perception and production of past tense in individual learners.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

The acquisition of inflectional morphology has been one of the major foci in the field of second language acquisition (SLA) research. Many studies have found that inflectional morphology is an area of specific difficulty for adult L2 learners (Parodi, Schwartz, & Clahsen, 2004; Slabakova, 2013; Zobl & Liceras, 1994). Adult L2 learners have been reported to omit or unsystematically use inflectional morphemes in spontaneous production (see White, 2003, for review). This difficulty has been shown to persist even at advanced proficiency levels (Bayley, 1994, 1996; Hawkins & Liszka, 2003; Lardiere, 1998a, 2000, 2003). English past tense morphology is a classic example of this phenomenon. An example is shown in (1) below.

(1) When I saw the film 'Lonely and Hungry" and it reminded me of the old time when life was very hard. ……I didn't remember clearly about what it *talk* about. I just *laugh* a lot (L1 Chinese; Hawkins & Liszka, 2003)

Various attempts have been made to account for L2 learners' difficulties with inflectional morphology. Whereas some researchers have claimed that the failure to consistently supply inflectional morphology in the L2 reflects the underlying syntactic impairment in the domain of functional categories or features (e.g., Hawkins & Chan, 1997), others have asserted that adult L2 learners' problems with overt morphology might be due to difficulties in syntax-morphology mapping rather than reflecting any underlying syntactic deficits (Lardiere, 1998a, 1998b; Prévost & White, 2000). In contrast to these explanations which both took non-phonological approaches, Lardiere (2003) proposes a third possibility: a potential role of transfer of L1 phonological constraints related to consonant clusters. A similar proposal is the Prosodic Transfer Hypothesis (PTH), which claims that L1 prosodic features affect morphological production (Goad & White, 2006; Goad, White, & Steele, 2003); specifically, the PTH argues that low suppliance of functional

morphology is due, at least in part, to the influence of L1 constraints on prosodic structures that are transferred into the interlanguage grammar (Goad et al., 2003).

Hawkins and Liszka (2003) argued against the role of L1 phonological transfer. They compared spontaneous oral production data from three small L1 groups: German and Japanese (which both have past tense markers) and Chinese (which has no past tense markers). Their results showed that the German and Japanese speakers provided past tense morphology more often than the Chinese speakers. Importantly, although Japanese, like Chinese, does not allow final consonant clusters, the Japanese speakers outperformed the Chinese speakers. Hawkins and Liszka concluded that adult L2 learners cannot establish functional features that are absent in their L1 grammars.

The present study, which built upon the work of Hawkins and Liszka (2003), investigated past tense marking by L2 English speakers with different L1 backgrounds and attempted to contribute to greater clarity and better understanding of the influence from L1 phonology and morphosyntax on the use of English regular past tense morphology.

In addition to examining issues that affect learners' production, such as consonant clusters, this study investigated a second, little-investigated related issue: that is, perception. Past tense formation in English often involves word-final consonant clusters (e.g., [-kt] as in *walked*), which are not allowed in many languages (Kager, 1999). It has been shown that adult L2 learners often have difficulties perceiving nonnative sounds of the target language, especially when these sounds are not present in their L1 phonological inventory (Best, 1995; Flege, 1995). In view of this, the present study also set out to investigate the role of L1 phonology as well as morphosyntax in the perception of English regular past tense morphology.

The process of L2 acquisition involves not only speech production but also speech

perception. A large number of studies have examined the relationship between L2 perception and production of phonetic segments. This line of research has generally reported positive, albeit moderate, correlations between L2 segmental perception and production (e.g., Bettoni-Techio, Rauber, & Koerich, 2007; Flege, Bohn, & Jang, 1997; Flege, MacKay, & Meador, 1999; Schmidt & Flege, 1995). There are other studies, however, showing no correlations between these two modalities (e.g., Hattori & Iverson, 2010; Peperkamp & Bouchon, 2011). Solt et al. (2004) examined the effects of perception on production of the English regular past tense morpheme with adult L2 learners from diverse L1 backgrounds. They concluded that L2 learners' inability to perceive the past tense morpheme consistently causes them to be unable to produce this morpheme in a native-like manner. However, the production task in Solt et al.'s study was in written format, making the performance in perception and production tasks not directly comparable. One goal of the present study was to address the issue of to what extent the perception of the English regular past tense morpheme correlates with the production of it.

Most previous studies simply looked at one factor or the other, but the present study attempted a more integrated approach to see the problem with past tense marking from multiple angles. Crucially, the current study considered all of these different factors with the same group of learners, rather than examining each issue with separate groups.

To summarize, the present study investigated whether or not the production and perception of the English regular past tense morpheme are subject to the influences from learners' L1 phonological constraints and morphosyntax. In order to achieve this goal, this study compared L2 learners whose L1s encode tense morphologically and permit final consonant clusters (i.e., Turkish) with those whose L1s encode tense morphologically but do not allow final consonant clusters (i.e., Korean) and those whose L1s do not mark tense and do not license final consonant

clusters (i.e., Mandarin Chinese). This study also attempted to address the link between production and perception of English regular past tense morphology within the same learner group in order to determine whether there is a correlation between these two modalities.

The rest of this dissertation is organized as follows. Chapter 2 explains the theoretical background for the present study, provides a detailed overview of relevant literature on second language production and perception of functional morphology, and gives a brief description of the morphosyntax of past tense and the syllable structures in English, Turkish, Korean, and Chinese. The research questions and the hypotheses for each of the questions are at the end of Chapter 2. Chapter 3 provides details on the participants, materials, experimental tasks, procedure, and statistical analysis. Chapter 4 reports the results, followed by a discussion in Chapter 5. Finally, Chapter 6 concludes the dissertation with a summary of the findings of the study and recommendations for future research.

CHAPTER 2: LITERATURE REVIEW

Within the generative framework, a number of proposals have attempted to account for variable suppliance of functional morphology in end-state and/or interlanguage grammars of L2 learners. Some approaches point to a syntactic representational deficit in the L2 grammar while other accounts have taken the position that problems in functional morphology may be due to factors other than syntactic ones. This section will discuss the relevant hypotheses and findings on the production and perception of functional morphology in the L2.

2.1 Second Language Production of Functional Morphology

2.1.1 Syntactic deficits in L2 acquisition

2.1.1.1 Representational Deficit Hypothesis

Some researchers argue that the non-target-like use of functional morphology among adult L2 learners reflects underlying representational syntactic deficits in functional categories (e.g., INFL or TENSE) or functional features (e.g., [±past]). This idea is expressed in the Representational Deficit Hypothesis (RDH) (Hawkins, 2005; Hawkins & Liszka, 2003; N. Smith & Tsimpli, 1995), formerly known as the Failed Functional Features Hypothesis (FFFH) (Hawkins & Chan, 1997). According to the RDH, adult L2 learners cannot acquire functional categories or features that are not instantiated in their L1 grammars, due to maturational or critical period effects. In other words, the only categories and features available for L2 learners are those that are present in their L1. Thus, post-puberty learners whose L1 grammars lack features such as tense or agreement are predicted to be unable to represent these features in their interlanguage grammar; consequently, they have difficulties consistently supplying relevant overt morphology in the L2.

Hawkins and Chan (1997) tested this proposal by investigating the grammaticality judgment on English restrictive relative clauses by L1 Chinese and L1 French speakers. They predicted that

Chinese speakers would not be able to acquire this structure, as Chinese and English restrictive relative clause structures are different in that Chinese does not have the [±wh] feature; on the other hand, French speakers should be able to acquire this structure because French and English restrictive clause structures both have the [+wh] feature, which triggers movement.

The results of Hawkins and Chan (1997) showed that while the English control group rejected ungrammatical resumptive pronoun sentences at 98%, the advanced Chinese group was able to reject only 90% of the sentences (compared to 38% of the elementary Chinese group). The authors maintained that the mental representations of the Chinese group are not native-like. On the other hand, the performance of their advanced French speakers was not statistically different from that of the native English speakers on extractions from wh-islands or complex-NPs.

Subsequently, Hawkins and colleagues extended the FFFH to other features such as tense. Hawkins and Liszka (2003) collected spontaneous oral production data from advanced English as a Second Language (ESL) learners with different L1 backgrounds—2 Chinese, 5 Japanese, and 5 German. Their results indicated that the Japanese and German learners (both of whom have past tense markers in their native languages) produced regular simple past tense morphology in over 90% of obligatory contexts, compared to 63% for the Chinese learners. If L1 phonology is indeed responsible for past tense omissions, one would expect that Chinese and Japanese speakers would experience similar problems, since Japanese (like Chinese) does not allow final consonant clusters. Furthermore, while the Japanese learners showed similar suppliance rates of final *-t/-d* in monomorphemic words and regular past tense verbs (96% and 92%, respectively), the two Chinese learners retained word-final *-t/-d* with monomorphemes more often (82% suppliance) than with regular past tense verbs (63% suppliance). Hawkins and Liszka cited similar findings from Bayley's (1996) study of 20 Chinese learners of English: 65% suppliance of *-t/-d* in

monomorphemic words versus 44% suppliance in regular past tense contexts. According to the authors, if tense morphology omission is due to a prohibition on clusters in Chinese as well as in Japanese, one should find similar proportions of *-t/-d* suppliance in past tense contexts and in monomorphemic words. According to their data (and Bayley's), this was not the case for the Chinese group. Since difficulties in production were specific to the Chinese group and Chinese learners' problems were specific to English past T(ense), Hawkins and Liszka suggested that the morphosyntactic representation of tense is absent from Chinese learners' interlanguage grammar. They concluded that "Chinese speakers cannot establish [±past] on T in English precisely because this feature is absent in their L1. By contrast [±past] is present on T both in Japanese and German" (p. 41).

Hawkins and Liszka (2003) used a morphology test to measure ESL learner knowledge of morphological processes involved in simple past tense marking. Study participants were asked to inflect real and nonce verb stems for simple past tense. Chinese learners performed nearly as well as Japanese and German learners and native English speakers, all of who use past tense markers in their native languages. This finding suggests that individuals in all three L2 groups understood the morphological properties of past tense marking in the context of English verbs.

Some limitations of Hawkins and Liszka's (2003) study require discussion. First, if Chinese learners of English are truly unable to represent the [±past] feature in their interlanguage, they should have similar difficulties marking simple past for regular as well as irregular verbs. However, the authors' data did not support this prediction: the suppliance of past tense forms was much higher for irregular (84%) than for regular verbs (63%). The authors' explanation for this finding is that learners store irregular past tense forms as separate lexical items from the uninflected bare forms, whereas regular verbs are stored only once and thus need to be inflected for past tense.

However, very little evidence is offered for this claim. In addition, their small sample sizes (n = 2, 5, 5) makes the generalization of their findings impossible. It remains to be shown whether similar results would be found with a bigger pool of participants. Finally, as pointed out by Goad and White (2006), Hawkins and Liszka's findings are based on small numbers of regular past tense contexts (40) and monomorphemic words (11); therefore direct comparisons of differences between these two categories should be regarded with caution.

Chen (2010, 2011) further investigated L1 influences on the use of L2 English past tense morphology with different L2 populations. She compared the performance of Chinese (who do not mark tense in their L1) and Korean learners (who do), all matched for proficiency, on three different tasks: an oral spontaneous production task, a written production task, and an untimed grammaticality judgment task (GJT). Participants were 20 Chinese and 19 Korean ESL learners and 14 native English speakers. Her results showed that Chinese performance was comparable to that of the native English speakers on the untimed GJT, but not on the written or oral production tasks. In addition, the Korean and Chinese learners performed similarly on the written production task (96% and 91.2%, respectively) and untimed GJT (96.7% and 97.1%, respectively); however, the Korean learners were statistically more accurate than the Chinese learners on the oral production task (79% and 50.8%, respectively). Chen's results corroborate previous findings showing that L1 phonological transfer may not be an appropriate explanation for Chinese learners' low suppliance of past tense morphology. Both Chinese and Korean languages do not license consonant clusters, so Chinese and Korean learners of English should have had similar results if L1 phonological factors were at play. Contrary to this prediction, the Chinese learners were found to be significantly less likely to inflect thematic verbs for past tense than the Korean learners on the oral production task. Chen, however, did not include an analysis of the deletion

rates of final *-t/-d* in monomorphemic words to further address the issues of phonological transfer. It should be noted, however, that only the presence or absence of consonant clusters was considered; it is possible that there are other differences in phonological properties between Chinese and Korean that could affect learner performance.

2.1.2 Non-syntactic deficits in L2 acquisition

2.1.2.1 The Missing Inflection Hypothesis

Research on L1 acquisition has shown that in non-null subject languages like French, German, and English, children go through a period of Optional Infinitives (OI) (Wexler, 1994) or Root Infinitives (RI) (Rizzi, 1993/94). This means that in main clause declarative sentences, children alternate between finite and nonfinite verb forms while adults use a finite form (Haznedar & Schwartz, 1997).

To account for the OI or RI phenomenon, several proposals have been offered. For example, the OI phenomenon was analyzed by Wexler (1994) as a deficit in the T(ense) projection in children's grammars. He argues that Tense is underspecified in early child grammars.[1] In an alternative view, Rizzi (1993/94, 1994) proposes that the set of functional categories in children's grammars is not underspecified and that the RI stage is due to truncation of the syntactic tree structure below CP. In order to determine whether OIs are a feature of child L2 language as well, Haznedar and Schwartz (1997) examined data from a Turkish child (*Erdem*) learning English as a L2. Although *Erdem* was found to use both finite and non-finite verb forms, there was little evidence of other properties that are typically associated with the OI stage in L1 acquisition, such as use of null subjects and accusative case markings in place of nominative. The authors concluded that this child's use of non-finite morphology did not indicate absence of the underlying syntactic

[1] Wexler's argument is somewhat parallel to one made by Hawkins for L2 acquisition—a representational deficit of functional features.

representations; rather, it was an effect of missing inflection: “a problem with just realizing the morphological form of finite verbs” (Haznedar & Schwartz, 1997, p. 266).

An argument similar to the one given by Haznedar and Schwartz (1997) is made by Lardiere (1998a, 1998b). She conducted a longitudinal investigation of simple past tense markings in the free speech of a L2 English speaker named Patty, whose L1s were Mandarin Chinese and Hokkien. Patty moved to the US when she was 22, and had been living in the US for ten years at the time of initial data collection. Patty used simple past tense for thematic verbs at a consistently low rate of suppliance in obligatory contexts—34%. Lardiere (1998a, 1998b, 2000) explained these results in terms of mapping problems between fully specified syntactic markers and surface morphophonology, and presented other evidence from Patty’s spontaneous oral production suggesting that her T(ense) category was fully specified for finiteness (e.g., correct use of nominative case marking, no thematic verb raising, and finite CP projection). According to these findings, the absence of overt inflectional morphology did not necessarily entail a deficit of the underlying syntactic representation.

Following Lardiere (1998a, 1998b, 2000), Prévost and White (2000) also argue for a mapping problem between surface morphological forms and abstract features. They examined the spontaneous oral production of verbal morphology produced by four adults. Two of the participants were Spanish and Portuguese speakers acquiring German as their L2, while the other two participants were native speakers of Moroccan Arabic acquiring French. The researchers predicted that (a) finite forms would be found only in finite positions (and not, for example, after a preposition or an auxiliary), and (b) when finite forms were used, agreement was fairly accurate, since the relevant features and feature-checking mechanisms were assumed to be at work. The first prediction was confirmed by their results: the average suppliance of non-finite verbs in

obligatory finite contexts was much higher than the suppliance of finite verbs in non-finite contexts (20% versus 5%). These results indicate that while finite forms were largely restricted to finite positions, non-finite forms appeared correctly in non-finite positions and were also used as a kind of default in finite positions when the finite form was not used. A further analysis of the distribution of finite forms showed that the learners did not use finite forms after a preposition, a negator, or another verb in the same clause, suggesting that these learners were aware of the differences between finite and non-finite morphology. The second prediction was also borne out: the accuracy in the use of verbal agreement was around 95% in the L2 French data and 88% in the L2 German data. Given these results, Prévost and White concluded that L2 learners have abstract features for finiteness and agreement in their interlanguage grammars and that "problems of adult L2 learners relate to the mapping of specific morphological forms to abstract categories" (Prévost & White, 2000, p. 129).

2.1.2.2 Missing Surface Inflection Hypothesis

Building upon the Missing Inflection Hypothesis of Haznedar and Schwartz (1997) as well as other studies (Lardiere, 1998a, 1998b; Prévost & White, 1999), Prévost and White (2000) propose the Missing Surface Inflection Hypothesis (MSIH). The MSIH makes it clear that "it is at the surface morphological level that inflection is assumed to be absent, rather than at the abstract featural level" (Prévost & White, 2000, p. 108). That is, according to the MSIH, the syntaxes of L2 learners are unimpaired, and therefore new features are in principle acquirable. L2 learners' problems with morphology are attributed to difficulties in mapping abstract syntactic features to surface morphological realizations. These difficulties are thought to be especially pronounced in production due to processing demands or communication pressure (Prévost & White, 2000). For example, L2 learners might be expected to show better performance in untimed tasks than in timed

tasks or in spontaneous production. Great emphasis has been placed on spoken production, where the locus of difficulty is predicted to reside, as illustrated by a summary by White (2011):

> Proponents of the Missing Surface Inflection Hypothesis argue that L2ers appropriately represent features at an abstract level, attributing failure to produce consistent inflection to temporary difficulties in accessing the relevant lexical items by which inflection is realized, particularly when speaking. (p. 585)

Lardiere (1998a) argues that mapping difficulties are due to a problem accessing morphological forms which have layers of feature, assuming a model of grammar where abstract features motivate syntactic computation and an autonomous morphological component "reads" the output of this computation (Lardiere, 1998a, 2000). Non-target-like production occurs when there is a failure in the morphological component to match feature bundles on syntactic nodes with morphological forms. Moreover, mapping difficulties are thought to be more pronounced when features are "highly layered" (Lardiere, 1998a)—in other words, when multiple features are associated with a single morpheme, L2 speakers are thought to experience greater difficulties. In the case of past tense marking, Lardiere assumes that once the terminal T node is specified as [+finite], yet another mapping is required. The morphological component has to decide whether it is [+past] or [−past]. If it is [+past], use suppletive forms in the case of irregular verbs or add the suffix *-ed* to the verb stem in the case of regular verbs.

Prévost and White (2000) formulate the mapping problem in terms of Distributed Morphology (DM) (Halle & Marantz, 1993). According to DM, an inflected form is assumed to be associated with grammatical features, such as tense, person, number, and gender. A lexical form can be inserted into a terminal node in the syntax as long as its features match the features of the terminal node. While the features of a syntactic node are fully specified, those of a lexical form

might be partially specified or underspecified. Therefore, it is possible for a lexical item to be inserted into the hosting node even though its features do not exactly match all the features of the hosting node. Prévost and White argue that L2 learners have acquired the relevant features of the terminal node in the syntax via the L1, Universal Grammar (UG), or L2 input, but they might not have fully acquired the feature specifications of the associated lexical items. Prévost and White propose that while in the grammar of an adult native speaker, finite forms are specified as [+finite] and non-finite ones are [−finite], in the L2 grammar, non-finite forms are underspecified with reference to finiteness and therefore may be inserted into a node involving the [+finite] feature. Finite forms, on the other hand, are fully specified as [+finite] and therefore show up in finite contexts and cannot be inserted into a node bearing the [−finite] feature. By reason of being underspecified, non-finite forms function as defaults in L2 grammars; they can appear either in [+finite] or in [−finite] contexts. On this account, there is no syntactic deficit in L2 grammars.

Several studies (e.g., Lardiere, 1998a, 1998b, 2000; Prévost & White, 2000) have demonstrated that the variable use of inflectional morphology does not reflect impairment or absence of the corresponding functional feature(s) in the underlying syntactic representation; rather, the problem lies in the complexity in mapping between abstract syntactic features and surface morphological forms. Lardiere (1998a) argues that successful mapping is affected when complex phonological forms are involved. In her words, "We can further imagine that an essentially morphological mapping procedure would be especially vulnerable to 'derailment' from a variety of post-syntactic or extra-syntactic factors, such as phonological transfer from the L1" (p. 21). Accordingly, the difficulties that Chinese learners have with English simple past tense in oral production are made more complex because English regular past tense frequently requires the use of final consonant clusters (e.g., [-kt] as in *walked*), which is not licensed in their L1.

In a later study, Lardiere (2003) speculated that Patty's low rate of past tense marking may have been partially due to L1 constraints against final consonant clusters. In support of this idea, Lardiere showed that Patty had similar deletion rates of final *-t/-d* in regular past tense verbs and monomorphemic words such as *pact*, in contrast to the results reported in Hawkins and Liszka's (2003) study. Moreover, by examining past tense marking on lexical main verbs, Lardiere showed that Patty's correct realization of irregular verbs (46%) was higher than for regular verbs—which, she notes, usually create consonant clusters (5.8%). Further, Patty showed a higher rate of past tense marking in written (78%) compared to oral production (34%).[2] According to the author, if omission of past tense marking is due to phonological factors, then a higher rate of past tense marking for written than for spoken contexts is exactly what one would expect. The higher rate of tense inflection in writing suggests that "phonological factors are responsible for at least some of the omissions in Patty's spoken data" (p. 179).

Prévost and White (2000) note that L2 learners continue to use underspecified forms (e.g., non-finite forms) even after they have acquired the more fully specified ones (e.g., finite forms). They speculated that due to communication pressure or processing difficulty, access to the more fully specified lexical items is sometimes blocked. However, others have argued against communication pressure as an explanation for learners' errors. Hawkins and Liszka (2003) examined the role of performance pressure in marking simple past tense in spontaneous oral production. If performance pressure is responsible for inconsistent use of past tense marking, it should have affected all the learners equally, not just the Chinese speakers. Their results, however, showed that the German and Japanese learners were significantly more accurate than the Chinese learners in simple past tense marking. Moreover, if performance pressure is involved, one might

[2] These rates refer to past tense marking on all verb types, including lexical main verbs, copula, auxiliaries, and modals.

expect to find similar problems in using past participles such as *is released* which are identical to the simple past tense forms. This prediction was not confirmed either. The Chinese speakers successfully inflected past participles, in contrast to simple past tense forms (100% versus 63%). These findings suggest that performance pressure is not the source of inflectional errors.

2.1.2.3 Prosodic Transfer Hypothesis

The discrepancy between the results of Lardiere (1998a, 1998b, 2000, 2003) and those of Bayley (1996) and Hawkins and Liszka (2003) clearly needs explanation and this has led Goad, White, and Steele (2003) to propose another possibility—the Prosodic Transfer Hypothesis (PTH), a phonological approach different from Lardiere's Consonant Cluster Reduction Hypothesis. Assuming a Selkirk-style (1997) prosodic hierarchy, the PTH predicts that difficulties experienced by L2 learners in the production of functional morphology stem from prosodic constraints that are transferred from the L1 grammar (Goad, 2011; Goad & White, 2004, 2006; Goad et al., 2003). Moreover, functional morphology may be variably produced in a non-target-like manner if the necessary prosodic representations are not present in the L1 grammar. On this account, the omission of English past tense inflection in the oral production by Mandarin speakers is, at least in part, due to differences in Mandarin and English prosodic adjunction structures. In English, inflection such as the past tense *-ed* and the 3rd person singular agreement *-s* is adjoined to the Prosodic Word (PWd) of its host as an "affixal clitic" (see Figure 1)[3]; on the other hand, in Chinese, inflection (aspect only) is organized inside the PWd of its host as an

[3] Different from the prosodic phonology framework in which a prosodic word is organized into the following hierarchy: prosodic word, foot, syllable, mora, and segment (Harris, 2004; Jensen, 2000; Nespor & Vogel, 1986), the prosodic structure presented in PTH does not show the mora level indicative of syllable weight. However, the absence of the mora does not imply that weight is not relevant. The problem, though, is that moraic theory does not include an onset constituent, and several of the phenomena Goad and her colleagues have been looking at have required reference to onsets (Goad, personal communication, August 16, 2013). Technically, though, onsets are not prosodic constituents. There is no easy solution to this–moraic theory captures certain concepts well; onset-rhyme theory others–but this is why the prosodic structure Goad and her colleagues give provides no structure below the level of the syllable.

"internal clitic" (see Figure 2).[4]

Figure 1. Prosodic Structure in English Regular Past Inflection and Agreement

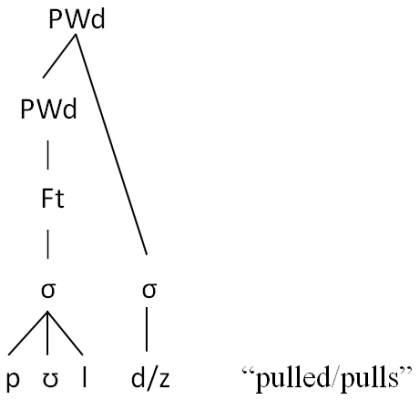
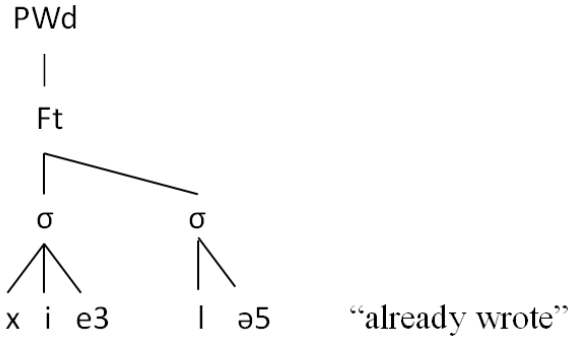


Figure 2. Prosodic Structure for Inflectional Morphology in Mandarin



While English regular inflection (for both past tense and past participles) is not incorporated into the PWd of its stem to which it attaches, irregular inflection is organized internal to the PWd of its host (see Figure 3). Figure 3 shows irregular inflection in the form of "pseudo-inflection" such as *kept* in (i) and ablaut inflection such as *ran* in (ii). On the other hand, monomorphemic forms follow the same rhyme constraints as irregular inflection, as shown in Figure 4 (adapted from Goad et al., 2003, p. 250).

[4] Pronunciations are written in *pinyin,* an alphabetic transcription of Chinese. The number indicates tones of Chinese: 1 (high level), 2 (mid rising), 3 (low falling then rising), and 4 (high falling), while 5 marks neutral-toned syllables.

Figure 3. Prosodic Structure in English Irregular Past Tense Form

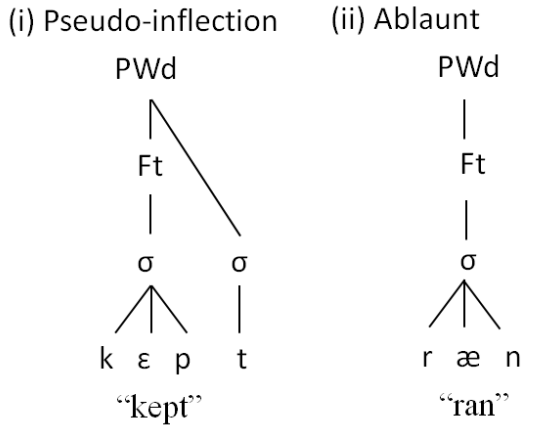
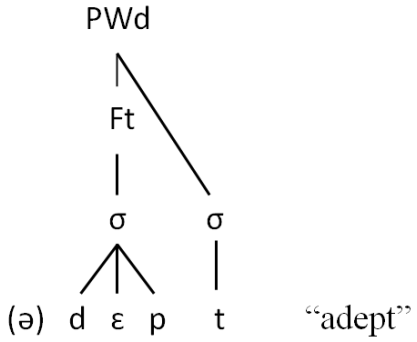


Figure 4. Prosodic Structure in English Monomorpheme with Consonant Cluster



Comparing the example shown in Figure 3 demonstrating English irregular past tense with that of Figure 2 illustrating Chinese inflection, it can be seen that the same structure is present in English and Chinese. Therefore, in accordance with the PTH, it is predicted that Mandarin speakers would have fewer problems with irregular inflection (both pseudo and ablaut) and monomorphemic words than they would with regular verbs.

To examine the effects of prosodic transfer, Goad et al. (2003) collected data from 12 high intermediate/low advanced Mandarin-speaking learners of English through picture description tasks. They focused on the examination of the English past tense and the 3rd person agreement, the

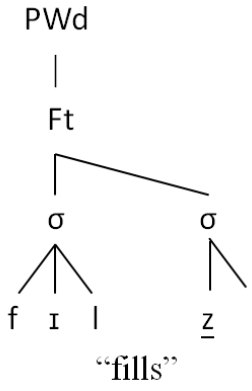
latter of which is prosodically organized in the same manner as tense. The prediction that Mandarin speakers would have less difficulty with irregular verbs than with regular ones was confirmed. Their results showed that the Chinese learners were more successful in marking irregular past forms (78%) than regular past forms (57%).

Goad et al. (2003) administered a grammaticality judgment task (GJT) to determine whether Mandarin speakers represent tense and agreement features in their IL grammars. Their results showed that Chinese performance was comparable to that of the native English speakers on the GJT, which targeted the knowledge of overt tense and agreement morphology. Furthermore, the oral production data showed a number of properties which are often taken to implicate the syntactic representation of tense and agreement, such as 100% accuracy on nominative case assignment (that is assigned by INFL which is [+tense]) and high accuracy in the use of copula *be* and auxiliaries (*be*, *have*, and *do*) (97% and 87%, respectively), which bear tense and agreement features.

Goad et al. (2003) also examined other incidences of agreement. Two patterns of behavior were observed: the across-the-board (ATB) deletion group, who deleted agreement across the board, supplying only 10% of agreement morphology, and the variable deletion group, who supplied the morphology approximately half of the time (49% suppliance). The learners in the ATB deletion group recognize that a stem-internal analysis of inflection is not allowed in English. For these learners, inflection must be treated uniformly in English, so they deleted inflection across the board, regardless of stem shape. On the other hand, for learners in the variable deletion group, inflectional morphology will be supplied for stimuli that can be incorporated into the PWd (like Mandarin aspect). That is, the variable deletion group supplied agreement morphology when certain conditions which reflected the prosodic structure of the L1 could be met. For example, the

variable deletion group achieved a 75% suppliance level when agreement is followed by a vowel-initial word, thus allowing the agreement morpheme to be syllabified as the onset of the following syllable, such as *builds on* /bɪldzɑn/. Moreover, the variable deletion group showed a 68% suppliance rate when agreement is attached to a base which is …VX] in shape (e.g., *fills* /fɪlz/), see Figure 5, which enables the agreement morpheme to be incorporated into the foot as an onset of empty-headed syllable, leading to a structure parallel to the Mandarin aspect, a PWd-internal analysis (see Figure 2). However, when a PWd-internal analysis is not possible in shape (i.e., agreement is attached to a base which is …VXC], such as *builds* /bɪldz/ (before a consonant-initial word or pause), this group of learners supplied only 9% of agreement morphology. In brief, the variable deletion group represented inflection PWd-internally, in the same manner that inflection is organized in their L1 Mandarin.

Figure 5. Prosodic Structure for Agreement as Foot-Internal Onset of Empty-Headed Syllable in English



The ATB and variable deletion groups performed similarly on their production of clusters in monomorphemic words (57% and 68% accuracy, respectively). A comparison of the ATB group's performance on clusters in monomorphemic words with clusters in forms like *fills* /fɪlz/ (57% vs.

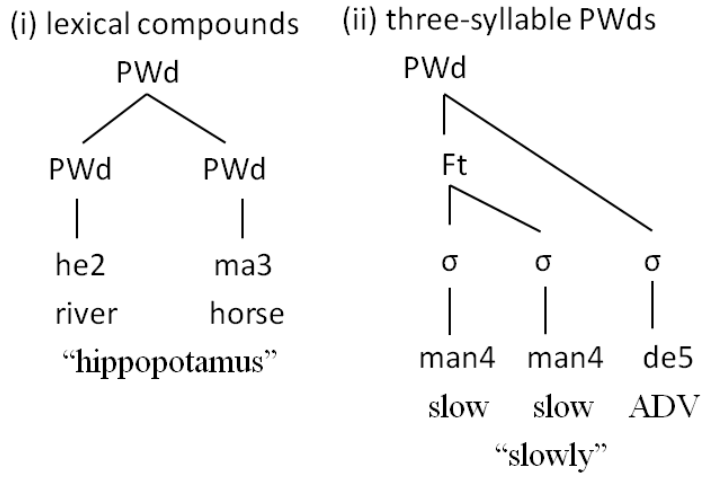
7%) reveals that (a) their behavior cannot be attributed to a general deletion of clusters, and (b) the clusters in inflection and those present in monomorphemic words are represented differently. On the other hand, for the variable deletion group, their suppliance rate of agreement in forms like *fills* /filz/ parallels their production of clusters in monomorphemic words (68% for each), suggesting that clusters in inflected forms and clusters in monomorphemic words are represented similarly.[5]

In subsequent work, Goad and White (2004, 2006) propose a somewhat weaker version of the PTH. According to this version of the PTH, learners can accommodate the needs of the L2 by minimally adapting their L1 structures; target prosodic representations can be built under two conditions: "(a) when they can be built through combining L1 licensing relations, or (b) when they involve L1 structures being licensed in new positions" (Goad & White, 2006, p. 247). In the case of English inflection, as previously discussed, the past tense morpheme *-ed* is adjoined to the PWd (see Figure 1 above). The target prosodic representation involves two components: (1) a PWd dominates another PWd (PWd-PWd), and (2) a PWd directly dominates a syllable (PWd-σ) at the right edge. Mandarin does not adjoin inflection (aspect only) to any PWd, but the target prosodic structure for English inflection can be built in the Mandarin-English interlanguage grammar by combining existing representations from the L1:PWd-PWd is the structure required for lexical compounds, and PWd-σ is the structure needed to prosodify three-syllable PWds, as shown below in Figure 6 (adopted from Goad & White, 2006, p. 251). Moreover, the revised version of the PTH makes developmental predictions. That is, for Mandarin speakers, initially the suppliance of simple past and past participle morphology will "be depressed, at least at earlier stages in development" (Goad & White, 2006, p. 250) but later in development, some (if not all) advanced speakers are predicted to provide tense and past participle morphology in a

[5] According to Goad (2011), the ATB group is considered to be more target-like. This is because these learners know that the representation for inflection in Mandarin is different from that in English. In contrast, the variable deletion group is still trying to use the L1 representation in L2 English.

native-like fashion if they have been able to build the target prosodic structure through adapting L1 structures.

Figure 6. Prosodic Structure for Lexical Compounds and Three-Syllable PWds in Mandarin



Goad and White (2004) conducted a case study with an advanced Turkish-speaking learner of English (known as SD) and found that for SD, in the case of tense, agreement and plural morphology, it was possible to build the appropriate prosodic representations in English by minimally adapting structures from L1 Turkish, so the suppliance rates were relatively high. However, in the case of articles, no such adaption was possible, leading to greater omissions of articles than tense, agreement and plural morphology. Similar results from ten L1 Mandarin speakers of L2 English were reported by Goad and White (2006). The Mandarin speakers showed high rates of suppliance of English past tense morphology (83%), which suggests that the Mandarin speakers were successful in accommodating the needs of English inflection. These findings led Goad and White (2006) to conclude that "target-like prosodic representations are ultimately attainable for at least some functional material which is absent from the L1" (p.264).

The preceding sections have described the theoretic framework of the present study.

Previous research on the use of inflectional morphology by L2 learners form different L1 backgrounds has also been reviewed. It has been shown that the observed variability in L2 inflectional morphology persists in some learner's speech but not others. L2 learners' first language has been identified as a possible source of problem. In regard to English past tense morphology, the research to date has not teased apart the influences of the L1 tense marking system ([±past]) and L1 phonology, notably with the consonant cluster/coda aspect of regular past tense with the *-ed* allomorph. The key question this study sought to address was whether the challenge L2 learners face in English with the regular past tense is due to the absence of tense in their L1, or rather a phonological problem in relation to consonant clusters. Toward this goal, similar to what Hawkins and Liszka (2003) did in their study, in the present study, the choice of L2 participants' L1s were balanced across [±past] and [±final consonant clusters]: Turkish ([+past, +final consonant clusters]), Korean ([+past, −final consonant clusters]), and Chinese ([−past, −final consonant clusters]). To collect spontaneous oral production data, this study implemented a story completion task in which participants were given the start of a story and were required to complete the story using the verbs provided (all regular verbs). By so doing, instances of the use of regular verbs would be ensured and the differences in performance across the three learner groups would be more suitable for direct comparison since all of the learners produced the same verbs.

Many previous studies (including Hawkins and Liszka (2003)) have largely used spontaneous oral production tasks; however, there is a possibility that L2 learner difficulties in simple past tense marking are due to their articulation problems, that is, whether L2 learners can accurately pronounce the past tense morpheme *-ed*. To test this question, the present study included an additional oral production task—a sentence repetition task in which the regular past

tense morpheme was specifically targeted. This would also allow for comparisons with the story completion task.

The sentence repetition task in the present study targeted not only regular verbs but also monomorphemic words that contained consonant clusters. The logic for comparing monomorphemic words against regular past tense forms is to tease apart what can be affected mainly by phonological transfer (monomorphemic words) from what can be affected by both phonological transfer and some other factors (e.g., mastery of inflectional morphology). If omission of English past tense morphology stems in part from consonant cluster reduction, then one would expect that phonological transfer will affect the performance of not only regular past tense verbs but also monomorphemic words.

2.1.3 Production challenges: Phonological factors

While L1 influences (e.g., morphological system, phonological constraints on consonant clusters, and prosodic structure) are important to take into account when investigating the difficulties adult L2 learners experience with English regular past tense, other phonological factors such as the phonetic form of past tense and the phonological environment have also been shown to impact the rate of past tense marking in English.

2.1.3.1 The phonetic form of verbs

With respect to the phonetic form of verbs, a large number of studies have shown that irregular verbs are more likely to be marked for past tense than regular verbs by L2 learners (e.g., Bayley, 1994, 1996; W.-H. Chen, 2010, 2011; Hawkins & Liszka, 2003; Lardiere, 2003; Wolfram, 1985, 1989; Wolfram, Christian, & Hatfield, 1986). One explanation for this finding is that the more salient the phonetic difference between the past and bare forms of the verb, the more likely it will be marked for past tense (Bayley, 1994; Wolfram, 1985, 1989). Both Bayley (1994) and

Wolfram (1985, 1989) have found that the incidence of past tense marking shows a systematic pattern of variation based upon the phonetic composition of the irregular verb forms. Thus, the past tense marking accuracy rate for suppletive forms (e.g., *go/went*) is higher than the type of irregular verbs that form the past tense by means of an internal vowel change plus the affixation of the suffix *-t/-d* (e.g., *keep/kept*; *leave/left*), which, in turn, is higher than the type of verbs that form the past tense by an internal vowel change (e.g., *come/came*), which, in turn, is higher than the type of verbs that form the past tense by final consonant replacement (e.g., *have/had*; *make/made*).

For similar reasons, there may be differences in the extent of past tense marking within regularly inflected verbs based on phonetic shape. The regular past tense morpheme has three different phonetic realizations: two non-syllabic allomorphs, [t] (as in *kissed*) and [d] (as in *killed*), and one syllabic allomorph [əd] (as in *waited*). The choice of [t], [d], or [əd] is determined by the phonological make-up of the final segment of the stem. Specially, the selection of [t] or [d] is dependent on the feature of [±voice] of the final segment of the stem, while [əd] is affixed to verbs whose stem ends with [t] or [d]. Bayley's (1994) study with Chinese learners of English showed that regular verbs with non-syllabic allomorph (e.g., *showed* and *walked*) appear to be marked for simple past more often than regular verbs with syllabic allomorph (e.g., *wanted*) (34% and 22%, respectively). However, Wolfram (1989)'s study with L1 Vietnamese speakers found a pattern opposite to what Bayley has observed: regular verbs with syllabic allomorph (e.g., *treated*) were slightly more likely to be marked for simple past than regular verbs ending in non-syllabic singleton [Vd] (e.g., *stayed*), and regular verbs ending in consonant clusters (e.g., *missed*) were least likely to be marked. These mixed findings highlight the need for continued research on the role of the phonetic composition of the regular verbs in past tense marking, and this was one of the goals of the present study.

The aforementioned results were obtained from studies (e.g., Bayley, 1994, 1996; Wolfram, 1989) that were conducted with L2 learners whose L1s do not license consonant clusters. It is unclear whether the same pattern will be found for L2 learners whose L1s allow consonant clusters. Thus, the present study also aimed to examine the possible interaction between L1 phonology and the phonetic form of the regular verbs.

2.1.3.2 The surrounding phonological environment

The strategy of *-t/-d* deletion from certain consonant clusters is commonly observed among native English speakers (Guy, 1991a, 1991b; Guy & Boyd, 1990; Labov, 1989). Deletion of *-t/-d* from consonant clusters are relevant to the discussion regarding past tense marking because the formation of English regular past tense frequently creates final consonant clusters, so the [t] and [d] allomorphs of the simple past may undergo the phonological process of *-t/-d* deletion, in other words, deletion of the past tense marker. Labov (1989) summarized the research findings of two decades on the *-t/-d* deletion phenomenon and provided a thorough description of the constraints on *-t/-d* deletion in native dialects of English. The phonetic feature of the preceding segment is one of the factors influencing *-t/-d* deletion. To be more specific, *-t/-d* is more likely to be omitted if it is preceded by an obstruent[6] than by a liquid (i.e., /l, r/), and *-t/-d* is least likely to be omitted when preceded by a vowel. Native speakers of English, for example, are more likely to omit *-t* in *west* (in which *-t* is preceded by a fricative) than *-d* in *cold* (in which *-d* is preceded by a liquid). The phonetic features of the following segment also constrain the *-t/-d* deletion. That is, word-final *-t/-d* is more likely to be deleted if the following word begins with an obstruent or a liquid rather than a glide or vowel, and *-t/-d* is least likely to be deleted when followed by a pause. For example, for native English speakers, *-t* is more likely to be deleted from *west* in the phrase *west side* than in the phrase *west wind*.

[6] Obstruents include stops, fricatives, and affricates.

With regard to past tense marking, L2 learners generally follow the pattern found in native speaker varieties. Bayley (1994, 1996) found that Chinese learners of English were more likely to produce the regular past tense morpheme *-ed* when it was preceded by a vowel (e.g., [ʃod] as in *showed*) than by a liquid (e.g., [smɛld] as in *smelled*); moreover, a preceding liquid was more likely to induce past tense marking than a preceding obstruent (e.g., [kɔzd] as in *caused*). In terms of the segmental context following inflection, similar to Labov's (1989) summary of constraints in native speaker varieties, the results from Bayley (1994, 1996) revealed that for Chinese learners, a following vowel (e.g., *tried on*) or glide (e.g., *tried one*) was more likely to induce past tense marking than a following obstruent or liquid (e.g., *tried some*). Similar findings were found from Wolfram's (1989) study with Vietnamese learners of English: a following vowel (e.g., *missed autumn*) was more likely to induce past tense marking than a following consonant (e.g., *missed school*).

2.1.3.3 The effect of consonant clusters

As stated previously, English regular past tense often requires the use of final consonant clusters, which are rarely seen in the world's languages (Kager, 1999). Research has shown that L2 learners of English employ different strategies in producing final consonant clusters. For example, Edge (1991) investigated the production of English word-final voiced obstruents by Japanese and Cantonese speakers and found that both learner groups devoiced the final voiced obstruents (a less marked option). Similarly, Chan (2007) found her Cantonese participants showed a high percentage of devoicing of English word-final voiced obstruents. Moreover, Hansen (2001) showed that Mandarin Chinese learners of English used different production strategies based on coda length: feature change was the favored modification strategy for single codas, epenthesis for two-member codas, and absence for three-member codas. For instances, Mandarin Chinese

learners' production of the single coda /m/ (as in *Sam*) is as /n/, an example of place change, and the production of the single coda /d/ is as /t/ as in *sat* instead of *sad* in the sentence "*He is sad*", an example of manner change. For two-member codas, *held* /hɛld/ is produced as /hɛl. də/ with a schwa inserted; and for three-member codas, /t/ is absent from three-member coda /sts/ such as in *lasts,* and the production of /rnd/ as in *learnd* is as /rn/,with an absence of /d/. There is one important caveat to take note of: Hansen's data came from a small sample (n = 3). Chan (2006) also found that consonant clusters in onsets were problematic; Cantonese learners of English had more difficulties in producing three-member onsets, e.g., /spl/ as in *splash,* than two-member onsets, e.g., /fr/ as in *freeze*, (62.6 % versus 80.5% accuracy) and strategies of deletion and substitution were commonly used by the participants. Collectively, these findings show that consonant clusters in any position are difficult for some learners.

In light of above background, in order to better understand whether there are differences in the extent of past tense marking within regular verbs based on their phonetic composition, critical verbs in the present study included four types of regular past tense forms—verbs ending in syllabic allomorph [əd] (e.g., *doubted*), non-syllabic allomorphs [d] and [t] (e.g., *killed* and *kissed*, respectively), and non-syllabic singleton [Vd] (where [d] is preceded by a vowel or glide, e.g., *showed*). The present study aimed to examine whether there are differences in the marking of past tense between regular syllabic verbs and regular non-syllabics and whether, among regular non-syllabic verbs, the phonetic composition of the verbs has a differential effect on past tense marking. To further control the effect of the immediately following phonological environment in which the past tense morpheme occurs, in the sentence repetition task, each critical verb was followed by a word beginning with a vowel sound (e.g., *faded away*). This design was also intended to maximize rater accuracy.

2.2 Second Language Perception of Functional Morphology

2.2.1 Perceptual challenges

The studies cited above have highlighted the role of L1 morphosyntax, the L1 phonological system, and some other phonological factors (e.g., the phonetic form of verbs and the surrounding phonological environment) in L2 production of English past tense morphology; however, relatively few studies have addressed the problems inherent in learners' perception of the input itself. The English regular past tense morpheme can pose perceptual challenges for a number of reasons. First, as mentioned previously (see section 2.1.3.1), the regular past tense morpheme is not always phonetically realized in the same way: there are two non-syllabic allomorphs, [t] and [d], and one syllabic allomorph [əd], depending on the last segment of the stem. Second, the degree of perceptual salience differs among the three allomorphs [t]/[d]/[əd]. Perceptual salience is defined by Goldschneider and DeKeyser (2001) in terms of number of phones, syllabicity,[7] and sonority. According to the sonority hierarchy given by Hogg and McCully (1987, p. 33) and Laver (1994, p. 504), vowels have the highest sonority while stops have the lowest; in addition, among stops, voiced stops (e.g., /b,d,g/) are more sonorous than voiceless stops (e.g., /p,t,k/) (Hogg & McCully, 1987, p. 33). As defined by the above criteria, syllabics (e.g., [əd]) are more perceptually salient than stops (e.g., [t]/[d]) because of their greater sonority, but are still short in duration and can be affected by the surrounding phonetic context (Collins, Trofimovich, White, Cardoso, & Horst, 2009). Stops are the least acoustically salient phonetic segments, which is aggravated by the fact that they occupy the least perceptually salient position—the coda (Pickett, 1999). Third, the perceptual challenge is further compounded by the fact that the formation of the English regular past tense often creates final consonant clusters, or complex codas, which are rare

[7] Goldschneider and DeKeyser (2001) used the term *syllabicity* to refer to "the presence or absence of a vowel in the surface form of a functor" (p.23). According to the authors, their definition of syllabicity is different from the phonological definition of the syllale but is still consistent with the literature on perceptual salience in SLA.

in the world's languages (Kager, 1999). What's more, many cross-language perceptual studies have revealed that adult L2 learners have considerable difficulty perceiving phonetic segments or contrasts not present in their L1 (e.g., Best, 1995; Flege, 1995; Strange, 1995). So if final consonant clusters are not present in a learner's L1, then it is reasonable to predict that this learner of English may face some challenges perceiving English regular past tense. One goal of the present study was to see whether L1 phonology as well as morphosyntax influence second language perception of the *-ed* morpheme, and the effects of perception on a learner's representation of past tense. For instance, if a person could not consistently perceive inflected verbs as different from uninflected verbs, it seems that for this person the past tense might be the same as the present tense (compare, e.g., "put" and "cut" which have the same present and past forms).

Goad (2011) pointed out some other phonological factors that may influence the aural perception of English past tense inflection. First, since English past tense and perfective are marked with coronal stops (thus low salience), they can be masked or shortened in the presence of a preceding adjacent consonant. A similar proposal comes from Strange (1995), who has suggested the intensity of the nasal murmur of [n] could mask the perceptual cues for a subsequent [d] (e.g., *learned*). Second, English syllable structure can further impede the ability to perceive non-syllabic allomorphs of inflection especially because of the stacking up of consonants at the right edge of the inflected form. Moreover, it is predicted that a sequence of two tautosyllabic stops (e.g., *walked*) will create more perceptual difficulty than a sequence of a continuant followed by a stop (e.g., *kissed*). Thus, the regular past tense morpheme *-ed* is more perceivable in such a sentence as "*I tried every shoe in the store*" than in "*I shelved every book in the library*", and least perceivable in "*I stacked every book in the library.*"

In addition to the segmental context preceding inflection, Goad (2011) also indicated that

the context following past tense marking can impede the ability to perceive non-syllabic allomorphs (e.g., a following obstruent). This phenomenon is generally confounded with syllabification. In other words, when the regular past tense morpheme *-ed* occurs before a vowel, it can be resyllabified as an onset, which indirectly enhances its perceptibility. Therefore, it is much easier to perceive the non-syllabic allomorph [d] in a sentence like "*I tried on some shoes*" than in "*I tried some shoes on*", and the non-syllabic allomorph [d] is least likely to be perceived in "*I tried the shoes on*."

2.2.2 Research on perception of English past tense

To my knowledge, only a handful of empirical studies have investigated L2 learners' perception of English past tense morphology. One such study is Solt et al. (2004), who examined whether phonological factors impact L2 learners' ability to perceive, as well as produce, the three allomorphs of English regular past tense morpheme in a group of adult L2 learners from diverse L1 backgrounds (e.g., Mandarin, Cantonese, Russian, Spanish, Turkish, Arabic, Ukrainian, and French Creole) at two proficiency levels (high versus low) and a control group of native English speakers. Each participant accomplished two tasks: a perception task followed by a perception/production task. In the first perception task, a native English speaker "A" read a sentence, and another speaker "B" repeated it. Sometimes, B correctly repeated the sentence, as seen in example (2) below, while other times, B omitted the relevant grammatical morpheme, as in (3) below.

	"A"	"B"
(2)	The test started at 8:30.	The test started at 8:30.
(3)	The test started at 8:30.	The test start at 8:30.

The participants were asked to decide whether the two sentences spoken by A and B were the same or different. In the second perception/ written production task, the participants heard a context and then a target sentence, e.g., "*Yesterday the man went to the station. He waited at the station for a train.*" The participants then saw "*He _____ at the station for a train*" and had to fill in the blank with the word they heard. To maximize the perceptibility of the morphology, verbs in auditorily-presented stimuli were all followed by a vowel.

Results of the first task showed that the L2 learners did not perceive the regular past tense morpheme in a target-like manner: the native English speakers performed significantly better than the high proficiency learners (99.1% and 74.5%, respectively), who, in turn, performed better than the low proficiency learners (68.2%). Among the three allomorphs of the *-ed* morpheme, L2 learners at both proficiency levels readily perceived the syllabic allomorph [əd] but were significantly less able to perceive the non-syllabic allomorphs [t]/[d]. Additionally, the high proficiency learners (though not the low proficiency group) performed more accurately on the perception of [t] than [d].

Results of the second task showed that the high proficiency learners performed as accurately as the native English speakers on the second task (90.6% and 100%, respectively). Given that the second task was a written, contextualized task that, according to Solt et al. (2004), was assumed to allow test takers to draw on grammatical knowledge in addition to perception, the authors interpreted these results as demonstrating that advanced learners are able to use contextual cues to aid in correct production of the regular past tense morpheme. As for the three allomorphs of the *-ed* morpheme, among the low proficiency learners, suppliance of past tense marking was significantly higher for verbs ending in syllabic allomorph [əd] than for those taking [d]. Among the high proficiency group, a significant difference was found between [t] and [d], with [t] being produced

at a higher accuracy rate. In sum, verbs ending in non-syllabic [d] were least likely to be inflected for simple past for L2 learners at both proficiency levels.

Solt et al. (2004) attempted to connect performance in perception with that in production. Based on their findings as summarized above, the authors concluded that "L2 learners' inability to perceive the past tense morpheme *-ed* consistently across its allomorphic variants—a systematic perceptual deficit—is a barrier to producing this morpheme in a target-like manner" (p. 562). However, considering that the production task in Solt et al.'s study was in written format, performance in perception and production tasks are not directly comparable. Additional research is required to address this specific issue.

The data from Solt et al. (2004) were subsequently reanalyzed, but with a different focus: the role of L1 phonology (Pugach, Stoyneshka, Solt, & Klein, 2004), types of codas created by *-ed* affixation (Adams, 2004), and the effect of perceptual salience (Klein et al., 2004). Pugach et al. found marginal L1 effects (Russian vs. Spanish vs. Chinese) on L2 learners' perception of the English regular past, even though the languages differed in terms of whether clusters of the required complexity are permitted. That is, Russian permits final consonant clusters while Spanish and Chinese do not. Adams observed a hierarchy of perceptual salience, from the most salient (e.g., syllabic [əd]), then [+continuant] obstruent followed by [t]/[d] (e.g., *kissed*) and then [-coronal] stop followed by [t] (e.g., *walked*), to the least (e.g., coronal nasal followed by [d], such as *learned*). Finally, Klein et al. compared the behavioral data on [əd] and [d] in the perception/written production task only, and they predicted that the syllabic [əd] should be easier for L2 learners to perceive and produce because it is more perceptually salient than the non-syllabic allomorph [d]. They found that while native English controls performed 100% accurately on the task, regardless of the perceptual salience of the past tense morpheme, L2 learners were more accurate on verbs

that require the syllabic allomorph [əd] than on verbs requiring the non-syllabic allomorph [d], thus supporting the prediction they made.

From these findings, one may conclude that L2 learners did not consistently perceive past-tense inflected forms as different from uninflected forms, especially in the case of non-syllabic allomorphs [t] and [d] (Klein et al., 2004; Pugach et al., 2004; Solt et al., 2004) and especially when the past tense morpheme is preceded by oral stops and nasals (Adams, 2004). However, Solt et al. did not include regular past tense verbs taking non-syllabic singleton [Vd] as in *showed*, making it difficult to tease apart the putative syllabicity effect from the effects of clustering. To properly support a syllabicity effect, the salience of *-ed*, when it forms a simple coda, must be compared in both its syllabic and non-syllabic allomorphic forms (e.g., *started* versus *studied*). Only when the *-ed* morpheme is shown to be more salient in verbs such as *started* than it is in verbs such as *studied* will the syllabicity effect have been adequately supported. Therefore, in the present study, regular verbs taking syllabic allomorph [əd] and non-syllabic singleton [Vd] were both included and then compared.

One objective of the present study was to explore the influence of L1 phonology as well as morphosyntax on second language perception of the past tense morpheme *-ed*. Previous studies on L2 learners' perception of English past tense morphology, with the exception of Solt et al. (2004), have treated [t] and [d] as one category (i.e., regular non-syllabic allomorphs). The present study attempted to investigate whether there are differences in perceptual difficulty between the two non-syllabic allomorphs. To this end, a perception judgment task was used, the experimental design of which largely followed the perception task used in Solt et al. (2004). The preceding discussion has suggested that perceptibility as well as production of English past tense forms is a function of the context in which they occur. Considering the possibility that even native

English speakers may have a harder time perceiving as well as producing the *-ed* morpheme when it is followed by an obstruent (especially in the case of homophonic stops and interdental fricatives),[8] in this study, each critical verb in the perception judgment and sentence repetition tasks was followed by a word beginning with a vowel sound in order to control the phonological environment following past tense marking and maximize the saliency of the *-ed* morpheme, and this is also what Solt et al. did in their study.

2.3 Relationship between Perception and Production in Nonnative Speech

The relationship between speech perception and production by L2 speakers has been widely investigated with a variety of populations (see Flege, 2003; Kartushina & Frauenfelder, 2014, for reviews). One core issue is the question of whether there is a causal relationship between these two modalities (see Llisterri, 1995, for review). In other words, is accurate perception necessary for accurate production, or vice-versa? Many researchers claim that perception precedes or is a prerequisite for production (e.g., Flege, 1995; Flege et al., 1997; Rauber, Escudero, Bion, & Baptista, 2005). According to this line of research, nonnative sounds must be adequately perceived before they can be adequately produced. These results are in line with the findings from L2 phonetic training studies, which found that adults who showed improvement in the perception of L2 phonetic segments as a result of perceptual training also showed gains in the production of L2 segments in the absence of production training (e.g., Bradlow, Akahane-Yamada, Pisoni, & Tohkura, 1999; Bradlow, Pisoni, Akahane-Yamada, & Tohkura, 1997; Lambacher, Martens, Kakehi, Marasinghe, & Molholt, 2005; Rochet, 1995). However, in some studies, L2 sound

[8] Wolfram (1985) eliminated homorganic stop samples from his data (e.g., *banned dogs*) due to "the difficulty in determining whether the past tense was phonetically marked or not" (p. 231). Bayley (1996) and Hawkins and Liszka (2003) also excluded homophonic stops and interdental fricatives (e.g., *walked towards* and *called the cops*) from analysis.

production has been found to be more accurate than perception (e.g., Bohn & Flege, 1997; Gass, 1984; Sheldon & Strange, 1982; C. Smith, 2001). So far, in the field of SLA, there is no general agreement on whether development of speech perception precedes development of production, or whether production skills develop before perception skills.

Alternatively, researchers sought to address the issue of whether perception and production are correlated. Several studies have found a moderate positive correlation between the perception and the production of phonetic segments in a L2 (e.g., Bettoni-Techio et al., 2007; Flege et al., 1997; Flege et al., 1999; Flege & Schmidt, 1995; Schmidt & Flege, 1995). However, there are some studies showing either no or only weak correlations between L2 segmental perception and production (e.g., Hattori & Iverson, 2010; Levy & Law, 2010; Peperkamp & Bouchon, 2011). From a standpoint of cognitive processing, there is agreement on the fact that there is considerable individual variability among learners so that often L2 phonetic training studies will not find a significant correlation between perception and production development. Research findings have demonstrated that perceptual training produces improvements in both perception and production; however, the amounts of gains in perception and production are uncorrelated (e.g., Bradlow et al., 1999; Bradlow et al., 1997). Against this background, the present study attempted to investigate the question of to what extent the perception of the regular past tense morpheme correlates with the production of this morpheme. To answer this question, separate oral production and perception tasks, namely sentence repetition and perception judgment tasks, were included in this study. Moreover, critical verbs in these two tasks were matched and, as stated above, each critical verb was followed by a word beginning with a vowel sound, such that the comparisons between perception and production were more relevant and direct.

2.4 Morphosyntax of Past Tense in English, Turkish, Korean and Chinese

Speakers of four languages were included in this study: English, Turkish, Korean and Chinese. This section describes the grammatical properties of past tense as they are instantiated in English, the target language, and Turkish, Korean and Chinese, the native languages of the L2 participants.

2.4.1 English past tense

English marks verbs in terms of tense (the location of an event in time) (Comrie, 1985) and aspect ("ways of viewing the temporal constituency of a situation") (Comrie, 1976, p. 3). In other words, tense locates a situation respective to a reference point, and considers relative sequential ordering between two time points. It thus enables listeners to reconstruct chronological relations among situations in a text. The two main tenses in English are present and past.

English expresses past tense through overt morphology on the verb.[9] For regular English verbs, the past tenses are generated by adding the suffix *-ed* to the verb stem. Irregular verbs, on the other hand, forms their past tenses by means of an internal vowel change (e.g., *run-ran*), the final consonant replacement (e.g., *lend-lent*), a combination of the above two (e.g., *teach-taught*), no change at all (e.g., *hit-hit*), or even total suppletion (e.g., *go-went*). Some researchers (e.g., Pinker & Ullman, 2002) claim that individuals retrieve regular and irregular verbs in different ways. Native language processing involves two separate brain memory systems: a declarative system that entails the storage of memorized words and phrases (e.g., irregular verbs), and a procedural system that includes the combinatorial rules of a language (e.g., regular verbs). In adult L2 processing, irregularly inflected verbs always depend on the lexical memory system (as in the L1), while "regular verbs show different patterns at different levels of experience and

[9] A special case is historical present. It refers to the use of the present tense when describing past events.

proficiency: at lower levels, regulars will tend to be stored, whereas at higher levels, they will be increasingly composed" (Bowden, Gelfand, Sanz, & Ullman, 2010, p. 49). In contrast, there are some memory models that propose a single system. For example, according to the associative models, all word forms are stored and processed within a single associative system (e.g., Elman et al., 1996; McClelland & Patterson, 2002; Seidenberg & Elman, 1999). In this study, I focused on the production and perception of regular English verbs only.

2.4.2 Turkish past tense

There are two past tenses in Turkish. The first is the definite past, used when the speaker has witnessed and seen the action taking place, and the second is the reported past, used when the speaker has not witnessed something directly (Kornfilt, 1997). The suffix used to create the definite past is -di-/-ti-, -dı-/-tı-, -dü-/-tü-, or -du-/-tu- (glossed as "PAST" in this study). The forms vary according to vowel harmony and consonant mutation rules. If the last letter in the verb stem is either k/p/ç/t/ş, then the "d" will become "t." An example is given in (4) (Kornfilt, 1997, p. 337). The reported past is expressed with the suffix -miş-, -mış-, -müş-, or -muş- (glossed as "Rep.PAST"). Again, the forms vary according to vowel harmony and consonant mutation rules. An example of the use of the reported past in Turkish is shown in (5) (Kornfilt, 1997, p. 337). The Turkish past tense morphemes are also distinguished by the slightly different personal ending that they are followed by. The paradigms are juxtaposed in (6) and examples are given in (7) (Kornfilt, 1997, p. 338).

(4)	Hasan	dün	opera	-ya	git	-ti
	Hasan	yesterday	opera	-DAT	go	-PAST
	Hasan went to the opera yesterday.					

(5) Hasan dün opera -ya git -miş

yesterday opera -DAT go -Rep.PAST

Hasan reportedly went to the opera yesterday.

It appears that Hasan went to the opera.

(6)

	Reported past	Definite past
1 sg.	-Im	-m
2 sg.	-sIn	-n
3 sg.	No personal ending	No personal ending
1 pl.	-Iz	-k
2 pl.	-sInIz	-nIz
3 pl.	-lAr	-lAr

(7) a. oku -du -núz

read -PAST -2 pl.

you read

b. oku -múş -sunuz

read -Rep.PAST -2 pl.

you supposedly read

2.4.3 Korean past tense

Like English which has two tenses (i.e., past and present or nonpast), the Korean language has been claimed to have a two-way distinction in its tense system: past and nonpast (H.-M.

Sohn, 1999; S. Sohn, 1995). The past tense is marked by the suffix *-ess*, and the nonpast tense is represented by the null form. The past tense describes an event before the utterance time, whereas the nonpast tense expresses the situation in which the event either follows or is simultaneous with the utterance time. Nonpast tense is basically concerned with present time, but it can also refer to future time.

The past tense morpheme *-ess* is known to have a secondary function: a marker of perfective aspect (S. Sohn, 1995). Consider the following sentences in (8) and (9) that illustrate the distinction between perfectivity and imperfectivity (S. Sohn, 1995, p. 28). The differences between (8a) and (8b) on the one hand, and (9a) and (9b) on the other, have to do with the contrast between perfective and imperfective rather than the contrast between past and nonpast. That is to say, the verb in the bracketed clause in (8a) and (9a) describes an uncompleted event, while the verb in (8b) and (9b) describes a completed event, although the time reference of both sentences is in the past.

(8) a. Kkoch-i [phi-Ø-taka] ci-ess-ta
Flowers-NOM bloom-TRANS fade-PAST-DECI
The flowers died while they were still blooming.

b. Kkoch-i [phi-ess-taka] ci-ess-ta
Flowers-NOM bloom-PERF-TRANS fade-PAST-DECI
The flowers bloomed and died.

(9) a. [ip-Ø-te-n] os-ul pes-ess-ta
Wear-RET-REL clothes-ACC take off-PAST-DECI
I took off the clothes that I started putting on.

b. [ip-ess-te-n] os-ul pes-ess-ta

Wear-PAST-RET-REL clothes-ACC take off-PAST-DECI

I took off the clothes that I was already wearing.

In regard to imperfective, Korean has an imperfective marker *-ko iss-*. *-ko iss-* expresses the ongoingness of the current situation and is treated as the progressive marker, similar to the English progressive form *be -ing* (K. Lee, 1993; Martin, 1992); an example is given in (10). Like Turkish, Korean is an agglutinative language.

(10) Ken-i ku-uy kacok-uy chosanghwa-lul kuli-ko iss-ess-ta.

Ken-NOM he-GEN family-GEN portrait-ACC paint-prog-PAST-decl

Ken was painting a portrait for his family.

2.4.4 Chinese past tense

The Chinese language does not add inflectional affixes to verbs to convey tense and aspect. Instead, Chinese speakers use pragmatic devices such as contextual clues and chronological order in narration to refer to time and the temporal locations of events. They also use lexical expressions (e.g., "yesterday," "last year," and "the next day") or aspect markers. Li and Thompson (1981) classify the aspect in Mandarin as (a) perfective (using the *-le* particle and perfectivizing expressions), (b) imperfective/durative (*zai* and *-zhe*), (c) experimental (*-guo*), and (d) delimitative (verb reduplication).

As shown in (11), the perfective marker *-le* indicates that an event can be regarded as bound when temporal, spatial, or conceptual limits are placed on it. Grammatically, *-le* is typically used when the event signaled by the verb is limited by overt phrases indicating "the extent to which the

event occurred, the amount of time it took, or the number of times it happened" (Li & Thompson, 1981, p. 186).

(11)	他	读	了	三	本	书
	ta	du2	le	san	ben	shu
	He	read	PERF	three	CL	book.

He read three books.

Chinese has two aspect markers that signal the durative nature of an event: in Mandarin they are the word *zai* and the suffix *-zhe*. As shown in (12), the preverbal *zai* highlights prominent actions. The other imperfective marker, *-zhe*, does not focus on progress as *zai* does; instead, it provides "a stative view of situations" (Yang, 1995, p. 128). In (13), the verb *ku* ("cry") is used with *-zhe* to form *ku-zhe*, a durative interpretation equivalent to "crying or in tears."

(12)	我	在	看	电视
	wo	zai	kan	dianshi
	I	PROG	watch	TV

I am watching TV (so Mom don't ask me to wash the dishes).

(13)	孩子	哭着	要	买	玩具
	haizi	ku- zhe	yao	mai	wanju
	Child	cry-DUR	want	buy	toy

The child is crying to make (mother) buy (him) a toy.

The experimental aspect *-guo* means that an event has been experienced with respect to

some time reference. Example (14) indicates that the subject has had the experience of reading the book in question.

(14)	我	读过	这	本	书
	wo	du- guo	zhe	ben	shu
	I	read-EXP	this	CL	book

I've read this book.

The delimitative aspect in Chinese means "doing an action 'a little bit', or for a short period of time" (Li & Thompson, 1981, p. 232). This aspect is expressed by the reduplication of the verb; this reduplication can optionally involve the insertion of *yi* "one" between the verb and the reduplicated syllable, as shown in (15). Some compound verbs can also be reduplicated, but typically without the insertion of *yi* "one" in between, like the compound verb *taolun* ("discuss") in (16).

(15)	我	到	公园	走	(一)	走
	wo	dao	gongyuan	zou	(yi)	zou
	I	to	park	walk	(one)	walk

I'm going for a walk in the park.

(16)	我们	讨论	讨论	再	决定
	women	taolun	taolun	zai	jueding
	we	discuss	discuss	then	decide

We'll decide after we discuss a little bit.

Chinese is a tenseless language in that it does not use verb affixes to signal the connection between the time a situation occurs and the time it is brought up in speech (Li & Thompson, 1981). Li and Thompson also note that past-time adverbs in Chinese mark an event as temporally, spatially, and conceptually bound, and indicate that the event occurred in the past in its entirety.

2.4.5 Interim summary

Table 1 presents a summary of how past tense is marked in English, Turkish, Korean, and Chinese. In brief, Chinese differs from English, Turkish and Korean in its absence of tense markers. While Chinese is a tenseless language, Turkish and Korean are closer to English in that both languages morphologically encode tense. Hence, according to the RDH, a prediction can be made that Chinese speakers would use English past tense morphology less accurately than Turkish and Korean speakers because Chinese does not have tense markers from which Chinese learners could map onto L2 English.

Table 1. *Summary of Past Tense Marking in English, Turkish, Korean and Chinese*

Languages		Morphology
English	Regular verbs	*-ed*
	Irregular verbs	Internal vowel change
		Final consonant replacement
		Internal vowel change + final consonant replacement
		No change
		Total suppletion
Turkish	Definite past	*-di-/-ti-, -dı-/-tı-, -dü-/-tü-, -du-/-tu-*
	Reported past	*-miş-, -mış-, -müş-, -muş-*
Korean	Past tense	*-ess*
Chinese	N/A (no tense markers)	Aspect markers:
		Perfective: *-le*
		Imperfective/durative: *zai, -zhe*
		Experimental: *guo*
		Delimitative: verb reduplication

2.5 Syllable Structure in English, Turkish, Korean and Chinese

2.5.1 English syllable structure

English vowel phonemes include /i, ɪ, e, ɛ, æ, u, ʊ, o, ɔ, ɑ, ʌ, ə/.[10] There are three diphthongs: /aɪ, aʊ, ɔɪ/. Table 2 lists those consonant phonemes that are common to most dialects of English.[11] Between pairs of stops, fricatives or affricates, the primary distinction is voiced and voiceless. In Table 2, when consonants appear in pairs, the one on the left is voiceless and the one on the right is voiced. In sum, there are 24 consonant phonemes found in most dialects of English, including six

[10] Dialects of English differ mainly in terms of their vowel systems. Consequently, the phonetic realizations of vowel phonemes will vary depending on the dialect under consideration. In this study, I focused on the vowel phonemes of General American (GA).

[11] The glottal /h/ is labeled as a fricative; nevertheless, it does not conform to the definition of a fricative because the air is not being forced through a narrow gap. The origin of the sound is the turbulence that is caused by the movement of air across the vocal cords and the rest of the surfaces of the vocal tract. /h/ is often characterized as a sound more like a noisy vowel (Ladefoged & Disner, 2012).

stops, nine fricatives, two affricates, three nasals, two glides, and two liquids (Bruce, 2009; Giegerich, 1992).

Table 2. *Chart of English Consonant Phonemes*

	Bilabial	Labio-dental	Dental	Alveolar	Post-alveolar	Palatal	Velar	Glottal
Stop	p b			t d			k g	
Fricative		f v	θ ð	s z	ʃ ʒ			h
Affricate					ʧ ʤ			
Nasal	m			n			ŋ	
Approximant					r	j	w	
Lateral Approximant				l				

The maximal syllable in English is CCCVCCCC. Onsets may consist of as many as three consonant phonemes in English. All consonants except /ŋ/ can occur in one-member onsets (Hammond, 1999). As for two-member onsets, there are three different groups: sC, Cj, and OA (obstruent-approximant) clusters (Hammond, 1999). In a three-member onset, the first consonant is always /s/, the second is one of the voiceless stops (i.e., /p/, /t/, or /k/), and the third is an approximant (i.e., /w/, /j/, /l/, /r/).

English allows as many as four consonants after a vowel in the same syllable. There are some restrictions on word-final consonant clusters. All consonants but /h/ can appear in a one-member coda (Hammond, 1999). Two-member codas are more numerous than two-member onsets, which is the result of consonantal suffixes such as *-ed* and *-s* as in *moved* and *cars*. Two-member codas can be grouped into the following types: 1) a nasal followed by an obstruent; 2) /s/ followed by a voiceless stop; 3) a liquid /l, r/ followed by a nasal, obstruent, or another liquid; and 4) any consonant followed by a coronal obstruent (Hammond, 1999). Larger word-final consonant clusters are generally built on well-formed smaller sequences (the Substring

Generalization). For example, the three-member word-final cluster /kst/ as in *text* is augmented with C (consonant) + COR (coronal obstruent) substrings. By suffixing the plural *-s* to the stem (i.e., *texts*), this constitutes a well-formed four-member coda /ksts/.[12]

2.5.2 Turkish syllable structure

Turkish has eight vowels (i.e., /i, y, ɯ, u, e, ø, a, o/) and 20 consonants (i.e., /p, b, t, d, k, g, ʧ, ʤ, f, v, s, z, ʃ, ʒ, m, n, l, ɾ, j, h/). Turkish has some restrictions on word-initial consonants. In Turkish, words of the native vocabulary do not begin with the following segments; /ʤ/, /f/, /ʒ/, /l/, /m/, /n/, /r/ or /z/ (Kornfilt, 1997).

In Turkish, there are some restrictions on word-final consonants as well; that is, devoicing of syllable-final plosives and affricates (Kornfilt, 1997). This rule applies to written language as well as very careful pronunciation. On the other hand, in colloquial speech, a word final consonant can be resyllabified when it is followed by a word-initial vowel. An example is given in (17) below (Kornfilt, 1997, pp. 491-492).

(17)	sarap		[ʃaɾa**p**]
	"wine"		
	sarab-I		[ʃaɾa**b**ɯ]
	"wine-Acc."		
	sarap al -dI -m	careful speech	[ʃaɾa**p**aldɯm]
	wine buy-Past -1.sg.	colloquial speech	[ʃaɾa**b**aldɯm]
	"I bought wine"		

[12] Note that many native English speakers do not pronounce all of the consonants in a four-member coda like /ksts/ as in *texts*, with the /t/ being deleted and the /s/ lengthened a bit.

Turkish is a language that in general does not permit word-initial consonant clusters. Such clusters are broken up via vowel epenthesis, "which usually (but not always) undergoes Vowel Harmony with the stem" (Kornfilt, 1997, p. 493). However, the cluster *sp* appears to be an exception to this generalization. Although many Turkish speakers tend to break up this cluster by inserting a high vowel, this cluster is often heard without expressing the epenthesis as well, as shown in (18) below (Kornfilt, 1997, p. 493).

(18) spiker "radio announcer" [sipikeɾ]
or [spikeɾ]

The Turkish language admits word-final consonant clusters. Nevertheless, no more than two consonants are allowed in coda position and the sequences of consonants are restricted. The possible sequences of consonant clusters in word-final position are given in (19) below (Kornfilt, 1997, pp. 493-494).

(19) a. sonorant + obstruent (e.g., [kyɾk] "fur", [kazanʧ] "gain")
b. fricative + stop (e.g., [ʧift] "couple", [aʃk] "love")
c. /k/ + /s/ (e.g., [boks] "box", [ɾaks] "dance")

Note that in Turkish, word-final /t/ or /d/ (the segments by which the English regular past tense is realized) is not able to combine freely with other consonant to form a two-member coda—/t/ or /d/ can be preceded only by a sonorant or fricative. Therefore, sound combinations where the past tense morpheme *-ed* is preceded by a stop or an affricate, such as /-kt/ (as in *kicked*), /-pt/ (as in *stopped*), /-ʤd/ (as in *charged*), or /-ʧt/ (as in *matched*), are phonotactically legitimate in English, but are prohibited in Turkish.

In Turkish, the possible syllable structures are as follows: (C)V, (C)VC, and (C)VCC

(Topbaş & Kopkallı-Yavuz, 2008), as shown in (20) below.

(20)	V	/o/	“he/she/it”	CVC	/bak/	“look”
	CV	/bu/	“this”	VCC	Alp	“Alp” (proper name)
	VC	/ev/	“house”	CVCC	/renk/	“color”

2.5.3 Korean syllable structure

There is no consensus among Korean phonologists with reference to the number of monophthongs in Korean. Generally speaking, there are three different views, as described below:

A. 10-vowel system: Both /ø/ and /y/ are monophthongs so there are ten vowels in Korean: /i, e, ɛ, ɨ, ə, a, u, o, y, ø/ (e.g., D.-Y. Lee, 1998; I. Lee & Ramsey, 2000; H.-M. Sohn, 1999; Song, 2005).
B. 9-vowel system: /ø/ as a monophthongs but /y/ is a diphthong (e.g., Kim, 1968; Martin, 1951).
C. 8-vowel system: Both /ø/ and /y/ are diphthongs (e.g., Magen & Blumstein, 1993).

With respect to consonants, the Korean language has a three-way contrast for oral stops and affricates, namely neutral (C), aspirated (C^h), and tensed segments (C’) (D.-Y. Lee, 1998). For fricatives, neutral *s* and tensed *s’* are found and there is also a glottal fricative /h/. In addition, Korean also has three nasals (i.e., /n, m, ŋ/) and the liquid /l/. In sum, Korean has 19 consonants: /p, p’, p^h, t, t’, t^h, c, c’, c^h, k, k’, k^h, s, s’, h, m, n, ŋ, l/.

Korean has few word-final consonants and lacks both initial and final consonant clusters. Each of the 19 consonants can occur in the syllable-initial position, whereas /ŋ/ does not occur in the word-initial position (H.-M. Sohn, 1999). Only seven out of 19 consonantal phonemes (i.e., /p, t, k, m, n, ŋ, l/) can be pronounced in codas (Kabak & Idsardi, 2009; Song, 2005). Other consonants undergo various process of neutralization when they occur in codas. For example,

strident consonants such as /c/, /c^{h}/, and /s/, when appearing in coda position, neutralize to the unreleased stop [t] (Kabak & Idsardi, 2009). For instance, /nac/ "daytime," /nac^{h}/ "face" and /nas/ "sickle," when they are pronounced in isolation, become homophonous (i.e., [nat]). Another example includes /p^{h}/. When it occurs in codas, it neutralize to /p/ in pronunciation. For instance, /cip^{h}/ "straw," when pronounced in isolation or followed by a word boundary or a consonant beginning particle, is uttered as [cip], just like /cip/ "house" is (Song, 2005).

Korean syllables are maximally CGVC, where G is a glide /j/ or /w/ (Kabak & Idsardi, 2009; H.-M. Sohn, 1999). There are eight possible syllable types in Korean, as shown in (21) below.

(21)						
	V	/i/	"tooth"	VC	/ip/	"mouth"
	GV	/wɛ/	"why"	GVC	/jok/	"abuse"
	CV	/no/	"oar"	CVC	/nok/	"rust"
	CGV	/hjə/	"tongue"	CGVC	/kwan/	"pipe"

To summarize, Korean allows only one consonant in coda position, and only voiceless stops, fricatives (i.e., /s/ and /h/), nasals, or the liquid /l/ can be found in codas, which is different from English where both voiced and voiceless stops can occur word-finally in past tense morpheme. Thus, the [-Vd] sequence as in *showed* is permissible in English but not in Korean. In addition, Korean has both aspirated and unaspirated voiceless stops but no voiced stops. Therefore, Korean speakers may find it difficult to perceive and produce the difference between voiced and voiceless stops in non-initial position (Avery & Ehrlich, 1992). In initial position, the aspiration of English will help Korean speakers distinguish between voiced and voiceless stops (Avery & Ehrlich, 1992).

2.5.4 Mandarin Chinese syllable structure

Standard Chinese (SC) has the following vowels: [i, y, e, ɛ, a, ə, ɤ, u, o, ɑ]. [ɛ] and [ɑ] can be treated as phonetic variants of the phoneme [a]; moreover, [e], [o] and [ɤ] can be treated as phonetic variants of the phoneme [ə] (Lin, 2007). Thus, SC has five vowel phonemes: /i, y, u, ə, a/ (Duanmu, 2007; Lin, 2007). In addition, there are four diphthongs in SC: /ai/, /ei/, /ɑu/, and /ou/ (Lin, 2007).

SC has three glides, /j, w, ɥ/. The glides /j/, /w/ and /ɥ/ are the non-syllabic counterparts of the high vowels /i/, /u/, and /y/, respectively (Lin, 2007). The three high vowels, /i/, /u/, and /y/, can occur before a non-high vowel, where they are treated as glides (Duanmu, 2007). For example, [jɛ] "also," [wai] "outside," and [ɥan] "round."

SC has the so-called retroflex vowel /ɹ/.[13] There are also two "apical vowels" [z] (which occurs only after the dentals [ts], [ts^{h}], and [s]) and [z̩] (which appears only after the retroflexes [tʂ], [tʂ^{h}], [ʂ], and [z̩]), such as [sz] "die" and [ʂz̩] "history," which are considered syllabic consonants that occupy the nucleus position and function like vowels (Duanmu, 2007; Lin, 2007).[14] In *pinyin,* the letter *i* is used for both vowels.

There are 19 consonants in SC, as shown in Table 3 (adapted from Lin, 2007, p. 41). Between pairs of stops or affricates, the primary distinction is aspirated versus unaspirated, which is different from English (i.e., voiced versus voiceless). Each pair of aspirated and unaspirated stops are separate phonemes in Standard Chinese but allophones in English.

[13] The so-called retroflexed vowel occurs in the rime *er* in SC and in *erhua* rimes in the speech of Beijing speakers. There are several ways of transcribing *er*, such as [ɾ], [ɹ], or [ɚ]. *er* can occur in words without a suffix, such as /er2/ "son" and /er3/ "ear"; and *er* can occur as a suffix and replace the coda of the syllable it attaches to. Compare /ba3/ "handle" (unsuffixed) and /bar3/ "handle" (suffixed). (Pronunciations are enclosed in back slashes and written in *pinyin*.)

[14] There is some disagreement among linguists on how to transcribe apical vowels in SC. In this study, I followed Duanmu (2007) in using [z] and [z̩] for the two apical vowels.

Table 3. *Chart of Standard Chinese Consonants*

	Bilabial		Labio-dental	Dental		Post-alveolar		Velar	
Stop	p	p^h		t	t^h			k	k^h
Fricative			f	s		ʂ		x	
Affricate				ts	ts^h	tʂ	$tʂ^h$		
Nasal	m			n				ŋ	
(Central) Approximant						ɹ			
Lateral (Approximant)				l					

The Chinese language has no consonant clusters in either syllable- or word-initial and syllable- or word-final position. The Standard Chinese syllable structure is maximally CGVX (Duanmu, 2011; Lin, 2007; van de Weijer & Zhang, 2008), where G is one of the glides /j, w, ɥ/, and X is either a consonant (i.e., /n, ŋ/), the second part of a diphthong (i.e., /i, u/), or the retroflex vowel /ɹ/. All 19 consonants but /ŋ/ can occur in onset position (Duanmu, 2007). All potential syllable types are exemplified in (22) below.

(22)	V	/e4/	[ɤ]	"hungry"	CVC	/xing1/	[ɕin]	"new"
	CV	/bi4/	[bi]	"arm"	CVV	/lei4/	[lei]	"tired"
	GV	/wa1/	[wa]	"frog"	GVC	/yan2/	[jan]	"salt"
	CGV	/tie3/	[tjɛ]	"iron"	GVV	/wai4/	[wai]	"outside"
	VC	/an1/	[an]	"peace"	CGVC	/liang2/	[ljɑŋ]	"cool"
	VV	/ai4/	[ai]	"love"	CGVV	/biao3/	[bjɑu]	"watch"

In sum, only /n, ŋ, ɹ, i, u/ can occur in coda position in SC. Moreover, SC doesn't allow either word-initial or word-final consonant clusters. These suggest that some Chinese speakers may have difficulty in perceiving and producing English verbs marked in simple past tense. In

addition, SC has three voiceless aspirated and three voiceless unaspirated stops, but no voiced stops. Research has shown that Chinese speakers, just like Korean speakers, may have problems with the distinction between voiced/voiceless stops in coda position (Avery & Ehrlich, 1992); for example, Chinese speakers' pronunciation of words such as *lack* and *lag* may sound identical ([læk]), and past tense verbs such as *stayed* may sound like [stet].

2.5.5 Interim summary

The syllable structures of English, Turkish, Korean and Chinese are summarized in Table 4. As mentioned earlier, the purpose of the present study was to investigate whether there are transfer effects of L1 phonological constraints related to consonant clusters on second language perception and production of the regular past tense morpheme. Turkish contrasts with Korean and Chinese in that Turkish permits up to two consonants in coda position while both Korean and Chinese allow only one-member codas. Considering this difference, test materials in the present study included regular verbs whose past tense forms having either one-member codas or two-member codas. To be more specific, regular verbs ending in syllabic allomorph [əd] (e.g., *doubted*) and regular verbs ending in non-syllabic singleton [Vd] (e.g., *showed*) are words with one-member codas. For regular verbs ending in non-syllabic allomorphs [t] and [d] (e.g., *kissed* and *killed*, respectively), only words with two-member codas were chosen; therefore, words such as *fixed* or *preserved*, which have three-member codas, were not selected. If properties of L1 phonology is responsible for at least some of the omissions of past tense marking, as suggested by Lardiere (2003), one would expect that Turkish speakers will outperform Korean and Chinese speakers in their use of English past tense morphology, especially in the case of regular verbs with two-member codas. Moreover, it is also predicted that Korean and Chinese speakers would experience similar

problems, since both languages do not license final consonant clusters.

Table 4. *Summary of Syllable Structures in English, Turkish, Korean and Chinese*

Languages	Maximal syllable structure	1-member onset	2-member onset	1-member coda	2-member coda	3-member coda
English	CCCVCCCC	√	√	√	√	√
Turkish	CVCC	√	-	√	√	-
Korean	CGVC	√	-	√	-	-
Chinese	CGVX	√	-	√	-	-

2.6 Research Questions and Hypotheses

Previous studies on second language production of English past tense morphology have not yet teased apart influence from the L1 phonological system and influence from L1 morphosyntax. As has been discussed previously, these are possible overlapping influences in the case of Chinese learners of English. It is thus necessary to investigate each of these two factors working in isolation. The aim of the present study, which represented an expansion of Hawkins and Liszka's (2003) and Solt et al.'s (2004) research, was to address the issue of L1 phonological and morphosyntactic transfer involved in second language production and perception of English regular past tense morphology. In addition, this study attempted to address the link between production and perception of English regular past tense morphology within the same learner group. Toward these goals, the present study included three groups of L2 English learners: Turkish ([+past, +final consonant clusters]), Korean ([+past, −final consonant clusters]), and Chinese ([−past, −final consonant clusters]). Comparing English regular past tense use by these three learner groups would allow an examination of morphosyntactic and phonological factors separately.

Moreover, the present study used parallel linguistic materials (i.e., verbs ending in syllabic

allomorph [əd], non-syllabic allomorphs [d] and [t], and non-syllabic singleton [Vd]) in four experimental tasks: two production tasks (i.e., story completion and sentence repetition) and two perception tasks (i.e., self-paced listening (SPL) and perception judgment). Previous research has relied mainly on spontaneous speech production data to describe nonnative speakers' use of English past tense morphology and other inflectional morphemes, but it is unclear whether L2 learners can accurately and consistently pronounce the past tense morpheme *-ed*, given that the formation of English regular past tense often creates final consonant clusters, which are not allowed in many languages. To further determine whether articulation problems contribute to learners' errors in tense marking, the present study included, in addition to a story completion task, a sentence repetition task in which the *-ed* morpheme was specifically targeted. In terms of the tasks assessing perception, the SPL task measured perception of the *-ed* morpheme as well as sentence comprehension (through comprehension questions related to stimuli). In parallel with the production tasks, which included both a form-oriented and meaning-oriented component, it was decided to incorporate a task that tapped directly into the perception of English regular past tense morphology. Thus, an additional perception judgment task was included in the present study. To summarize, compared to the story completion and SPL tasks which predisposed participants to focus on meaning, the sentence repetition and perception judgment tasks were more form-oriented in nature. The design features of the four experimental tasks are summarized in Table 5.

Table 5. *Summary of Experiments in the Present Study*

	Meaning-oriented	Form-oriented
Production	Story completion	Sentence repetition
Perception	Self-paced listening	Perception judgment

The present study was motivated by the following research questions. Also listed below are

the hypotheses made for each research question, based on previous literature on the topic.

(1) *Do L1 phonology and morphosyntax affect L2 learners' production of the English regular past tense morpheme across its four allomorphs?*

According to the PTH, one would predict that L1 constraints on prosodic structure will have a negative impact on the production of past tense that goes above and beyond any morphosyntactic transfer issues (Goad et al., 2003), although it is possible that for some learners, these issues will resolve at more advanced levels.

As can be recalled from section 2.5, Turkish permits the types of word-final consonant clusters typically found in English simple past tense forms (e.g., word-final *-t/-d* is preceded by a sonorant or a fricative). On the other hand, Korean is similar to Chinese in that both languages do not allow word-final (and word-initial) consonant clusters. Collectively, it was hypothesized that for native speakers of Turkish, L1 phonological transfer would play a positive or neutral role in the production of English past tense morphology, whereas for Korean and Chinese speakers, L1 phonological transfer would negatively affect their past tense marking in English. In particular, it was hypothesized that Turkish speakers would outperform Korean and Chinese speakers in the use of English past tense morphology, especially in the case of regular verbs ending in two-member codas and that Korean and Chinese speakers, but not Turkish speakers, would have higher rates of suppliance for past tense forms with a simple coda than for past tense forms with a complex coda.

As mentioned earlier, the sentence repetition task in the present study included both regularly inflected verbs (e.g., *filled* and *missed)* and monomorphemic words containing consonant clusters (e.g., *field* and *mist*). If L1 constraints against final consonant clusters are one of the causes for past tense omissions, then one would predict to find similar deletion rates of

final *-t/-d* in regular past tense verbs and in monomorphemic words. It was hypothesized that both Korean and Chinese speakers would show similar proportions of *-t/-d* deletion in regular past tense verbs and in monomorphemic words, because both languages do not license final consonant clusters.

(2) *Do L1 phonology and morphosyntax affect L2 learners' perception of the English regular past tense morpheme across its four allomorphs?*

The PTH is mainly concerned with "the role that the L1 plays in the production of functional material in L2 outputs" (Goad & White, 2004, p. 119). However, there is a growing body of evidence showing that adult L2 learners' difficulties with inflectional morphology also extend to comprehension and processing (e.g., L. Chen, Shu, Liu, Zhao, & Li, 2007; Clahsen, Felser, Neubauer, Sato, & Silva, 2010; Clahsen, Martzoukou, & Stavrakaki, 2010; Grüter, Lew-Williams, & Fernald, 2012; Jiang, 2007; McCarthy, 2008). Lieberman (2012, 2013) argues that since the same grammar is presumably used both for production and comprehension, the PTH should apply to comprehension as well. In a similar vein, prosodic transfer effect should extend to perception, under the assumption that speakers have a single prosodic grammar. If a speaker's grammar does not license a particular prosodic structure, it is reasonable to expect that the speaker would be not able to perceive it well. Under this assumption, word- final consonant clusters are thought to cause difficulties not only in production but also possibly in perception, especially for L2 learners whose L1s do not allow them (e.g., Korean and Chinese). In addition, previous research has also shown that adult L2 learners often have problems perceiving phonetic segments not present in their L1 (e.g., Best, 1995; Flege, 1995; Strange, 1995). Therefore, for perception, a hypothesis similar to the one for production is formulated: Turkish speakers would

have an L1-based advantage over Korean and Chinese speakers in the perception of the English regular past tense morpheme, especially in the case of regular verbs ending in two-member codas. Moreover, it was hypothesized that the perception of the English regular past tense morpheme by Korean and Chinese speakers, but not Turkish speakers, would be lower for past tense forms with a complex coda than for past tense forms with a simple coda.

(3) *Does the phonetic form of the regular verbs affect L2 learners' production of English past tense morphology?*

The issue of the role of the phonetic form of regular verbs in English past tense marking is far from resolved. As mentioned earlier (see section 2.1.3.1), in Bayley's (1994) study, he found that Chinese learners of English marked regular verbs with non-syllabic allomorph for past tense more often than regular verbs with syllabic allomorphs. However, Wolfram (1989) showed that for Vietnamese learners of English, regular verbs ending in syllabic allomorph were slightly more likely to be inflected for simple past than regular verbs ending in non-syllabic singleton [Vd], and regular verbs ending in consonant clusters were least likely to be inflected for simple past in obligatory context. Bayley's results of regular syllabics, by his own admission, appear to contradict the saliency hypothesis. In his words, "a complete syllable, after all, would seem to be more salient than a final segment, particularly a segment that is usually the final element of a consonant cluster and therefore subject to deletion" (Bayley, 1994, p. 171). In accordance with this idea and also based on the results of Wolfram (1989), the syllabic allomorph [əd] should be more accurately produced than the non-syllabic allomorphs. Moreover, previous studies have shown that a preceding vowel is more likely to induce past tense marking than a preceding liquid or obstruent (Bayley, 1994, 1996). Accordingly, among the non-syllabic allomorphs, the

non-syllabic singleton [Vd] should be more accurately produced than the non-syllabic allomorphs [t]/[d].

Both Bayley (1994, 1996) and Wolfram (1989) were conducted with L2 English speakers whose L1s do not license consonant clusters. It is unclear whether or not learners whose L1s permit consonant clusters will show the same pattern and to what extent L1 phonology interacts with the phonetic form of the regular verb forms. If it is the case that the similarity of the phonology in the L1 (that is, the presence of consonant clusters) means that there is little to impede pronunciation of the various past tense forms, Turkish speakers should show no significant differences in suppliance of past tense marking across its four allomorphs, whereas Korean and Chinese speakers would produce the syllabic allomorph [əd] more accurately than the non-syllabic singleton [Vd] and they would be least accurate in the production of the non-syllabic allomorphs [t]/[d].

(4) *Does the phonetic form of the regular verbs affect L2 learners' perception of English past tense morphology?*

Based on the criteria of perceptual salience as defined by Goldschneider and DeKeyser (2001), syllabics (e.g., [əd]) are more perceptually salient than stops (e.g., [t]/[d]). Moreover, among stops, voiced stops (e.g., /b,d,g/) are assumed to be more acoustically salient than voiceless stops (e.g., /p,t,k/) because of their greater sonority (Hogg & McCully, 1987, p. 33). Accordingly, the syllabic allomorph [əd] is more perceptually salient than the non-syllabic allomorph [d], which, in turn, is more perceptually salient than the non-syllabic allomorph [t].

As previously mentioned, there is a possibility that compared to the syllabic allomorph [əd] (e.g., *shouted*), the perceptual difficulty of the non-syllabic allomorphs [t]/[d] (e.g., *kissed* and

filled) may result from the syllabicity effect (i.e., the allomorph [əd] is its own syllable) and/or the effects of clustering. In view of this, the present study included regular verbs ending in non-syllabic singleton [Vd] (e.g., *snowed*) to isolate the syllabicity effect from the effects of clustering. By comparing the perception accuracy of the syllabic allomorph [əd] with that of the non-syllabic singleton [Vd], this will allow an examination of the syllabicity effect.

In line with the idea that a syllable is assumed to be more perceptually salient than a consonant (or consonant clusters), the syllabic allomorph [əd] is predicted to be more accurately perceived than the non-syllabic singleton [Vd]. Moreover, previous research (e.g., Goad, 2011) has suggested that a sequence of a vowel followed by a stop will create less perceptual difficulty than a sequence of consonant clusters. Thus, among the non-syllabic allomorphs, the non-syllabic singleton [Vd] should be more perceptually salient than the non-syllabic allomorphs [d] and [t].

In brief, according to the preceding discussion, the hierarchy of perceptual salience among the four allomorphs of the past tense morpheme *-ed* is: syllabic allomorph [əd] > non-syllabic singleton [Vd] > non-syllabic allomorph [d] > non-syllabic allomorph [t] (where > denotes "more perceptually salient than").

So far, the number of studies that have investigated L2 learners' perception of English past tense morphology is rater limited. It remains to be shown whether L1 phonology interacts with the phonetic form of the regular verbs and to what extent the convergence of both factors influences second language perception of the *-ed* morpheme. If it is the case that L1 phonology is a factor in L2 learners' perception of the *-ed* morpheme, then it was hypothesized that for Turkish speakers, there would be no significant differences in their perception of the *-ed* morpheme among its four allomorphs, unless some forms are just universally harder to perceive; for Korean and Chinese speakers, according to the criteria of perceptual saliency, the syllabic allomorph [əd]

would be better perceived than the non-syllabic singleton [Vd], which, in turn, would be better perceived than the non-syllabic allomorph [d], which, in turn, would be better perceived than the non-syllabic allomorph [t].

(5) *Does L2 learners' perception of the regular past tense morpheme correlate with how they produce it?*

Previous studies on the relationship between second language perception and production have reported positive, albeit moderate, correlations between L2 segmental perception and production (e.g., Bettoni-Techio et al., 2007; Flege et al., 1997; Flege et al., 1999; Flege & Schmidt, 1995; Schmidt & Flege, 1995). In the present study, to examine the question of to what extent the perception of the regular past tense morpheme correlates with the production of this morpheme, the results from the sentence repetition task and those from the perception judgment task were compared. Remember that critical verbs in these two tasks were matched. Under the assumption that speakers have a single prosodic grammar, it was hypothesized that there would be a positive correlation between learners' perception and production of the English regular past tense morpheme.

CHAPTER 3: METHOD

3.1 Participants

A total of 189 participants took part in different stages throughout this study, including the materials development stage, two pilot studies, and the primary experiment. Reported below are data on the participants of the primary experiment who submitted all study tasks (i.e., story completion, sentence repetition, SPL, perception judgment, and language background questionnaire).

The participants (n = 86) were all matriculated students at Michigan State University. The number of ESL participants was 62 in total, including 18 L1 Turkish speakers (mean age: 27.67, range: 18-35), 21 L1 Korean speakers (mean age: 23.62, range: 19-30), and 23 L1 Chinese speakers (mean age: 24.78, range: 21-38). They were mostly doctoral students (10 Turkish, 8 Korean, and 9 Chinese) and masters students (6 Turkish, 3 Korean, and 14 Chinese) with a few undergraduate students (2 Turkish and 10 Korean). The L2 participants all had standardized test scores on the Test of English as a Foreign Language (TOEFL) internet-based test (iBT) that were high enough (80+) for them to be accepted into the regular undergraduate or graduate studies at Michigan State University. Their self-reported TOEFL iBT scores were used as the primary source of information about their level of English proficiency. To determine whether the three learner groups were comparable in terms of English proficiency, their TOEFL scores were submitted to a one-way ANOVA. The results indicate no statistically significant differences, $F(2,59) = .031$, $p = .969$. Therefore, any difference in performance between learner groups is unlikely to be due to pre-existing English proficiency differences. Demographic data of the L2 learners who participated in the primary experiment are shown in Table 6. Upon completion of the study tasks, the L2 learners received a payment of $20 in cash for their participation.

Table 6. *English Learning Background of the Nonnative Participants*

	Turkish	Korean	Chinese
Number	18	21	23
Gender	12 male, 6 female	5 male, 16 female	6 male, 17 female
Age	27.67 (4.74)	23.62 (3.67)	24.78 (3.59)
Age of onset	11.06 (2.44)	9.86 (2.41)	9.78 (2.09)
Age at US arrival	24.5 (4.12)	20.95 (4.95)	23.61 (2.39)
Length of US residency (years)	3.08 (1.66)	2.07 (1.74)	1.39 (1.3)
TOEFL iBT score	99.11 (8.42)	99.57 (9.82)	99.74 (5.78)

Note. Values given are means, with SDs in parentheses.

A group of 24 native speakers of English was also included to serve as controls. One native participant was excluded for failing to complete the study tasks. This resulted in a sample size of 23 for the control group. The native English participants (all born in the US) were between the ages of 19 and 24 ($M = 20.87$, $SD = 1.49$). They were mostly seniors ($n = 12$) and juniors ($n = 9$) with a few sophomores ($n = 2$). They received course credit for their participation.

3.2 Materials

3.2.1 Regular verbs

As described in section 2.5, Turkish is different from Korean and Chinese as Turkish permits up to two consonants in coda position while both Korean and Chinese allow only one-member codas. The present study had the aim of testing whether L1 phonology influences second language production and perception of the past tense morpheme *-ed*. To achieve this, regular past tense verbs with either one-member or two-member codas were chosen; therefore, verbs such as *fixed* or *involved*, which have three-member codas, were excluded from the present study. Moreover, in Turkish, word-final *-t/-d* can be preceded only by a sonorant or fricative.

Thus, regular past tense verbs in which the final segment before inflection is a stop, such as *talked* or *stopped,* were not selected. In addition to the above two criteria, previous research has shown that many Korean speakers tend to substitute /l/ for /r/ in onset position, producing "lip" instead of "rip" (Avery & Ehrlich, 1992). To avoid the possibility that Korean learners' omissions of past tense marking are due to their pronunciation difficulties caused by the /r/ sound, regular verbs with /r/ in coda position, such as *preserved* and *returned,* were not included. This criterion of selection overlapped with the first criterion (i.e., only verbs with one-member or two-member codas were chosen) because words with /r/ in coda position often have three or more consonants in the coda.

The present study involved two production tasks and two perception tasks. If the same target word is used in the two production/perception tasks, there is a risk that there will be priming effects, which could positively or negatively affect the results of the second production/perception task taken. To reduce such priming effects, two parallel word lists (list 1 and list 2) were constructed. Each word list included thirty-two English regular past tense verbs, divided evenly by phonetic form of the past tense morpheme: 8 verbs ending in syllabic allomorph [əd], 8 ending in non-syllabic allomorph [d], 8 ending in non-syllabic allomorph [t], and 8 ending in non-syllabic singleton [Vd] (where the final segment before inflection is a vowel or glide). The two word lists were comparable in that regular past tense verbs in one list had their counterparts in the other list (e.g., *shouted/doubted, filled/killed, missed/kissed, snowed/showed*, each word pair had the same nucleus and coda). According to this criterion, the verb *ruined* was not the counterpart of the verb *joined* because these two verbs did not have the same nucleus.

The majority of regular verbs used in the present study were from the "Top 5,000 lemmas"

list in the Corpus of Contemporary American English (COCA).[15] A few regular verbs were selected from the 7,000 most common lemmas found on the website "Word and Phrase," with two exceptions: *fry* and *faint*, both of which were not among the 7,000 common lemmas.[16] To equate the two word lists on frequency, a protocol similar to the one used in Marshall and van der Lely (2006) and Campos Dintrans (2011) was followed. That is, the frequency counts of each verb in the two word lists were obtained from the website "Word and Phrase" and were then converted to natural logarithm.[17] Independent-samples t-tests were conducted between each matched condition (e.g., syllabic allomorph in List 1 and List 2) to verify that there were no significant differences between the two word lists in each of the allomorph types (see Table 7 for more details).

Table 7. *Pairwise Comparisons of the Mean Log Frequency Values*

	Natural log value		Independent-samples t-test	
Allomorph type	List 1	List 2	*t*	*p*
Syllabic allomorph [əd]	10.19	9.55	1.864	.083
Non-syllabic allomorph [d]	9.91	10.24	-.616	.548
Non-syllabic allomorph [t]	9.66	9.82	-.385	.706
Non-syllabic singleton [Vd]	10.16	10.88	-1.084	.297

In short, regular verbs were selected based on the criteria as summarized below:

I. Regular verbs whose past tense forms have either one-member or two-member codas.

II. Regular verbs in which the final segment before inflection is a sonorant or fricative.

III. Regular verbs with no /r/ in coda position.

[15] The COCA (http://corpus.byu.edu/coca/) is composed of 450 million words from more than 160,000 texts. The texts come from a variety of sources: spoken, fiction, popular magazines, newspaper, and academic texts. The corpus was created by Mark Davies at Brigham Young University.

[16] The website "Word and Phrase" (www.wordandphrase.info) contains information on the lemma and part of speech for the top 60,000 words (lemmas) of English based on data from the COCA.

[17] Calculating the natural logarithm of the frequency counts makes comparisons easier, especially in the case of the number of occurrences obtained from a huge corpus where the range of values can vary greatly.

IV. Regular verbs and their counterparts have the same nucleus and coda.

V. Regular verbs and their counterparts are matched for frequency.

The full list of critical verbs is provided in Table 8. While regular verbs ending in syllabic allomorph [əd] and regular verbs ending in non-syllabic singleton [Vd] are words with one-member codas, regular verbs ending in non-syllabic allomorphs [d] and [t] are words with two-member codas.

Table 8. *List of Critical Verbs and Monomorphemic Words*

Allomorph type	Regular verbs								Mono-morphe-mic words
	One-member codas				Two-member codas				
	List 1		List 2		List 1		List 2		
Syllabic allomorph [əd]	A	shouted traded waited painted	a	doubted faded rated fainted	n/a		n/a		(set 1) vivid valid splendi d solid
	B	noted prevented pretended landed	b	voted rented attended handed					rigid rapid stupid arid
Non-syllabic allomorph [d]	n/a		n/a		A	filled planned mailed caused	a	killed scanned failed paused	(set 2) field brand gold *sand*
					B	claimed spelled piled trained	b	blamed smelled smiled explained	*cold* wild mild trend

Table 8 (cont'd)

								(set 3)
					practiced		promised	list
				A	smashed	a	flashed	*belt*
					punished		finished	*draft*
Non-syllabic allomorph [t]	n/a		n/a		brushed		flushed	*adult*
					missed		kissed	mist
				B	produced	b	introduced	test (n)
					impressed		expressed	best
					pressed		dressed	rest (n)
								(set 4)
		played			prayed			speed
	A	died	a		lied			side
		tried			cried			tide
Non-syllabic singleton [Vd]		fried			dried	n/a	n/a	wide
		snowed			showed			road
	B	married	b		carried			bead
		sprayed			stayed			shade
		applied			relied			slide (n)

Note. Words in italics indicate that they do not match regular past tense verbs exactly (i.e., not the same coda).

3.2.2 Monomorphemic words

Another condition added to the test materials was monomorphemic words. As shown in Table 8, monomorphemic words were divided into two coda types: those that contained one-member codas (i.e., words of set 1 and set 4); and those that comprised two-member codas (i.e., words of set 2 and set 3). Every effort was made to maintain resemblance between regular past tense verbs and monomorphemic words in the coda. Monomorphemic words of set 1 were comparable in word-final phonological structure to regular verbs with syllabic allomorph [əd] in that the former all ended in [ɪd]. Likewise, monomorphemic words of set 4 resembled regular verbs with non-syllabic singleton [Vd] in that the former also ended in [Vd]. Other than these

two sets of words, however, monomorphemic words of set 2 and set 3 did not match perfectly with regular verbs ending in non-syllabic allomorphs [d] and [t] in terms of final consonant clusters. That is, while there were four types of final consonant clusters in regular verbs ending in non-syllabic allomorph [d] (i.e., [ld], [nd], [md], and [zd]), there were only two types in monomorphemic words of set 2 (i.e., [ld] and [nd]) because there were no monomorphemic words with [md] and [zd] clusters in the coda. Additionally, whereas all of the regular verbs ending in non-syllabic allomorph [t] finished with either [st] or [ʃt] clusters, monomorphemic words of set 3 ended in either [st] or [lt]/[ft]. No monomorphemic words were found containing [ʃt] clusters in coda position.

Similar to regular verbs, all monomorphemic words selected were from the 7,000 most common lemmas found on the website "Word and Phrase," with two exceptions: *splendid* and *arid*. The frequency of monomorphemic words was matched as closely as possible with the frequency of regular verbs, using the protocol described above.

3.2.3 Distribution of target words

As displayed in Table 8, word list 1 contained two sublists: sublist 1A and sublist 1B. Similarly, word list 2 included sublist 2a and sublist 2b. Each sublist consisted of 4 verbs ending in syllabic allomorph [əd], 4 ending in non-syllabic allomorph [d], 4 ending in non-syllabic allomorph [t], and 4 ending in non-syllabic singleton [Vd]. Target words used in each experimental task were as follows:

- Production tasks:

    Story completion: sublist 1A and sublist 2b

    Sentence repetition: sublist 1B, sublist 2a, and monomorphemic words

- Perception tasks:

    SPL: list 1 (sublist 1A and sublist 1B)

    Perception judgment: list 2 (sublist 2a and sublist 2b).

Thus, each critical verb would appear once in a production task and once in a perception task. The two production/perception tasks would not test the same critical verb. This design limits the priming effects on the second production/perception tasks taken. Each of the four experimental tasks included equal number of regular verbs representing each of the four allomorphs of the *-ed* morpheme. Monomorphemic words were tested only in the sentence repetition task. See Table 9 for a complete list of target words used in each experimental task.

Table 9. *Target Words Used in Each of the Four Experimental Tasks*

	Story completion	Sentence repetition		Self-paced listening	Perception judgment
		Verbs	Monomorphemes		
Syllabic allomorph [əd]	shouted	doubted	vivid	shouted	doubted
	traded	faded	valid	traded	faded
	waited	rated	splendid	waited	rated
	voted	noted	solid	noted	voted
	painted	fainted	rigid	painted	fainted
	rented	prevented	rapid	prevented	rented
	attended	pretended	stupid	pretended	attended
	handed	landed	arid	landed	handed
Non-syllabic allomorph [d]	filled	killed	field	filled	killed
	planned	scanned	brand	planned	scanned
	blamed	claimed	*cold*	claimed	blamed
	smelled	spelled	wild	spelled	smelled
	smiled	piled	mild	piled	smiled
	explained	trained	trend	trained	explained
	mailed	failed	gold	mailed	failed
	caused	paused	*sand*	caused	paused
Non-syllabic allomorph [t]	kissed	missed	mist	missed	kissed
	introduced	produced	test (n)	produced	introduced
	expressed	impressed	best	impressed	expressed
	practiced	promised	rest (n)	practiced	promised
	dressed	pressed	list	pressed	dressed
	smashed	flashed	*belt*	smashed	flashed
	punished	finished	*draft*	punished	finished
	brushed	flushed	*adult*	brushed	flushed
Non-syllabic singleton [Vd]	showed	snowed	road	snowed	showed
	carried	married	bead	married	carried
	played	prayed	speed	played	prayed
	died	lied	side	died	lied
	tried	cried	tide	cried	tried
	fried	dried	wide	fried	dried
	stayed	sprayed	shade	sprayed	stayed
	relied	applied	slide (n)	applied	relied

Table 9 (cont'd)

Note. Words in italics indicate that they do not match regular past tense verbs exactly (i.e., not the same coda).

3.2.4 Word familiarity rating scale

To make sure that participants knew the meanings of the target words that they had to respond to in the primary experiment, a word familiarity rating scale was administrated to students in the English Language Center (ELC) at Michigan State University. The ELC offers ESL classes in the Intensive English Program (Level 1 to Level 4 from lowest to highest) and also in the English for Academic Purposes Program (EAP) (Level 5). The EAP program is designed for students who have not met MSU's minimum proficiency requirement in English. Therefore, if students in the EAP program knew the target words, then it can be safely concluded that target participants (i.e., matriculated students) would know them, too.

Per their request, the instructors of the EAP program administered the word familiarity rating scale, which was presented in hard copy format (double-sided, one page). Not all of the target words were included in the rating scale because the rating scale needed to be manageable in length so that it could be administered to the students within regular class time. Therefore, the word familiarity rating scale consisted of only 71 out of the 96 target words (64 critical verbs and 32 monomorphemic words). Words that were highly frequent, such as *best, road,* and *try,* were not used in the rating scale under the assumption that learners must know them.[18] Seventy-seven students in the EAP program agreed to participate. They were asked to evaluate how familiar they were with the words by choosing a score on a 3-point scale. Point 1 on the scale indicated "I know this word", 2 indicated "I've heard of this word, but don't know it well", and 3 indicated "I

[18] Words that were not used in the word familiarity rating scale included: best, road, cold, test, wait, shout, paint, kill, spell, pause, plan, smile, train, miss, kiss, practice, finish, snow, show, marry, play, die, cry, try, stay.

don't know this word." See Appendix A for the word familiarity rating scale.

The results indicated that most of the target words (with some exceptions, as detailed below) were familiar to the students in the EAP program. The word *splendid* had the highest average rating point (M = 2.25), in which 38 of the 77 students (49%) indicated they did not know this word (Point 3) and 20 students (26%) indicated they had heard of this word but did not know it well (Point 2). The words *rigid* and *arid* also got an average rating above 2 points (M = 2.07 and M = 2.05, respectively). Words whose average rating was between 1.5 and 2 points included *faint* (M = 1.92), *spray* (M = 1.81), *valid* (M = 1.71), *mist* (M = 1.71), *bead* (M = 1.62), *vivid* (M = 1.58), and *fade* (M = 1.57). However, the rest of the words were very familiar to the students, with an average rating of 1.07. Based on these results, it would be reasonable to expect that target participants should know most of the target words in this study, although a few may be somewhat unfamiliar.

3.3 Instruments

Data for this study came from four experimental tasks: story completion, sentence repetition, SPL, and perception judgment.

3.3.1 Story completion task

The purpose of the story completion task was to elicit a natural sample of participants' use of English past tense morphology, while still obtaining the targeted regular past tense verbs. In this task, participants were given the start of eight stories, one at a time, each 25-65 words in length. The descriptions of each story were presented in paper format. The stories were unfinished, so participants needed to create follow-up stories using the verbs written below each

story. A sample story is given below.

Story: New headphones

Mary's younger brother Andy is eight years old and he is a very naughty boy. Last month, Mary bought a new set of cups at a department store. Last week, Andy kicked a ball at home.

What happened? (smash into)

What did Mary do? (shout / blame (v.) / punish)

Participants had 30 seconds for planning before recording their stories. Moreover, participants were instructed to complete each story at their own pace but not to spend too much time on any particular story. Participants' responses were recorded using an Audio-Technica (AT2020) microphone connected to a computer, and the software used was Audacity.

The start of each story contained an adverbial denoting past time (e.g., *last week*), setting up a past context, so participants were expected to use the critical verbs in regular past tense forms. During test administration, in cases where participants did not produce the targeted forms (i.e., when a target verb was used as a gerund or infinitive), they were asked further questions whenever possible. For example, it was possible that participants responded *"Mary wanted their mother to punish her brother."* When this happened, the researcher asked them "*How did their mother punish Andy?*" In the few cases where participants did not use the target verb in their responses to the researcher's follow-up questions (e.g., "*She put him outside for a few hours*"), the researcher asked them directly to use the verb (e.g., "*Can you use punish in your sentence?*").

The order of the eight stories was randomized among participants. See Appendix B for the stories used for this task. This task lasted approximately 12-15 minutes for the native English participants and 15-25 minutes for the L2 participants.

As mentioned in section 3.2.3, the critical regular verbs tested in the story completion task

consisted of verbs from sublist 1A and sublist 2b, for a total of 32 verbs (including 8 verbs ending in syllabic [əd], 8 ending in [d], 8 ending in [t], and 8 ending in singleton [Vd]). See Table 9 above for a complete list of verbs used in this task.

3.3.2 Sentence repetition task

The sentence repetition task was designed to investigate whether articulation problems contribute to learners' errors in past tense marking. As elaborated in section 2.6, while the story completion task predisposed participants to focus on meaning, the sentence repetition task focused more on form, thereby allowing participants more cognitive resources for articulation.

The critical regular verbs tested in this task comprised verbs from sublist 1B and sublist 2a, including 8 verbs ending in syllabic [əd], 8 ending in [d], 8 ending in [t], and 8 ending in singleton [Vd] (see Table 9 for a full list of verbs used in the sentence repetition task). For each critical verb, a test sentence was created. Considering that the past tense morpheme *-ed* is not released if it is followed by an obstruent, thus in each test sentence, the critical verb was always followed by a word beginning with a vowel sound. This design was also intended to facilitate data coding.

In addition to regular past tense verbs, the sentence repetition task also targeted monomorphemic words. Half of the monomorphemic words contained two-member codas and the other half involved one-member coda. The test sentences that assessed the production of monomorphemic words (henceforth, monomorpheme sentences) were constructed in the same manner as for the sentences that tested regular past tense verbs (henceforth, regular past sentences) in which each monomorphemic word was followed by a word starting with a vowel sound.

In sum, the sentence repetition task had a total of 64 test sentences, including 32 regular

past sentences and 32 monomorpheme sentences. All test sentences were constructed specifically for this study. The length of each test sentence was made as short as possible (4-9 words, 12-31 characters). Across this task, three factors were manipulated: word type, coda length, and rhyme type. Thus, this task had eight experimental conditions (8 test sentences in each condition). An example of each condition is given in Table 10. The complete version of the test sentences for this task is provided in Appendix C.

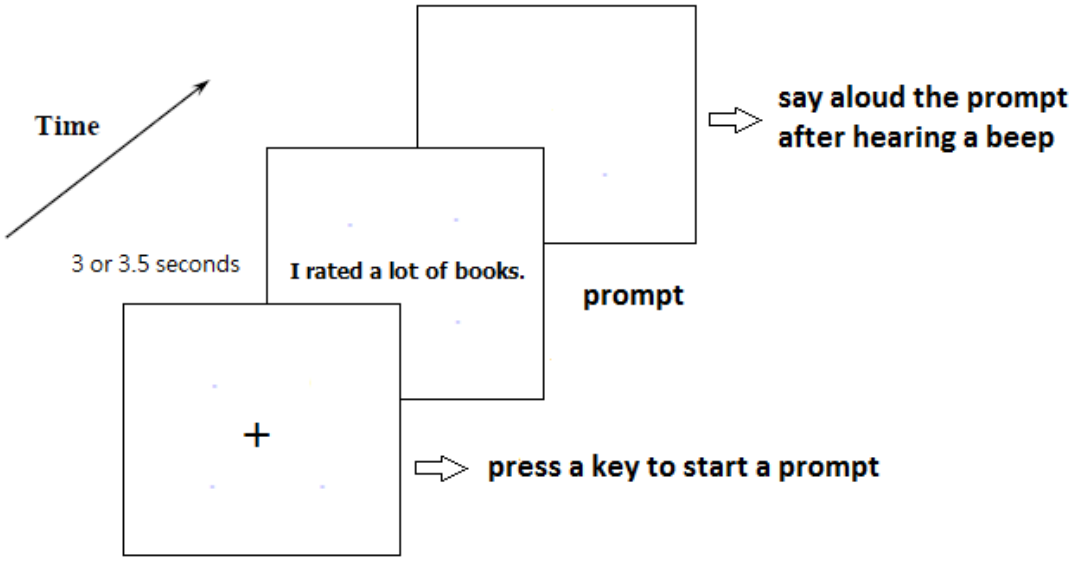
Table 10. *Experimental Conditions in the Sentence Repetition Task*

Word type	Coda length	Rhyme type	Sample test sentence
Regular past	One-member coda	[əd]	I doubted all the answers.
		[Vd]	She lied about her past.
	Two-member coda	[VC-d]	A man killed a lot of people.
		[VC-t]	I missed a call from her.
Monomorpheme	One-member coda	[ɪd]	This is not a valid address.
		[Vd]	The speed is too fast.
	Two-member coda	[VCd]	He found lots of gold and silver.
		[VCt]	The test is very easy.

This task was programmed and run using SuperLab software (version 4.5). The design was as follows. Participants were seated in front of a 17-inch screen. Each trial began with a plus symbol (+) in the center of the screen. Participants pressed any key on the keyboard to start a test sentence. Pilot testing led to the decisions that the test sentence was presented visually on the screen for 3 or 3.5 seconds, depending on the length of the sentence (i.e., a sentence would be presented for 3.5 seconds if the number of characters composing the sentence was more than 25). There were two exceptions (i.e., “It was a vivid and emotional painting” and “The trend of wearing skirts is fading”), which were presented for 4 seconds. Participants then saw a blank screen, which remained on screen for 1 second. Immediately after that, a beep sound played to alert

the participants to say aloud the sentence they just saw. Stimuli presentation is schematically illustrated in Figure 7.

Figure 7. A Schematic Illustration of the Sentence Repetition Task



Prior to the main task, participants performed four practice items to familiarize themselves with the task. Test trials were pseudo-randomized to ensure that not more than two trials in a row were of the same sentence type (regular past versus monomorpheme). Test sentences were presented in two blocks, with a break in between. The production data were recorded using Audacity software via an Audio-Technica (AT2020) microphone. The participants completed the sentence repetition task in about 15 minutes.

3.3.3 Self-paced listening task

The goal of the SPL task was to measure sentence comprehension as well as perception of the regular past tense allomorphs in English. The basic assumption of the SPL task is that listening times (measured in milliseconds) for words or phrases reflect their processing time. Thus, longer

listening times at a particular region in a sentence (relative to the same region in a control condition) are thought to indicate difficulties in comprehending a particular unit or segment. Comparison of listening times at particular regions of grammatical and ungrammatical versions of a sentence can reveal whether or not participants detect certain grammatical errors while their primary focus is on comprehension (listening for meaning). If listening times at regions of interest are longer for the ungrammatical sentence than for the grammatical one, one could assume that it is the participants' sensitivity to the ungrammaticality during on-line sentence comprehension that results in the listening-time slowdowns.

Thirty-two experimental sentences were developed for each critical verb in list 1 with the regular verb being followed by a vowel-initial word. Moreover, the subject in each experimental sentence was always a concrete noun (but not a pronoun or human name). This decision was made on the basis that with no context information provided, pronouns and human names will have vague references (Nicol & Swinney, 2002), which may lead to longer processing time. Each sentence had a grammatical and an ungrammatical version. The grammatical version included a time adverbial that was congruent with the past tense marker while the ungrammatical version included the adverbial "Right now" that was incongruent with the past tense marker. Thus, there are eight experimental conditions of interest (4 sentences per condition), as shown in Table 11 below, which allows an examination of the effects of allomorph type ([əd] vs. [d] vs. [t] vs. [Vd]) and sentence type (grammatical versus ungrammatical).

Table 11. *Experimental Conditions in the Self-Paced Listening Task*

Allomorph type	Sentence type	Regions of interest			
		Region 1	Region 2	Region 3	Region 4
Syllabic allomorph [əd]	grammatical	Last night	the mother shouted	angrily	in the room.
	ungrammatical	Right now	the mother shouted	angrily	in the room.
Non-syllabic allomorph [d]	grammatical	Yesterday	the man filled	a glass	with beer.
	ungrammatical	Right now	the man filled	a glass	with beer.
Non-syllabic allomorph [t]	grammatical	Yesterday	the man pressed	a button	to start the car.
	ungrammatical	Right now	the man pressed	a button	to start the car.
Non-syllabic singleton [Vd]	grammatical	Last year	the woman married	a rich man	in China.
	ungrammatical	Right now	the woman married	a rich man	in China.

There were also 32 filler sentences. Half of them involved the use of plural nouns and the other half were in relation to verb subcategorization. All of the filler sentences were adapted from Jiang (2007).[19] In parallel with the construction design of the experimental sentences, only concrete nouns, but no pronouns or human names, were used as the subjects in filler sentences. Following Jiang (2007), errors in the plurality sentences all contained such structures as "all of the …" and "one of the …." On the other hand, the ungrammatical versions of the subcategorization sentences all involved the incorrect use of an object complement pertaining to a verb. Sample filler sentences are given in (23) and (24).

(23) *filler: plurality*

a. The child / was watching / some of the rabbits / in the room.

b. *The child / was watching / some of the rabbit / in the room.

[19] Jiang (2007) examined L2 learners' sensitivity to grammatical errors in a self-paced reading task by testing their knowledge of plural morphology and verb subcategorization.

(24) *filler: verb subcategorization*

a. Headquarters / decided to / order the crew / to come back.

b. *Headquarters / decided to / put the crew / to come back.

The 32 experimental sentences and their ungrammatical counterparts and the 32 filler sentences and their ungrammatical variants were used to construct two different presentation lists. Each list contained 16 grammatical experimental sentences, 16 ungrammatical experimental sentences, 8 grammatical plurality distracters, 8 ungrammatical plurality distracters, 8 grammatical subcategorization distracters, and 8 ungrammatical subcategorization distracters. The grammatical and ungrammatical versions of a sentence always appeared in different presentation lists so that each participant encountered only one version of each sentence. Test sentences within each presentation list were pseudo-randomized such that sentences of the same type (experimental vs. plurality vs. subcategorization) never appeared in sequence. All experimental and filler sentences were 7 to 12 words in length. The experimental sentences were matched across conditions for syllable length in presentation list 1 (M = 12.22, range: 10-15) and in presentation list 2 (M = 12.19, range: 9-15). The number of syllables for the filler sentences was not as tightly controlled as for the experimental sentences. The filler sentences were 11 to 17 syllables in length (M = 14.14) in presentation list 1 and were 10 to 18 syllables in length (M = 14.31) in presentation list 2.

Each test sentence was followed by a yes/no comprehension question. These questions were all newly created for this study. The comprehension questions asked only fact questions (thus no referential questions). Moreover, the comprehension questions were all formulated in the same way ("Is this sentence about …?"), thereby no past tense being used in the questions. For

example, the comprehension question for the experimental sentence "Last night the mother shouted angrily in the room" was "*Is this sentence about a parent?*" Half of the comprehension questions required a positive answer and the other half required a negative answer. Furthermore, to prevent participants from developing a strategy whereby they did not fully process the earlier parts or the latter portion of a stimulus sentence, comprehension questions may refer to any part of the stimulus sentence. All test sentences and their related comprehension questions can be found in Appendix D.

In the SPL task, participants were seated in front of a 17-inch screen and were instructed to listen carefully to the pre-recorded sentences over headphones. Each trial began with a plus symbol (+) in the center of the screen. Participants pressed a button on a response pad to start a test sentence. All test sentences were presented in a word-by-word or phrase-by-phrase fashion, with each sentence being divided into four regions as indicated in Table 10 and examples (25) and (26). Participants pressed a button to receive successive words or phrasal units. The end of a sentence was indicated by a beep. Listening times between button presses were recorded in millisecond. After hearing the entire sentence, participants responded to the corresponding comprehension question, which was presented visually on a screen, by pressing either the A (Yes) or B (No) buttons on the response pad. The inclusion of comprehension questions was to ensure that participants focused on the task of comprehending the stimulus sentences rather than pressing the button mechanically. Participants were instructed to press as quickly as possible to receive the next unit and answer the comprehensions questions as accurately as possible.

All test sentences were read by a male native speaker of North American English at a normal speaking rate in a quiet research room at Michigan State University and were recorded and digitized using Audacity software, with a sampling rate of 44.1 kHz and 16-bit quantization.

All audio files were presented in the form of waveform files.

As described above, test sentences were all divided into four regions of interest. For the experimental sentences, listening times in two critical regions were examined: region 2 (the subject and the critical verb) and region 3 (i.e., the spill-over region: the unit immediately following the critical verb). If participants were sensitive to the grammatical error in the ungrammatical sentences, they were expected to show a delay (i.e., longer reaction times (RTs)) at critical regions.

Presentation of the stimuli, listening times on sentence units, and responses to comprehension questions were controlled by SuperLab software (version 4.5). Participants received instructions for performing the task and six practice items before they were tested in the main task. The SPL task was divided into two sessions by a short break. This task took about 15 minutes for the participants to complete.

3.3.4 Perception judgment task

The perception judgment task tapped directly into the perception of the English regular past tense morpheme. Specifically, this task aimed to examine influences of L1 phonology on the perception of the past morpheme *-ed* and to investigate the perception accuracy of the regular past tense allomorphs (i.e., [əd], [d], [t], and [Vd]).

The experimental design of the perception judgment task largely followed the one used in Solt et al. (2004, the perception task). The design was as follows. Participants were seated in front of a 17-inch screen. Each trial began with a plus symbol (+) in the center of the screen. Aural stimuli were presented at a comfortable listening level through high-fidelity headphones. Participants pressed a button on a response pad to listen to a pair of sentences with an

interstimulus interval of 1000 ms. Participants were instructed to decide whether the words of the two sentences were exactly the same or if there was a difference by pressing either the A (same) or B (different) buttons on the response pad (see Figure 8). The trial ended only after a response was given. The next trial started 1000 ms later.

Figure 8. Instructions for the Sentence Repetition Task

You will first see a + symbol in the center of the screen. You will then hear two sentences. Sometimes the words in the two sentences will be EXACTLY the same, but sometimes there will be a difference. You will decide whether the words in the two sentences are exactly the same, or if there is a difference. You will press A on the response pad if the words in the two sentences are EXACTLY the same based on what you hear. . You will press B on the response pad if the words in the two sentences are different based on what you hear. Please focus on whether the WORDS in the two sentences are EXACTLY the same. Press any button on the response pad to continue with these instructions.

Critical verbs in word list 2 (see Table 9 for a complete list of verbs used in this task) were used to construct experimental sentences for this task. In each experimental sentence, the critical verb was followed by a word beginning with a vowel sound for the purpose of controlling the phonological environment following past tense marking and maximizing the saliency of the *-ed* morpheme. Each critical verb appeared twice in the task, once in a "same" pairing (where the second sentence was the same as the first sentence) and once in a "different" pairing (where the *-ed* morpheme was omitted in the second sentence). This resulted in 64 experimental sentence pairs (32 critical verbs × 2). The perception judgment task thus had eight experimental conditions

(8 sentence pairs per condition), manipulating allomorph type ([əd] vs. [d] vs. [t] vs. [Vd]) and type of sentence pairs (same versus different). An example of the eight conditions is presented in Table 12.

Table 12. *Experimental Conditions in the Perception Judgment Task*

Allomorph type	Sentence pair type	Sample sentence pair	
Syllabic allomorph [əd]	same	I attended a meeting.	I attended a meeting.
	different	I attended a meeting.	I attend a meeting.
Non-syllabic allomorph [d]	same	They smiled at me.	They smiled at me.
	different	They smiled at me.	They smile at me.
Non-syllabic allomorph [t]	same	I finished off the cake.	I finished off the cake.
	different	I finished off the cake.	I finish off the cake.
Non-syllabic singleton [Vd]	same	I lied about my age.	I lied about my age.
	different	I lied about my age.	I lie about my age.

In addition to the experimental sentences, 34 filler sentences were also included in this task. Of the filler sentences, 24 sentences each contained one of the following grammatical morphemes: plural *-s* (*n* = 6), third person singular *-s* (*n* = 6), progressive *-ing* (*n* = 6), and comparative *-er* (*n* = 6). Similar to the construction design of the experimental sentences, the grammatical morphemes in the filler sentences were all followed by a vowel sound; moreover, each filler grammatical morpheme also appeared twice in this task, once in a "same" and once in a "different" pairing. The remaining 10 filler sentences were the so-called performance check sentences, which were added to the test based on the pilot study results. The performance check sentences were designed to evaluate whether participants were paying attention to the task. Each performance check sentence was paired up with a similar but different sentence where one or two words in the original sentence were replaced by other words, thus presenting a clear-cut difference between the two sentences. Sample filler sentences are presented in (25) through (29). In sum, in the

perception judgment task, there were 58 filler sentence pairs (24 fillers × 2 + 10 performance check sentence pairs which all appeared in different pairings).

(25) plural -*s*

I bought two skirts and a bag. / I bought two skirt and a bag.

(26) third person singular -*s*

Bob works in a restaurant. / Bob work in a restaurant.

(27) progressive -*ing*

I am eating an apple. / I am eat an apple.

(28) comparative -er

She is taller than her sister. / She is tall than her sister.

(29) performance check

Luke has cleaned his room. / Luke has cleaned his office.

All experimental and filler sentences were 4 to 9 words in length and were matched for syllable length. The mean number of syllables was 6.84 for the experimental sentences and 7.0 for the filler sentences. The whole set of test sentences for this task can be found in Appendix E.

The perception judgment task was composed of 64 experimental sentence pairs and 58 filler sentence pairs, for a total of 122 sentence pairs. Due to length, this task was split into four sections, with the first two sections including 31 sentences pairs (16 experimental, 15 filler) and

the latter two involving 30 sentences pairs (16 experimental, 14 filler). Test items within each section were pseudo-randomized to ensure that no more than two experimental sentences or two filler sentences appeared in sequence and that there were no more than two "same" sentences in a row and no more than two "different" sentences in a row. After completing each section, participants were allowed to take a short break if needed. Before the main task, a practice session with 6 sentence pairs was completed. This task was completed in no more than 20 minutes in total.

The auditory stimuli were spoken by a male native speaker of North American English at a regular speaking rate. All of the experimental sentences were read with the focal stress falling on the main verb. The stimuli were recorded at a sampling rate of 44.1 kHz and were digitized and normalized for peak amplitude using Audacity software. The presentation of the auditory materials and the recording of the participants' performance were done with SuperLab software (version 4.5).

3.3.5 Language background questionnaire

The language background questionnaire included questions about participants' age, gender, first language, self-reported English proficiency test score, self-estimated English proficiency in the areas of listening, speaking, reading, and writing, major field of study, year in college, and English learning background. See Appendix F for the background questionnaire for the L2 learners and Appendix G for the background questionnaire for the native English speakers.

3.3.6 Piloting

The initial version of the four experimental tasks was piloted with eight native speakers of

English and five ESL learners (1 Turkish, 2 Korean, and 2 Chinese). These participants were similar in terms of background and English proficiency to the learner group of participants that the final experiment was administered to. After this pilot testing, all of the four experimental tasks went through major revisions.

For the story completion task, it was found that some critical verbs needed their own guided questions rather than sharing with other verbs the same guided question. This was because some participants tended to use the words with the same guided question in one single sentence. As shown in Table 13, in the original version of the story "workshop," some participants in the pilot study responded "the thunderstorm *caused* her to *wait* in the bus stop for twenty minutes." For another instance, in the original version of the story "New US experience," several participants gave such responses as "Sam *planned* to *attend* …" or "Sam *planned* to *stay* there…." These results led to the decisions that verbs such as *cause* or *plan* should not be put together with other critical verbs in the same guided question. Rather, separate guided questions should be constructed for these verbs.

Table 13. *Comparison of Original Version and Revised Version of Stories in the Story Completion Task*

Original version	Revised version
Story: Workshop After the workshop, Rachel went to the bus station to take a bus home. However, there was a severe thunderstorm later that day. *What happened? (cause / wait)*	Story: Workshop After the workshop, Rachel went to the bus station to take a bus home. However, there was a severe thunderstorm later that day. *What happened? (cause (v.))* *How long did Rachel wait? (wait)*
Story: New US experience Joe has lived in Los Angeles for several years. Last summer, his cousin, Sam, came to visit him. It was Sam's first time to travel to the United States. Sam was very excited but he does not speak English well. Sam found that there was a language program offered by the University of California, Los Angeles. *What did Sam do? (attend / rent (v.) / plan (v.) / stay)*	Story: New US experience Joe has lived in Los Angeles for several years. Last summer, his cousin, Sam, came to visit him. It was Sam's first time to travel to the United States. Sam was very excited but he did not speak English well. *What did Sam do to improve his English? (attend)* *Where did Sam live during his visit in the U.S.? (rent (v.))* *What else did Sam do during his visit in the U.S.? (plan (v.))* *How long did Sam stay in the U.S. ? (stay (v.))*

Regarding the sentence repetition task, initially, the presentation time of every test sentence on a screen was set at 3 seconds. After participants completed this task, they were asked to indicate whether they had enough time to read each sentence. Some participants mentioned that 3 seconds was not long enough to read certain sentences. After reviewing their comments and also based on the results of the pilot testing, it was decided that if the number of characters

composing a sentence was more than 30, the presentation time would be set at 4 seconds; if the number of characters was more than 25 but less than 30, the presentation time would be 3.5 seconds; otherwise, the presentation time would be 3 seconds.

With reference to the SPL task, the auditory stimuli were originally recorded by a female native speaker of North American English. Although the speaker was instructed to speak at a regular conversational speed, several of the native speaker participants pointed out that the audio recordings sounded unnatural because the speech rate was slower than normal speaking rate. Therefore, all of the auditory stimuli had to be re-recorded.

As for the perception judgment task, the original design of the filler sentences was that each filler sentence included one of the following grammatical morphemes: plural *-s*, third person singular *-s*, progressive *-ing*, comparative *-er*, and perfective. However, the researcher observed that one native speaker participant did not appear to fully attend to the materials. It was thus necessary to include some filler items that measured whether participants paid attention to the task. Due to length of time engaged in this task, it was decided to remove the filler sentences that targeted perfective aspect in order to add a new set of the so-called performance check sentences to the test.

The test sentences in the SPL and perception judgment tasks were re-recorded by a male native speaker of North American English. The modified version of the four experimental tasks was piloted with another eight native speakers of English and another five ESL learners (2 Turkish, 1 Korean, and 2 Chinese). Again, these participants were comparable in proficiency levels to the participants that the final experiment was administered to. No significant revisions were made to the content or the experimental design as a result of this pilot study, with only a few minor changes being implemented to the story completion task. These changes included the

provision of a short definition of the word *patch* (which was used in the description of the story "Jack-O-Lantern!"). Moreover, even though participants were instructed to create follow-up stories by using the given "verbs," some of them still used the verb as a noun. This observation led to the decisions that the part of speech for certain verbs (e.g., *kiss, smell, smile*, *hand* and *mail*) should be explicitly indicated as a reminder to the participants.

At the end of each pilot testing, the researcher asked the L2 participants if there were any unknown words in the test sets. In particular, they were asked whether they knew the words *splendid, rigid, arid, faint,* and *spray*. The L2 participants in the two pilot studies all reported that there were no unknown words, further confirming that target participants should know most of the target words in this study.

3.4 Procedure

Participants were tested individually with the researcher in a quiet research room at Michigan State University. First, participants read the consent form and were encouraged to ask any questions they had about the study procedures. Then, they completed the four experimental tasks in the following order: story completion, sentence repetition, self-paced listening, and perception judgment. The rationale for this order is that production tasks precede perception tasks and that meaning-oriented tasks precede form-oriented tasks for the purpose of preventing the participants for learning the true purpose of the experiment or being aware of what the researcher was trying to investigate. After completion, L2 participants were asked whether there were any unknown words in the task. Finally, all the participants filled out an exit questionnaire about their language history. The whole procedure lasted approximately 65-75 min for the L1 participants and 75-85 min for the L2 participants. A summary of the procedure is displayed in Table 14.

Table 14. *Summary of the Data Collection Procedure*

		L1 participants	L2 participants
1. Consent form		5 mins	5 mins
2. Story completion	(8 stories)	12-15 mins	15-25 mins
3. Sentence repetition	(4 practice items, 64 test items)	15 mins	15 mins
4. Self-paced listening	(6 practice items, 64 test items)	15 mins	15 mins
5. Perception judgment	(6 practice items, 122 test items)	15-20 mins	20 mins
6. Language background questionnaire		2 mins	5 mins

3.5 Analysis

Target words that were reported as unknown to L2 participants were excluded from any data analyses, affecting 0.44% of the overall data. All of the statistical analyses were carried out using SPSS ver. 19.0. The alpha for achieving statistical significance was set at .05.

3.5.1 Data coding and rating: Production tasks

The audio files of the story completion task and sentence repetition task were transcribed by two native English speakers who had received formal training in phonetics and phonology. Both had regular contact with non-native speakers of English (though not necessarily the L2 groups of interest here) so they have had previous exposure to foreign accents in English. Raters were asked to provide a broad transcription on the target words (i.e., critical verbs or monomorphemic words) and the words immediately following them. The transcriptions of the two raters were then compared. Interrater reliability was 92.3% for the story completion task and 95.7% for the sentence repetition task. The researcher resolved the discrepancies between the raters.

Regarding the story completion task, the researcher computed the suppliance rates of past

tense marking in obligatory contexts, presented as percentage accuracy scores. In cases where there were self-corrections, only the first utterances were counted; these affected 2.2% of the overall data for the story completion task. Moreover, instances where inflected regular verbs were followed by homophonic stops as in *walked to,* or interdental fricatives as in *washed the car*, were removed from analysis, which resulted in a loss of 8.4% of the data. This decision was made because word-final -t/-d in these cases could not be analyzed with confidence due to coarticulation effects. Wolfram (1985), Bayley (1996) and Hawkins and Liszka (2003) also excluded these cases from analysis in their studies.

With reference to the sentence repetition task, with the transcriptions, the researcher decided whether the past tense morpheme *-ed* was supplied or not in the case of regular past tense verbs. As for the monomorphemic words, there are no supplied/not supplied morphemes, but since the present study aimed to compare consonant cluster reduction in regular past tense verbs and monomorphemic words, monomorphemic words were rated in the same procedure as the inflected forms. For example, the monomorphemic word *list* was rated as accurate/supplied if the broad transcription was [lɪst], and as inaccurate/not supplied if it was pronounced as [lɪs]. The researcher computed the suppliance rates of word-final *-t/-d* in regular past tense verbs and monomorphemic words, presented as percentage accuracy scores. Similar to the coding procedure for the story completion task, when self-correction occurred, only the first utterance was counted; these affected 0.26% of the overall data for the sentence repetition task.

3.5.2 Data trimming and coding: Perception tasks

With regard to the SPL task, prior to the examination of the participants' reaction time (RT) data, each participant's comprehension rate was first calculated. The plan was that if a participant

had an accuracy rate lower than 80%, his or her data would be removed from any RT analysis. However, no participants were deleted due to high error rates. Following Chondrogianni, Marinis, Edwards, and Blom (2015), extreme values, namely RTs greater than 2000 ms, were eliminated, affecting 0.074% of the overall data (0.1% fell into this category for the English speakers, 0.78% for the Turkish speakers, 1.34% for the Korean speakers, 0.95% for the Chinese speakers). Participants' RTs were then screened for outliers. Following common practice in the SPL studies, RTs that were 2 standard deviations longer or shorter than a participant's mean in each condition were trimmed to the participant's mean for that condition, affecting 1.88% of the overall data (1.63% fell into this category for the English speakers, 2.43% for the Turkish speakers, 1.79% for the Korean speakers, 1.49% for the Chinese speakers).

Regarding the perception judgment task, participants were screened by their performance on the performance check sentences to verify whether they were paying attention to the task. The plan was that if a participant had an accuracy rate lower than 80% for the performance check sentences, his or her data would be excluded from further analysis. However, no participants were removed due to high error rates. Then, the mean percentage of correct responses on the experimental sentences was computed for each of the four phonetic forms of the past tense morpheme among the L2 participants and the native speaker controls.

3.5.3 Statistical analysis

3.5.3.1 Research question 1

The first research question examined whether L1 phonology and morphosyntax affect second language production of the English regular past tense morpheme across its 4 allomorphs. To answer the question, the data collected from the story completion and sentence repetition tasks

were entered into SPSS for statistical analysis. The normal distribution of the data was examined using Kolmogorov-Smirnov (K-S) tests and the homogeneity of variance was checked using Levene's test. Results revealed that normal distribution was not evident in the data of many variables and that the assumption of homogeneity of variance was violated. Therefore, non-parametric analyses were used.

To determine whether there were statistical differences in the production of the past tense morpheme *-ed* among participant groups, a Kruskal-Wallis test was performed. For the post-hoc analysis, Mann-Whitney U tests were conducted to locate sources of significance and the level of significance was adjusted with the Bonferroni method.

To further examine whether L2 learners' production of regular past tense verbs is affected by L1 phonology (recall that both Korean and Chinese speakers do not allow word-final consonant clusters while Turkish speakers do), within each group, a comparison was made between simple past forms with one-member codas (i.e., verbs ending in syllabic allomorph [əd] and non-syllabic singleton [Vd]) and simple past forms with two-member codas (i.e., verbs ending in non-syllabic allomorphs [d] and [t]). To test for significance, Wilcoxon signed rank tests were performed on the results of the production of the *-ed* inflection in cluster and non-cluster contexts by the same group of participants. Moreover, to decide whether there were statistical differences in the production of the *-ed* inflection in cluster contexts among participant groups, a Kruskal-Wallis test was conducted. For the post-hoc analysis, Mann-Whitney U tests were carried out and a Bonferroni correction was applied to adjust the level of significance.

Another way in which the transfer effect of L1 phonology can be assessed was by comparing word-final *-t/-d* in monomorphemic words and regular past tense verbs. Therefore, in the sentence repetition task, within each group, performance on simple past forms ending in

two-member codas was compared against monomorphemic words containing consonant clusters using Wilcoxon signed rank tests.

3.5.3.2 Research question 2

To answer the question of whether L1 phonology and morphosyntax affect second language perception of the English regular past tense morpheme across its 4 allomorphs, the data collected from the perception judgment task were entered into SPSS for statistical analysis. One-way ANOVA was subsequently conducted, with group (English, Turkish, Korean, Chinese) serving as the independent variable, and accuracy rates in the perception judgment task serving as the dependent variable. In cases of significant *F* ratios, post-hoc Games-Howell tests were conducted to locate the sources of significance.

To further investigate whether L2 learners' perception of past tense morpheme *-ed* is affected by L1 phonology, the results of the perception judgment task were broken down by cluster type (one-member codas versus two-member codas). Then, within each group, performance on the following two conditions was compared: (a) simple past forms with one-member codas (i.e., verbs ending in syllabic allomorph [əd] and non-syllabic singleton [Vd]), and (b) simple past forms with two-member codas (i.e., verbs ending in non-syllabic allomorphs [d] and [t]). As the Kolmogorov-Smirnov (K-S) tests revealed non-normal distribution of many variables, non-parametric Wilcoxon signed rank tests were performed on the results of each group separately. Moreover, to decide whether there were statistical differences in the perception of the *-ed* inflection in cluster contexts among participant groups, a non-parametric Kruskal-Wallis test was run, followed by Mann-Whitney U tests to compare the pairs of groups. A Bonferroni correction was applied to adjust the significance level.

3.5.3.3 Research question 3

To answer the question of whether the phonetic form of the regular verbs affects second language production of English past tense morphology, the results of the story completion and sentence repetition tasks were each broken down by allomorph type (syllabic [əd], non-syllabic allomorph [d], non-syllabic allomorph [t], non-syllabic singleton [Vd]). Within each group, percentage accuracy scores of each allomorph type in the story completion task were then compared using non-parametric Friedman tests to identify if any of the four allomorph types was more accurately produced than others. When the result of the Friedman tests was significant, Wilcoxon signed rank tests were conducted as post-hoc tests and the significance level was adjusted with the Bonferroni method. The same analysis procedure was applied to the sentence repetition data.

3.5.3.4 Research question 4

To answer the question of whether the phonetic form of the regular verbs affects second language perception of English past tense morphology, the results of the perception judgment task were broken down by allomorph type (syllabic [əd], non-syllabic allomorph [d], non-syllabic allomorph [t], non-syllabic singleton [Vd]). As the Kolmogorov-Smirnov (K-S) tests showed non-normal distribution of many variables, non-parametric Friedman tests were performed on the results of each group separately to identify if any of the four allomorph types was better perceived than others. For the post-hoc analysis, Wilcoxon signed rank tests were carried out and a Bonferroni correction was applied to adjust the significance level.

Concerning the SPL task, for each allomorph type and region of interest, mean RTs were submitted to a 4×2 mixed-design ANOVA with Group (English, Turkish, Korean, Chinese) as the

between-subjects variable and Grammaticality (grammatical, ungrammatical) as the within-subjects variable in the by-subjects (F_1) and by-items (F_2) analysis. For all ANOVAs, effect sizes were calculated using partial eta squared (η^2_{part}). Analyses that showed a significant interaction between Group and Grammaticality were followed up with paired-samples t-tests. ANOVAs were performed not only on critical and spill-over regions of the sentences but also on non-critical regions.

3.5.3.5 Research question 5

The final research question probed the relationship between second language perception and production of the regular past tense morpheme. To answer this question, the data collected from the perception judgment and sentence repetition tasks were entered into SPSS for statistical analysis. As the data of many variables were not normally distributed, Spearman's rho rank correlation coefficients were calculated for each learner group separately. Correlation coefficients were also calculated for each of the four allomorphs.

CHAPTER 4: RESULTS

4.1 Story Completion Task

As detailed in section 3.3.1, the stimuli of the story completion task contained 32 regular past tense verbs (including 8 verbs ending in syllabic [əd], 8 ending in non-syllabic [d], 8 ending in non-syllabic [t], and 8 ending in non-syllabic singleton [Vd]).

4.1.1 Past tense production: Overall comparison

The first comparison across groups involves all simple past forms combined (the four allomorphs of English regular past tense morpheme). Descriptive statistics for simple past tense marking in obligatory contexts are displayed in Table 15. As shown, the native English speakers had a 97.58% accuracy rate. It is interesting to note that the native controls did not achieve 100% accuracy (in both the story completion and sentence repetition tasks). Such results could have been due to a number of factors, such as participants' boredom, lack of attention, test effects, and the result of articulation that was not audible by the coder(s). Among the L2 groups, the Turkish group supplied past tense morphology at around 87.6%. The Korean group seems to perform similarly to the Turkish group (M = 86.48%), while the Chinese group provided past tense morphology at a lower rate as compared to the other two learner groups (M = 68.83%).

Table 15. *Mean Percentages of Past Tense Production in the Story Completion Task*

	English	Turkish	Korean	Chinese
Mean	97.58%	87.59%	86.48%	68.83%
SD	3.04%	14.83%	16.27%	17.75%

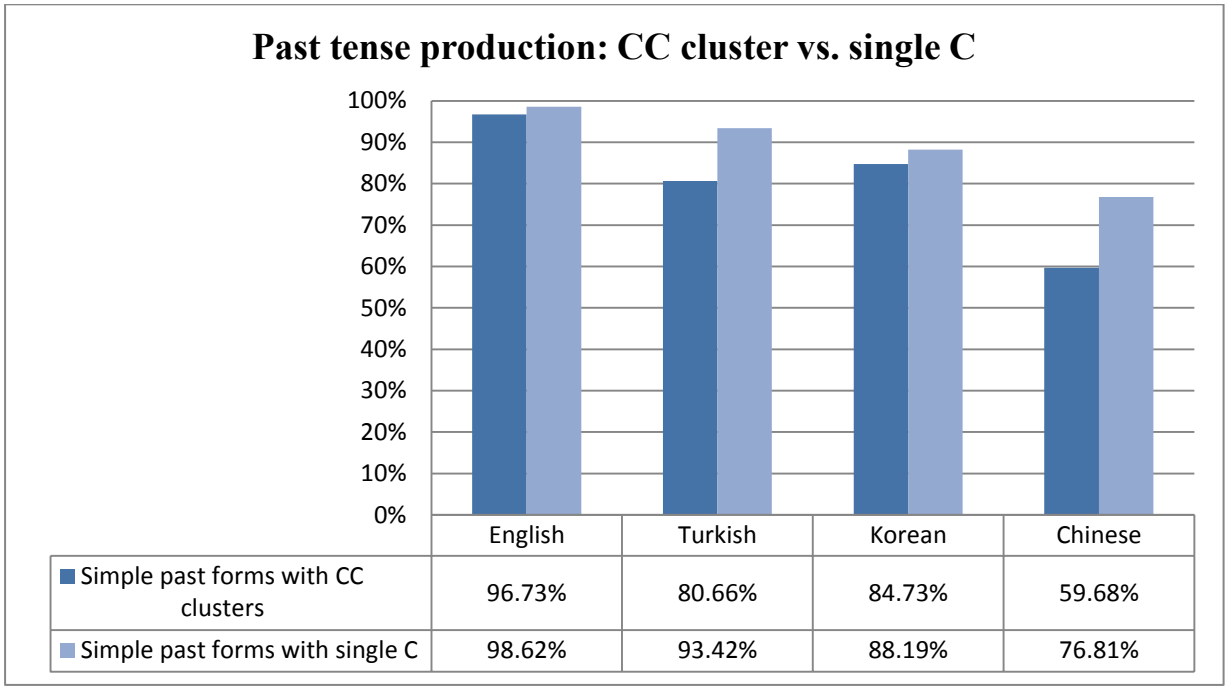
To test for significance among groups, a Kruskal-Wallis test was performed. The results indicated significant differences among groups, $\chi^2(3) = 41.509$, $p < .001$. According to post-hoc

Mann-Whitney tests, significance was located between the native speaker and Turkish groups (p = .012), between the native speaker and Korean groups (p = .006), and between the native speaker and Chinese groups (p = .001). Comparisons among L2 groups also revealed significant differences of the Chinese group with both the Turkish and Korean groups (p = .001 in both cases), and no significant differences were found between the Turkish and Korean groups (p = 1).

4.1.2 Past tense production: Cluster type (consonant cluster and non-cluster)

To check if the variable use of past tense morphology and the observed differences among the participant groups can be associated with L1 phonological constraints related to consonant clusters, comparisons were made between simple past forms with one-member codas (i.e., verbs ending in syllabic allomorph [əd] and non-syllabic singleton [Vd], e.g., *shouted* and *snowed*, respectively) and simple past forms with two-member codas (i.e., verbs ending in non-syllabic allomorphs [d] and [t], e.g., *filled* and *missed*, respectively). Figure 9 gives the overall trend of the comparisons just mentioned (consonant cluster versus a single consonant).

Figure 9. Production of Past Tense *-ed* Broken Down by Consonant Clusters and Single Consonants in the Story Completion Task



	English	Turkish	Korean	Chinese
Simple past forms with CC clusters	96.73%	80.66%	84.73%	59.68%
Simple past forms with single C	98.62%	93.42%	88.19%	76.81%

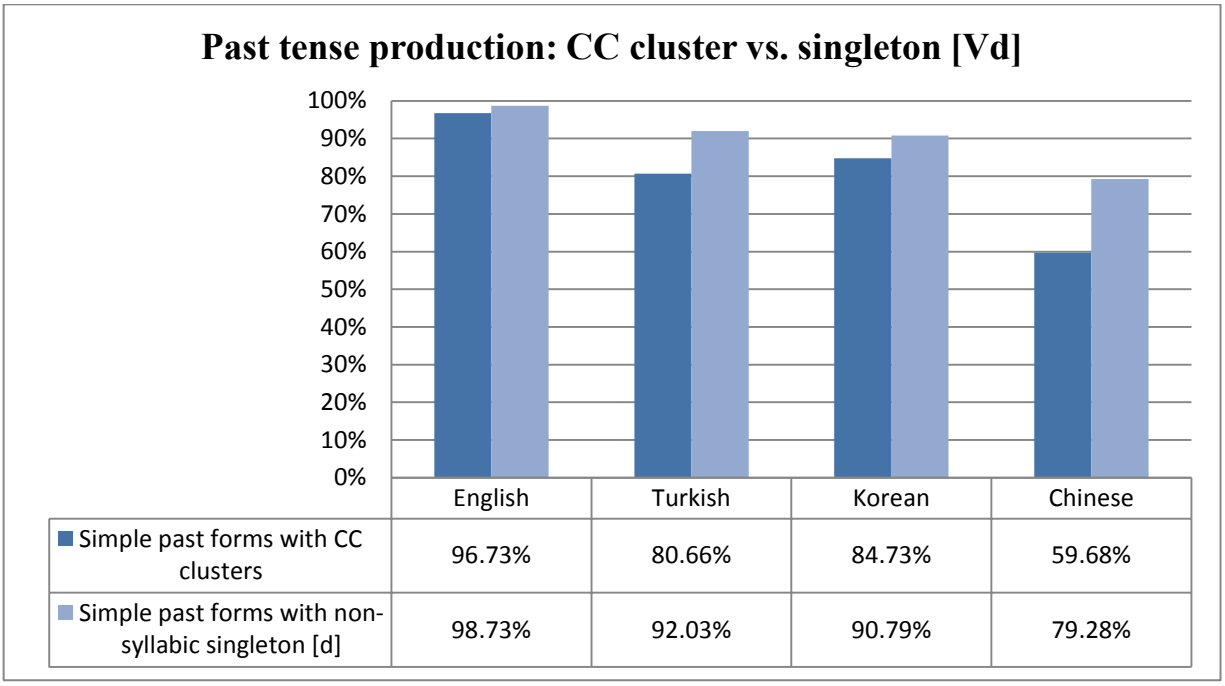
As shown in Figure 9, when producing regular verbs ending in consonant clusters, the native controls had a 96.72% accuracy rate, followed by the Korean and Turkish groups (84.73% and 80.66%, respectively). The Chinese group had an accuracy rate around 60%. To decide whether these differences were significant, a Kruskal-Wallis test was conducted. The results indicated significant differences among groups, $\chi^2(3) = 39.975$, $p < .001$. Post-hoc testing (Mann-Whitney tests) revealed that significance was located between the native speaker and Turkish groups ($p = .006$), between the native speaker and Korean groups ($p = .012$), and between the native speaker and Chinese groups ($p = .001$). Comparisons among L2 groups also showed significant differences of the Chinese group with both the Turkish and Korean groups ($p = .006$ and $p = .001$, respectively). No significant differences were found between the Turkish and Korean groups ($p = .723$).

Figure 9 also shows that the production of the past tense morpheme *-ed* is seemingly

higher in verbs ending in a single consonant than verbs with consonant clusters, especially in the performance of the Turkish and Chinese groups. These two conditions were analyzed using Wilcoxon signed rank tests within each participant group. The results indicated that accuracy on simple past forms ending in a single consonant was significantly higher than accuracy on simple past forms ending in consonant clusters for the Turkish group ($Z = -3.622$, $p < .001$) and the Chinese group ($Z = -3.652$, $p < .001$). However, the difference between the production of the *-ed* inflection in cluster and non-cluster contexts was not significant in the performance of the native controls ($Z = -1.479$, $p = .139$) and the Korean group ($Z = -1.2$, $p = .23$).

It is possible that accuracy scores were higher on verbs ending in a single consonant than verbs with consonant clusters due to the syllabicity effect of the syllabic allomorph [əd] (i.e., the allomorph [əd] is its own syllable). A complete syllable "would seem to be more salient than a final segment, particularly a segment that is usually the final element of a consonant cluster and therefore subject to deletion" (Bayley, 1994, p. 171). To avoid this confound and to further decide whether consonant clusters are challenging by themselves, additional comparisons were made between simple past forms with two-member codas and simple past forms taking non-syllabic singleton [Vd] (e.g., *snowed*). Figure 10 presents the results of these comparisons (consonant cluster versus non-syllabic singleton [Vd]).

Figure 10. Production of Past Tense *-ed* Broken Down by Consonant Clusters and Non-Syllabic Singleton [Vd] in the Story Completion Task



	English	Turkish	Korean	Chinese
Simple past forms with CC clusters	96.73%	80.66%	84.73%	59.68%
Simple past forms with non-syllabic singleton [d]	98.73%	92.03%	90.79%	79.28%

As can be seen in Figure 10, there is a visual asymmetry between the rates of suppliance, with simple past forms ending in singleton [Vd] at a much higher rate, especially in the case of the Turkish and Chinese groups. The visual difference was confirmed by the results of Wilcoxon signed rank tests (the Turkish group: $Z = -3.623$, $p < .001$; the Chinese group: $Z = -3.734$, $p < .001$). For the Korean group, unlike the results of previous analysis comparing simple past forms ending in consonant clusters with simple past forms ending in a single consonant, the difference between simple past forms with consonant clusters and simple past forms taking singleton [Vd] approached significance ($Z = -1.852$, $p = .06$). For the native controls, again, accuracy on simple past forms ending in singleton [Vd] was not significantly higher than accuracy on simple past forms ending in consonant clusters ($Z = -1.053$, $p = .292$).

4.1.3 Past tense production: Allomorph type

As mentioned before, the regular past tense morpheme has four allomorphs. The story completion task contained equal number of verbs representing each of the four variants. One of the research questions examined whether the phonetic form of the regular verbs affects the production of English past tense morphology. The results of the production of the *-ed* inflection in these four allomorphs by four participant groups are presented in Table 16.

Table 16. *Production of Past Tense -ed by Allomorph Type in the Story Completion Task*

	English	Turkish	Korean	Chinese
Syllabic allomorph [əd]	98.58% (4.82%)	95.04% (9.28%)	85.55% (22.8%)	74.35% (26.47%)
Non-syllabic allomorph [d]	98.76% (4.12%)	83.08% (22.97%)	90.84% (15.34%)	57.17% (22.07%)
Non-syllabic allomorph [t]	94.64% (10.95%)	78.49% (19.38%)	79.91% (23.57%)	62.54% (27.4%)
Non-syllabic singleton [Vd]	98.73% (4.25%)	92.03% (14.08%)	90.79% (18.82%)	79.28% (16.96%)

Note. Standard deviations are in parentheses.

As shown in Table 16, the production of the non-syllabic allomorph [t] was lower than that of other allomorphs. To determine statistical significance, Friedman tests were performed on the accuracy scores for each participant group separately and the results showed the following:

- For the native controls, there were no significant differences in the production of the past tense morpheme *-ed* across the four allomorphs ($\chi^2(3) = 3.19$, $p = .363$).
- For the Turkish group, there was a significant difference in the production of the past tense morpheme *-ed* across the four allomorphs ($\chi^2(3) = 21.389$, $p < .001$). Post-hoc Wilcoxon signed rank tests (Bonferroni corrected) showed that the production of the non-syllabic allomorph [t] was significantly lower than that of the syllabic [əd] ($Z = -3.193$, $p = .006$)

and the non-syllabic singleton [Vd] (Z = -3.194, p = .006). The difference between the production of the non-syllabic allomorph [d] and that of the syllabic [əd] (Z = -2.552, p = .066) and the non-syllabic singleton [Vd] also approached significance (Z = -2.449, p = .084). There were no significant differences between the results of any of the other combinations (ps > .10).

- For the Korean group, there was a marginally significant difference in the production of the past tense morpheme *-ed* across the four allomorphs ($\chi^2(3) = 7.409$, p = .06). Post-hoc Wilcoxon signed rank tests (Bonferroni corrected) showed that the difference between the production of the non-syllabic allomorph [t] and that of the non-syllabic singleton [Vd] approached significance (Z = -2.555, p = .066). There were no significant differences between the results of any of the other combinations (ps > .10).
- For the Chinese group, there was a significant difference in the production of the past tense morpheme *-ed* across the four allomorphs ($\chi^2(3) = 18.142$, $p < .001$). Post-hoc Wilcoxon signed rank tests (Bonferroni corrected) showed that the production of the non-syllabic allomorph [d] was significantly lower than that of the syllabic [əd] (Z = -3.043, p = .012) and the non-syllabic singleton [Vd] (Z = -3.34, p = .006). Moreover, the production of the non-syllabic allomorph [t] was significantly lower than that of the non-syllabic singleton [Vd] (Z = -2.713, p = .042). There were no significant differences between the results of any of the other combinations (ps > .10).

4.2 Sentence Repetition Task

As described in section 3.3.2, the stimuli of the sentence repetition task contained 32 regular past tense verbs (including 8 verbs ending in syllabic [əd], 8 ending in non-syllabic [d], 8

ending in non-syllabic [t], and 8 ending in non-syllabic singleton [Vd]) and 32 monomorphemic words (including 16 words ending in one-member codas and 16 words ending in two-member codas).

4.2.1 Past tense production: Overall comparison

As with the story completion task, the first comparison across groups involves the suppliance rates of past tense morphology. As shown in Table 17, the native controls performed at ceiling level (98.51% accuracy), and all L2 groups supplied past tense morphology with accuracy over 90%. Compared with the story completion task, all L2 groups provided past morphology at a higher rate, especially in the case of the Chinese group; moreover, there was less variation in all groups, as suggested by the smaller standard deviations.

Table 17. *Mean Percentages of Past Tense Production in the Sentence Repetition Task*

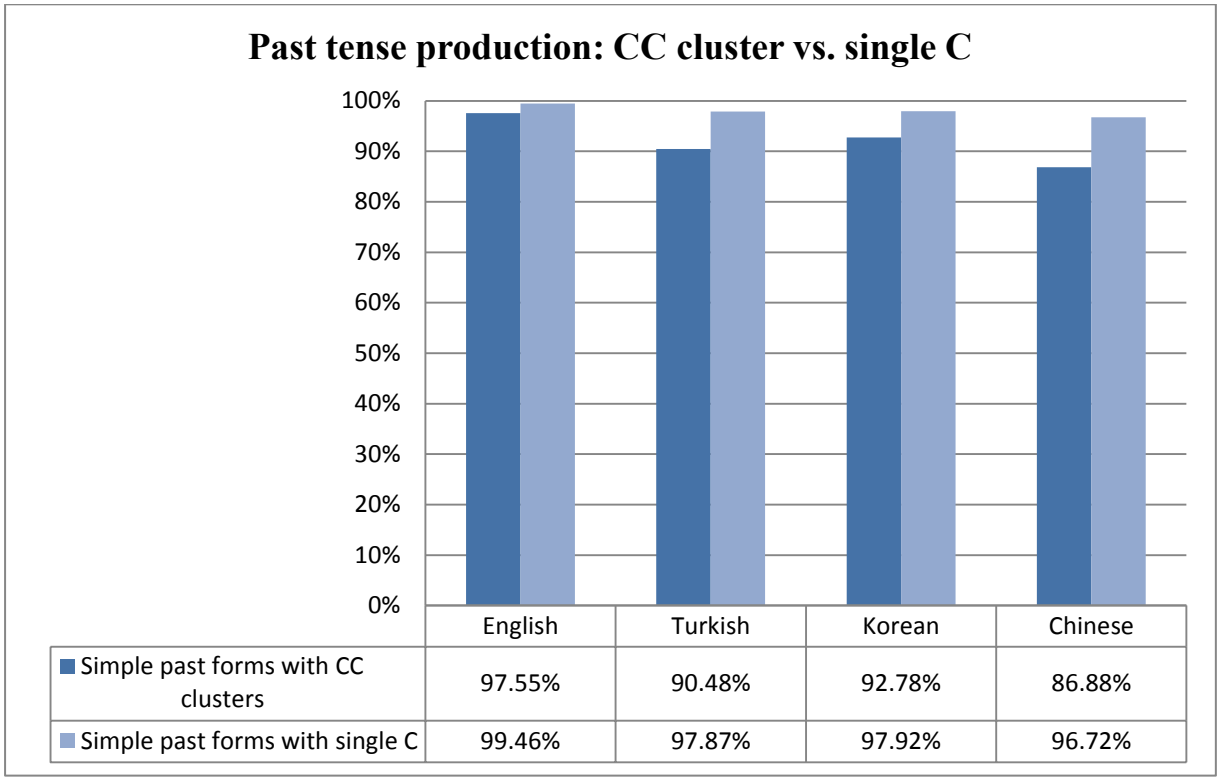
	English	Turkish	Korean	Chinese
Mean	98.51%	94.2%	95.48%	91.78%
SD	(2.81%)	(4.68%)	(5.83%)	(8.17%)

A Kruskal-Wallis test was conducted to compare the percentages of suppliance across groups. The results showed significant differences among groups, $\chi^2(3) = 16.093$, $p = .001$. Post-hoc Mann-Whitney tests revealed significant differences of the native control group with both the Turkish and Chinese groups ($p = .006$ in both cases), but no significant differences with the Korean group ($p = .192$). Among the learner groups, no significant differences were found ($ps > .10$).

4.2.2 Past tense production: Cluster type (consonant cluster and non-cluster)

Similar to the analysis of the story completion task results, comparisons were made between simple past forms with one-member codas and simple past forms with two-member codas. This was done by combining the results of non-syllabic allomorphs [d] and [t] (e.g., *filled* and *missed*, respectively) on the one hand and those of syllabic [əd] and non-syllabic singleton [Vd] (e.g., *shouted* and *snowed*, respectively) on the other. Figure 11 demonstrates these comparisons.

Figure 11. Production of Past Tense *-ed* Broken Down by Consonant Clusters and Single Consonants in the Sentence Repetition Task



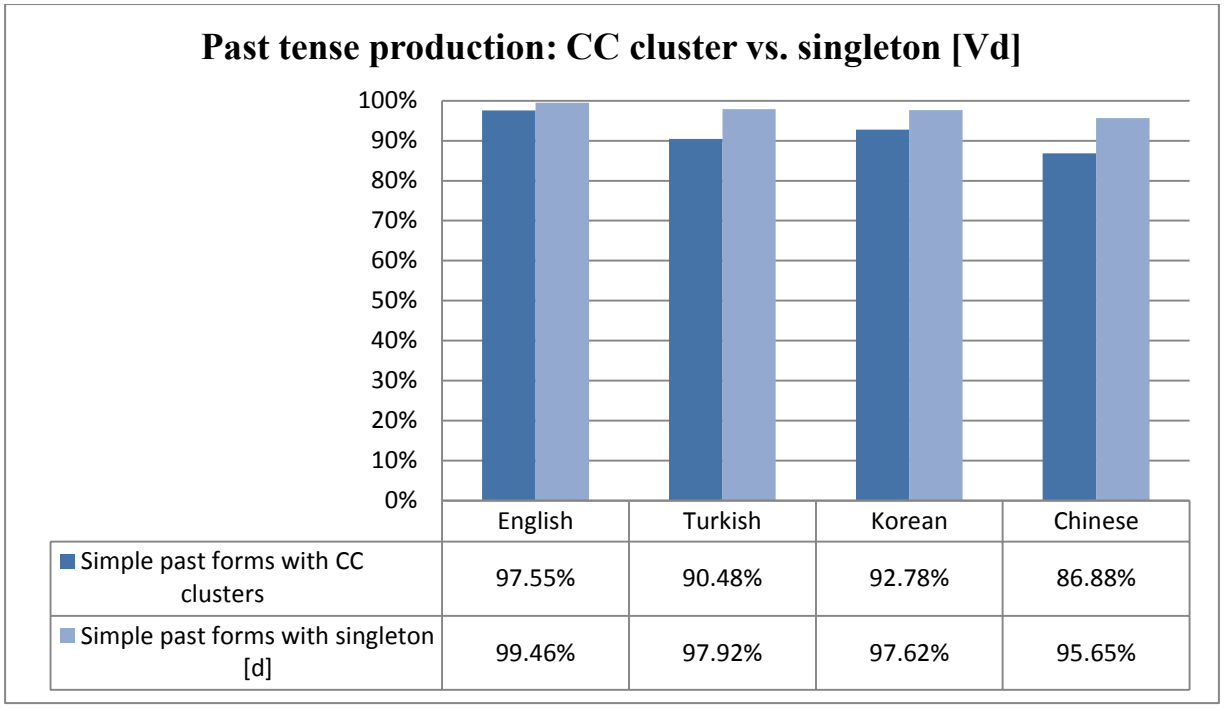
	English	Turkish	Korean	Chinese
Simple past forms with CC clusters	97.55%	90.48%	92.78%	86.88%
Simple past forms with single C	99.46%	97.87%	97.92%	96.72%

Figure 11 shows that in the sentence repetition task, the native controls had a 97.55% accuracy rate in producing simple past forms ending in consonant clusters. Among the learner groups, the high-to-low order of accuracy rates was the Korean group (92.78%) followed by the Turkish group (90.48%), which, in turn, was followed by the Chinese group (86.88%). To decide whether these differences were significant, a Kruskal-Wallis test was carried out. The results indicated significant differences among groups, $\chi^2(3) = 15.878$, $p = .001$. According to post-hoc Mann-Whitney tests, significance was located between the native speaker and Turkish groups ($p = .006$) and between the native speaker and Chinese groups ($p = .006$), but not between the native speaker and Korean groups ($p = .174$). Comparisons among L2 groups revealed no significant differences ($ps > .10$), suggesting similar performance among them.

As can be seen in Figure 11, the three learner groups produced the past tense morpheme *-ed* slightly higher in verbs ending in a single consonant than verbs with consonant clusters. To test for significance, Wilcoxon signed rank tests were conducted on the results of each group separately. The results indicated that accuracy on simple past forms ending in a single consonant was significantly higher than accuracy on simple past forms ending in consonant clusters for the Turkish group (Z = -3.216, p = .001), the Korean group (Z = -2.795, p = .005), and the Chinese group (Z = -3.383, p = .001). For the native controls, the difference between the production of the *-ed* inflection in cluster and non-cluster contexts approached significance (Z = -1.897, p = .058).

As was also done for the results of the story completion task, additional comparisons were made between simple past forms with two-member codas and simple past forms taking non-syllabic singleton [Vd] (e.g., *snowed*). Figure 12 shows these comparisons visually.

Figure 12. Production of Past Tense *-ed* Broken Down by Consonant Clusters and Non-Syllabic Singleton [Vd] in the Sentence Repetition Task



	English	Turkish	Korean	Chinese
Simple past forms with CC clusters	97.55%	90.48%	92.78%	86.88%
Simple past forms with singleton [d]	99.46%	97.92%	97.62%	95.65%

As Figure 12 demonstrates, the Turkish and Chinese groups produced the past tense morpheme *-ed* slightly higher in verbs ending in non-syllabic singleton [Vd] than verbs with consonant clusters. These two conditions were analyzed using Wilcoxon signed rank tests for each participant group separately. The results revealed that the accuracy rates were significantly higher in simple past forms ending in singleton [Vd] than simple past forms ending in consonant clusters for all participant groups (the native controls: $Z = -2.121$, $p = .034$); the Turkish group: $Z = -2.972$, $p = .003$; the Korean group: $Z = -2.374$, $p = .019$; the Chinese group: $Z = -2.304$, $p = .021$).

4.2.3 Consonant clusters in regular past tense verbs and monomorphemes

In order to further determine whether L1 phonology plays a role in second language production of English regular past tense, accuracy rates of simple past forms with two-member codas (e.g., *filled* and *missed*) were compared against monomorphemic words containing consonant clusters (e.g., *field* and *mist*). Results are presented in Table 18. As shown, L2 learners' performance on monomorphemic words with consonant clusters was around 92%-97% accuracy level; in addition, monomorphemic words with consonant clusters appear to be more accurately produced than simple past forms with consonant clusters for all of the three learner groups. On the other hand, the native controls' performance was similar in these two conditions.

Table 18. *Accuracy Rates of Regular Past Tense Verbs with Consonant Clusters and Monomorphemes with Consonant Clusters in the Sentence Repetition Task*

	English	Turkish	Korean	Chinese
Simple past forms with CC clusters	97.55% (4.89%)	90.48% (7.7%)	92.78% (9.62%)	86.88% (13.58%)
Monomorphemes with CC clusters	98.1% (2.94%)	97.07% (3.39%)	96.98% (5.49%)	91.99% (8.65%)

Note. Standard deviations are in parentheses.

To check for significance, Wilcoxon signed rank tests were run on the results of each group separately. The results showed that the rate of accuracy was not affected by the type of word for the native controls (Z = -.258, p = .796). Among the L2 groups, accuracy on monomorphemic words with consonant clusters was significantly higher than accuracy on simple past forms ending in consonant clusters for the Turkish group (Z = -2.916, p = .004). However, for the other two learner groups, there was no significant contrast between monomorphemic words with consonant clusters and simple past forms ending in consonant clusters (the Korean group: Z = -1.647, p = .10; the Chinese group: Z = -1.661, p = .097), suggesting that there are no statistical differences in the production of consonant clusters when they involve morphology (simple past tense) or are part of the monomorpheme.

4.2.4 Past tense production: Allomorph type

The results of the sentence repetition task were broken down by allomorph type of the *-ed* morpheme in order to examine whether the phonetic form of the regular verbs is a factor in the production of English past tense morphology. Table 19 summarizes the results of the production of the *-ed* inflection in its four allomorphs by the four participant groups.

Table 19. *Production of Past Tense -ed by Allomorph Type in the Sentence Repetition Task*

	English	Turkish	Korean	Chinese
Syllabic allomorph [əd]	99.46% (2.61%)	97.92% (4.79%)	98.21% (5.98%)	97.83% (4.84%)
Non-syllabic allomorph [d]	98.91% (3.6%)	94.15% (8.35%)	95.24% (7.37%)	84.78% (17.66%)
Non-syllabic allomorph [t]	96.2% (6.98%)	86.81% (11.72%)	90.22% (13.89%)	89.13% (16.56%)
Non-syllabic singleton [Vd]	99.46% (2.61%)	97.92% (6.43%)	97.62% (5.03%)	95.65% (9.69%)

Note. Standard deviations are in parentheses.

As Table 19 shows, similar to the results of the story completion task, the production of the non-syllabic allomorph [t] was lower than that of other allomorphs in the sentence repetition task. To determine if any allomorph was easier or more difficult to produce by these participants, Friedman tests were conducted on the accuracy rates of production of the four allomorphs for each participant group separately. The results showed the following:

- For the native controls, there was a significant difference in the production of the past tense morpheme *-ed* across the four allomorphs ($\chi^2(3) = 10.2$, $p = .017$). Post-hoc Wilcoxon signed rank tests (Bonferroni corrected) showed that the difference between the production of the non-syllabic allomorph [t] and that of the non-syllabic allomorph [d] approached significance ($Z = -2.236$, $p = .15$). There were no significant differences between the results of any of the other combinations ($ps > .20$).
- For the Turkish group, there was a significant difference in the production of the past tense morpheme *-ed* across the four allomorphs ($\chi^2(3) = 16.107$, $p = .001$). Post-hoc Wilcoxon signed rank tests (Bonferroni corrected) showed that the production of the non-syllabic allomorph [t] was significantly lower than the production of the syllabic [əd] ($Z = -2.818$, p

= .03) and the non-syllabic singleton [Vd] (Z = -2.859, p = .024). There were no significant differences between the results of any of the other combinations (ps > .10).

- For the Korean group, there was a significant difference in the production of the past tense morpheme *-ed* across the four allomorphs ($\chi^2(3) = 15.489$, p = .001). Post-hoc Wilcoxon signed rank tests (Bonferroni corrected) showed that the production of the non-syllabic allomorph [t] was significantly lower than that of the syllabic [əd] (Z = -2.911, p = .024). In addition, the difference between the production of the non-syllabic allomorph [t] and that of the non-syllabic singleton [Vd] approached significance (Z = -2.401, p = .096). There were no significant differences between the results of any of the other combinations (ps > .10).
- For the Chinese group, there was a significant difference in the production of the past tense morpheme *-ed* across the four allomorphs ($\chi^2(3) = 16.099$, p = .001). Post-hoc Wilcoxon signed rank tests (Bonferroni corrected) showed that the production of the non-syllabic allomorph [d] was significantly lower than the production of the syllabic [əd] (Z = -3.097, p = .012) and the non-syllabic singleton [Vd] (Z = -2.675, p = .042). Moreover, the production of the non-syllabic allomorph [t] was significantly lower than that of the syllabic [əd] (Z = -2.654, p = .048). There were no significant differences between the results of any of the other combinations (ps > .10).

4.2.5 Self-Corrections

In both the story completion and sentence repetition tasks, a few L2 participants were found to show some instances of self-corrections on the target words. Most of the time it was wrong the first time, with a few cases where the first utterances were right. Table 20 displays the

incidence of self-corrections occurred in each of the two oral production tasks and the rate of whether the participants got it right on the second time. There were 56 instances of self-corrections observed in the story completion task compared to only 14 instances in the sentence repetition task. As Table 20 shows, the L2 participants did not always produce the words correctly on the second try. In addition, compared with the results of the story completion task, the L2 participants had a higher chance of producing the correct responses on the second time in the sentence repetition task. However, there is a caveat here because the number of self-corrections was relatively small in the sentence repetition task, so interpretations should be made with caution.

Table 20. *Frequency of Self-Corrections on the Target Verbs in the Story Completion and Sentence Repetition Tasks*

Task	L1	Number of self-corrections	Second try accuracy rate
Story completion	Turkish	3/8	37.5%
	Korean	5/10	50%
	Chinese	21/38	55.3%
	All L2 participants	29/56	51.8%
Sentence repetition	Turkish	2/3	66.7%
	Korean	3/4	75%
	Chinese	5/7	71.4%
	All L2 participants	10/14	71.4%

4.3 Self-Paced Listening Task

Prior to the analysis of the participants' RT data, accuracy on the end-of-trial comprehension questions was first analyzed. Table 21 provides the overview of the mean percentages of correct responses to the comprehension questions. As shown in Table 21, specifically, accuracy on comprehension question following the experimental items was 98.37%

for the native controls, 95.49% for the Turkish group, 94.79% for the Korean group, and 94.43% for the Chinese group. One-way ANOVA indicated significant differences among groups, $F(3, 81) = 4.544$, $p = .005$. The Games-Howell post-hoc tests revealed that the Turkish, Korean and Chinese groups had significantly lower accuracy in the comprehension questions following experimental items than the native controls ($p = .043$, $p = .016$, and $p = .005$, respectively). Among the learner groups, L2 participants did not differ from each other (ps > .10). No participants were removed from subsequent RT analysis due to high error rates.

Table 21. *Mean Percentages of Correct Responses to Comprehension Questions in the SPL task*

	English	Turkish	Korean	Chinese
Accuracy on questions following experimental items	98.37% (1.6%)	95.49% (4.04%)	94.79% (4.77%)	94.43% (4.8%)
Accuracy on questions following filler items	97.96% (2.92%)	95.66% (4.81%)	93.9% (3.89%)	94.43% (4.42%)
Overall Accuracy	98.17% (1.74%)	95.57% (3.84%)	94.35% (3.81%)	94.43% (3.52%)

Note. Standard deviations are in parentheses.

4.3.1 Past tense perception: Syllabic allomorph [əd]

An overview of participants' mean RTs at each region for sentences targeting syllabic allomorph [əd] (e.g., *shouted*) is provided in Table 22. The mean RTs for each region across sentence types are plotted for the native control, Turkish, Korean and Chinese groups in Figure 13, 14, 15 and 16, respectively.

Table 22. *Mean RTs and Standard Deviations for Grammatical and Ungrammatical Sentences Targeting Syllabic Allomorph [əd] by Region and Group*

		Region			
L1	Sentence Type	1	2	3	4
English Group	Grammatical	257	238	270	338
(N=23)		(101)	(102)	(115)	(104)
	Ungrammatical	241	262	303	357
		(96)	(105)	(96)	(141)
Turkish Group	Grammatical	269	266	365	429
(N=18)		(103)	(130)	(157)	(203)
	Ungrammatical	332	323	403	433
		(139)	(173)	(209)	(207)
Korean Group	Grammatical	300	330	417	442
(N=21)		(96)	(175)	(176)	(250)
	Ungrammatical	336	433	465	477
		(149)	(264)	(205)	(188)
Chinese Group	Grammatical	310	374	385	479
(N=23)		(135)	(215)	(156)	(206)
	Ungrammatical	295	398	407	505
		(148)	(188)	(174)	(210)

Note. All RTs are given in milliseconds; standard deviations are in parentheses.

Figure 13. Mean RTs for Sentences Targeting Syllabic Allomorph [əd] for the English Group

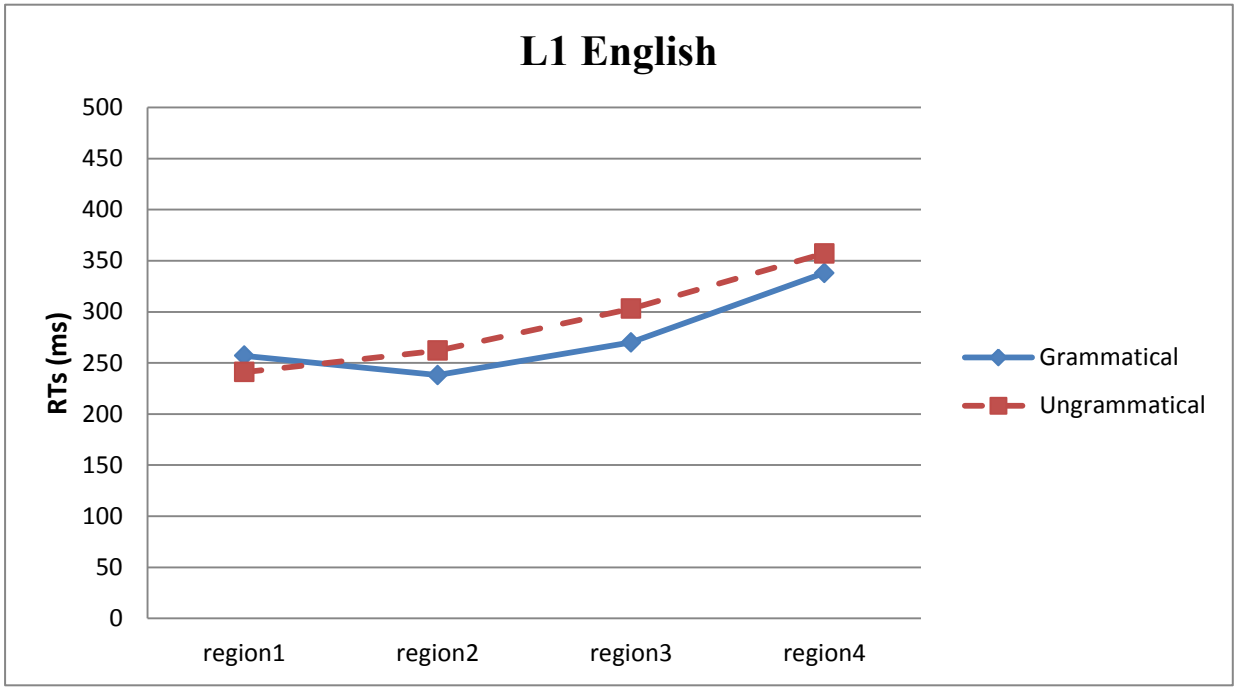


Figure 14. Mean RTs for Sentences Targeting Syllabic Allomorph [əd] for the Turkish Group

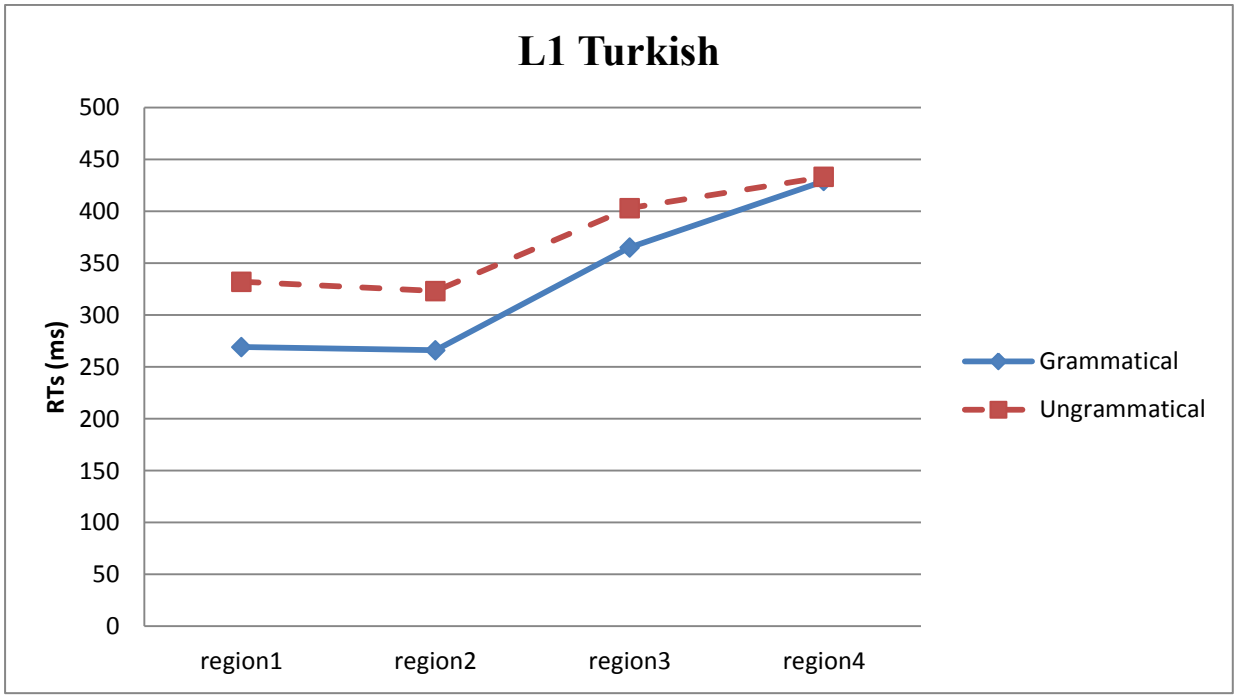


Figure 15. Mean RTs for Sentences Targeting Syllabic Allomorph [əd] for the Korean Group

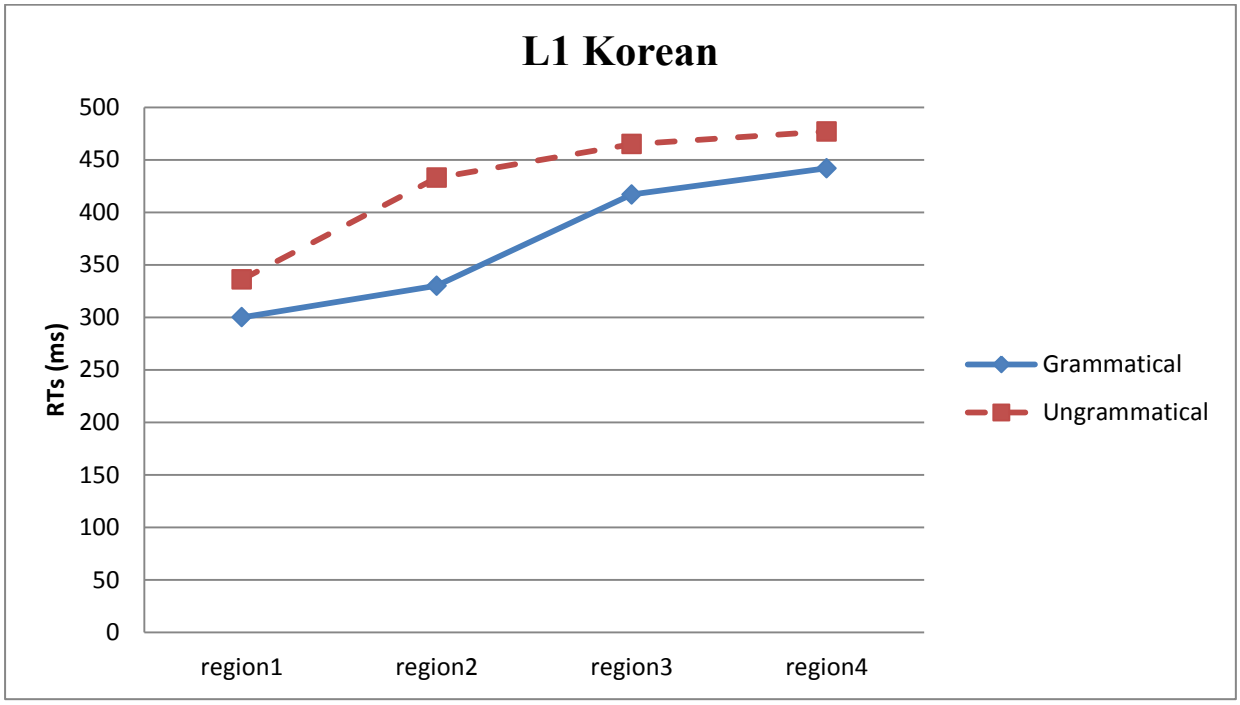
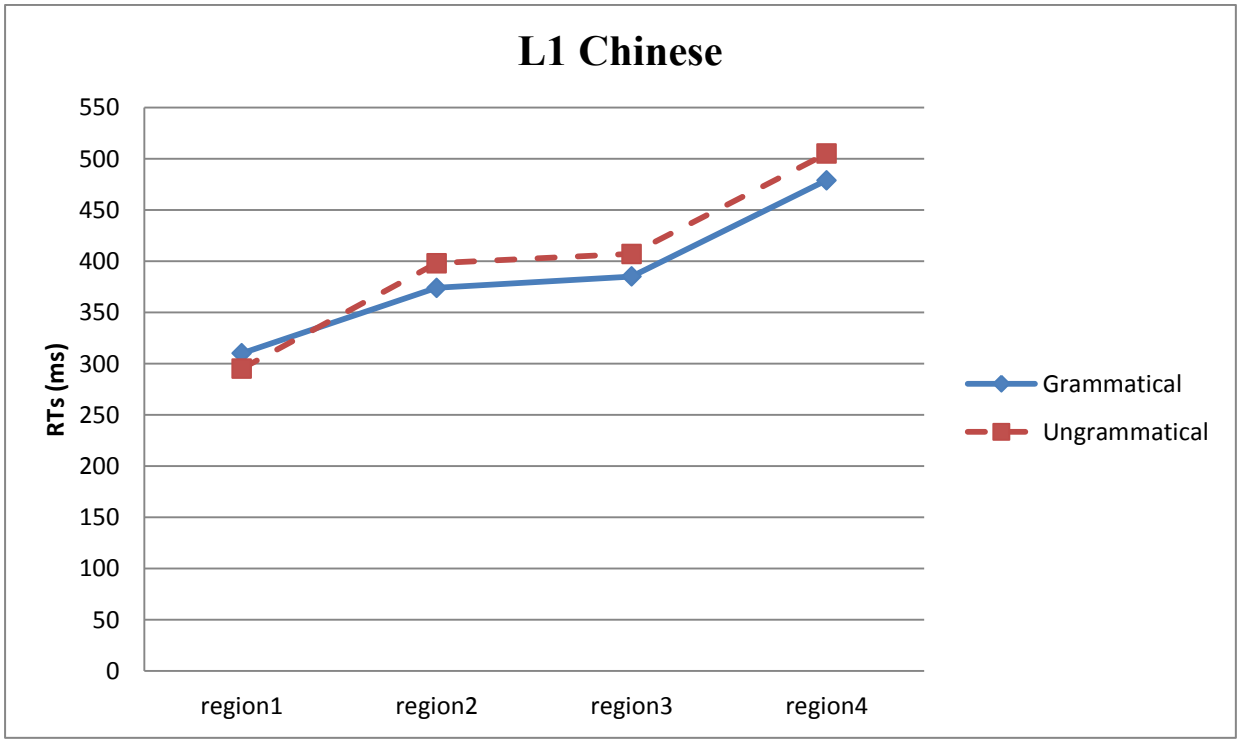


Figure 16. Mean RTs for Sentences Targeting Syllabic Allomorph [əd] for the Chinese Group



For the pre-critical region (region 1), the mixed-design ANOVA revealed no effect of Group in the subjects analysis and a marginally significant effect in the items analysis ($F_1(3, 81) = 1.7$, $p = .174$, $\eta^2_{part} = .059$; $F_2(1.477, 10.338)$[20] $= 4.22$, $p = .055$, $\eta^2_{part} = .376$). No significant effect of Grammaticality was found ($F_1(1, 81) = 1.87$, $p = .176$, $\eta^2_{part} = .023$; $F_2(1, 7) = .35$, $p = .575$, $\eta^2_{part} = .047$), and the interaction between Group and Grammaticality was not significant either ($F_1(3, 81) = 2.36$, $p = .078$, $\eta^2_{part} = .08$; $F_2(3, 21) = 1.58$, $p = .223$, $\eta^2_{part} = .184$).

For the critical region (region 2), the mixed-design ANOVA showed an effect of Group ($F_1(3, 81) = 4.33$, $p = .007$, $\eta^2_{part} = .138$; $F_2(3, 21) = 8.18$, $p = .001$, $\eta^2_{part} = .539$). There was a main effect of Grammaticality in the subjects analysis only ($F_1(1, 81) = 6.78$, $p = .011$, $\eta^2_{part} = .077$; $F_2(1,7) = 1.51$, $p = .26$, $\eta^2_{part} = .177$), reflecting longer RTs for ungrammatical sentences compared to grammatical sentences. However, there was no significant interaction between Group and Grammaticality ($F_1(3, 81) = .91$, $p = .443$, $\eta^2_{part} = .032$; $F_2(3, 21) = .82$, $p = .50$, $\eta^2_{part} = .104$), which suggests similar performance among the participant groups at this region.

For the spillover region (region 3), there was a main effect of Group ($F_1(3, 81) = 4.38$, $p = .007$, $\eta^2_{part} = .139$; $F_2(3, 21) = 7.59$, $p = .001$, $\eta^2_{part} = .52$). The main effect of Grammaticality was significant for subjects but not for items ($F_1(1, 81) = 4.99$, $p = .028$, $\eta^2_{part} = .058$; $F_2(1,7) = .2$, $p = .668$, $\eta^2_{part} = .028$), which reflects that RTs were longer at this region for ungrammatical sentences than for grammatical sentences. The analysis revealed no significant interaction between Group and Grammaticality ($F_1(3, 81) = .13$, $p = .95$, $\eta^2_{part} = .005$; $F_2(3, 21) = .89$, $p = .462$, $\eta^2_{part} = .113$), suggesting similar performance among the participant groups at this region.

For the post-spillover region (region 4), the ANOVA showed a main effect of Group ($F_1(3, 81) = 3.2$, $p = .028$, $\eta^2_{part} = .106$; $F_2(3, 21) = 3.07$, $p = .05$, $\eta^2_{part} = .305$), which indicates that the

[20] The assumption of sphericity was violated, and therefore Greenhouse-Geisser is reported (Field, 2009).

native controls had shorter RTs than the L2 groups. There was no main effect of Grammaticality ($F_1(1, 81) = 1.002$, $p = .32$, $\eta^2_{part} = .012$; $F_2(1, 7) = .004$, $p = .951$, $\eta^2_{part} = .001$) and no significant interaction between Group and Grammaticality ($F_1(3, 81) = .09$, $p = .968$, $\eta^2_{part} = .003$; $F_2(1.483, 10.381) = .78$, $p = .447$, $\eta^2_{part} = .1$).

4.3.2 Past tense perception: Non-syllabic allomorph [d]

Table 23 provides an overview of participants' mean RTs at each region for sentences targeting non-syllabic allomorph [d] (e.g., *filled*). The results from the native control, Turkish, Korean and Chinese groups are plotted in Figure 17, 18, 19 and 20, respectively.

Table 23. *Mean RTs and Standard Deviations for Grammatical and Ungrammatical Sentences Targeting Non-Syllabic Allomorph [d] by Region and Group*

		Region			
L1	Sentence Type	1	2	3	4
English Group	Grammatical	277	284	269	334
(N=23)		(111)	(154)	(108)	(128)
	Ungrammatical	263	278	263	358
		(116)	(120)	(112)	(149)
Turkish Group	Grammatical	291	328	340	396
(N=18)		(142)	(136)	(156)	(162)
	Ungrammatical	322	335	377	473
		(188)	(124)	(188)	(173)
Korean Group	Grammatical	303	395	434	471
(N=21)		(134)	(170)	(216)	(210)
	Ungrammatical	321	445	368	449
		(93)	(246)	(111)	(193)
Chinese Group	Grammatical	282	437	470	483
(N=23)		(121)	(213)	(264)	(187)
	Ungrammatical	298	423	473	470
		(159)	(184)	(227)	(207)

Note. All RTs are given in milliseconds; standard deviations are in parentheses.

Figure 17. Mean RTs for Sentences Targeting Non-Syllabic Allomorph [d] for the English Group

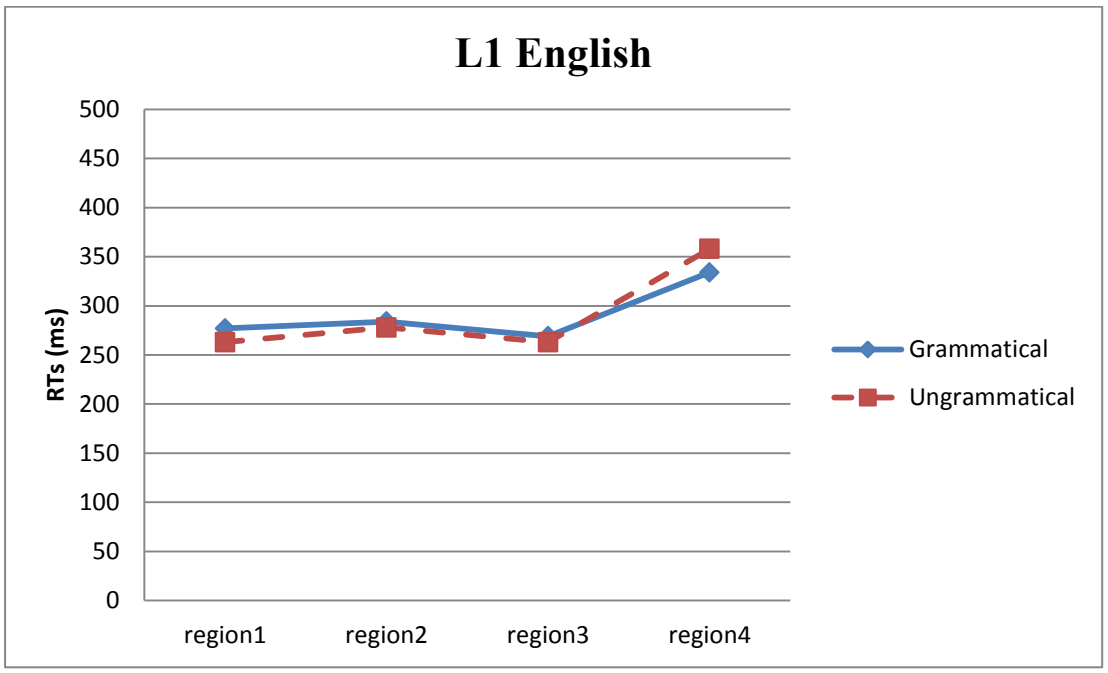


Figure 18. Mean RTs for Sentences Targeting Non-Syllabic Allomorph [d] for the Turkish Group

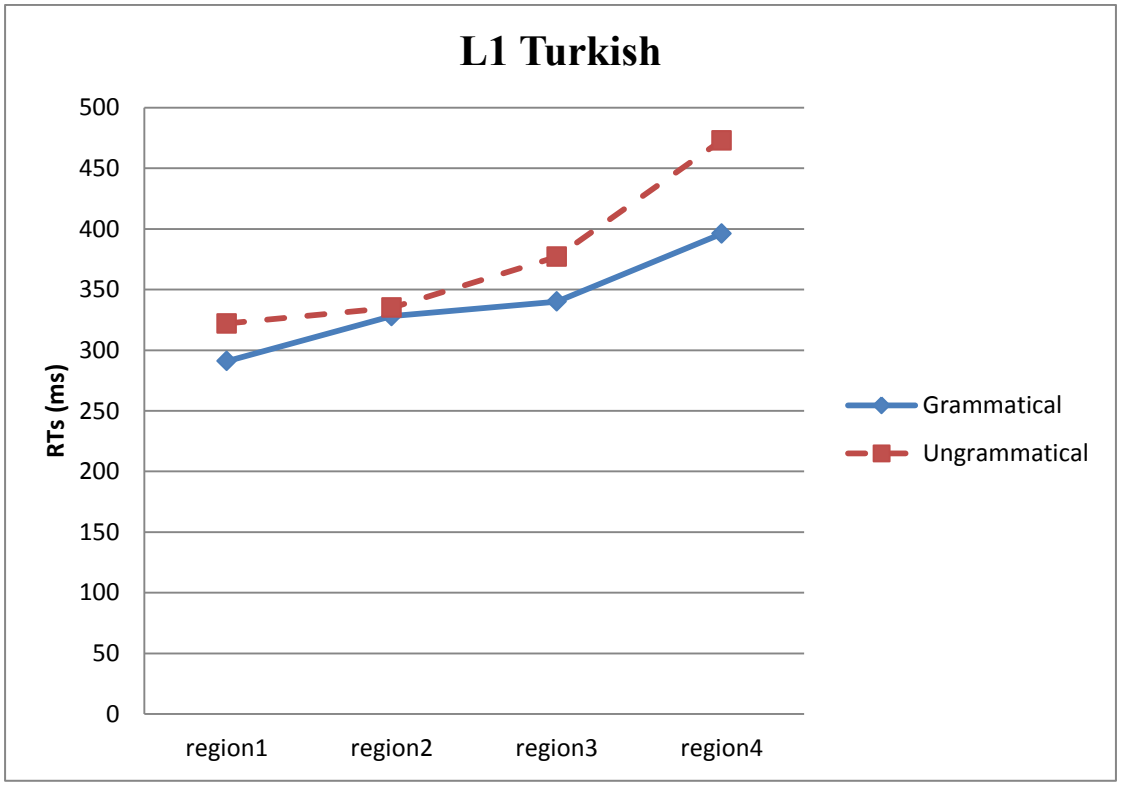


Figure 19. Mean RTs for Sentences Targeting Non-Syllabic Allomorph [d] for the Korean Group

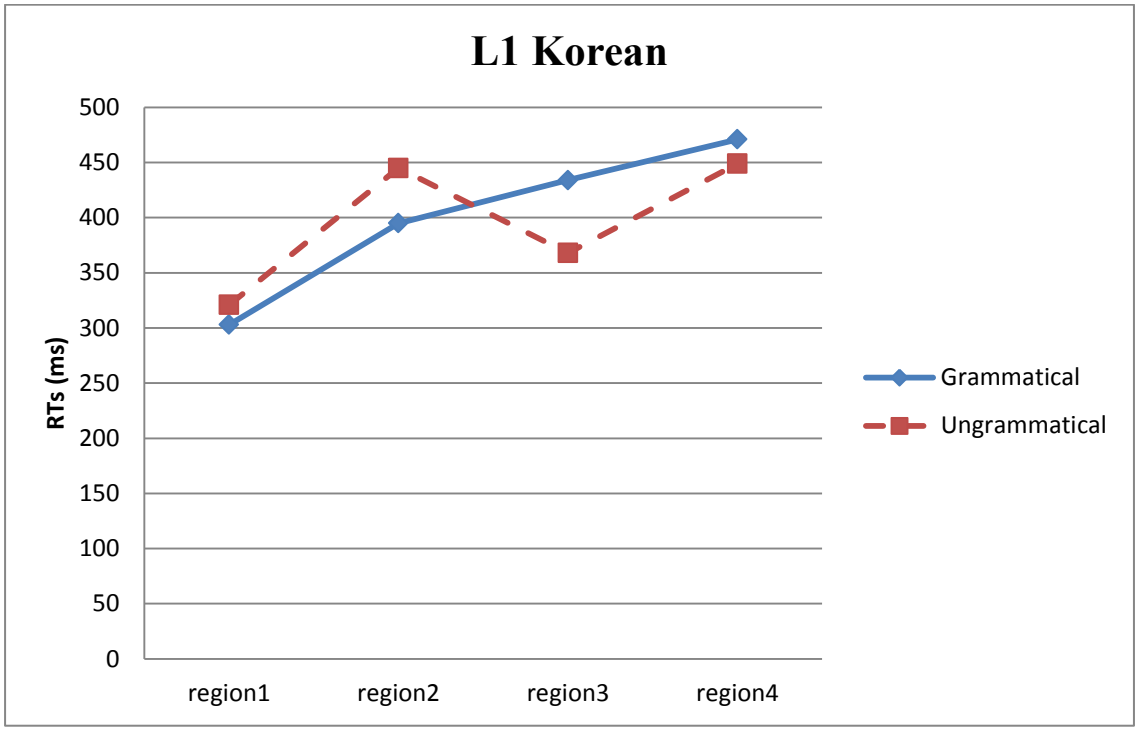
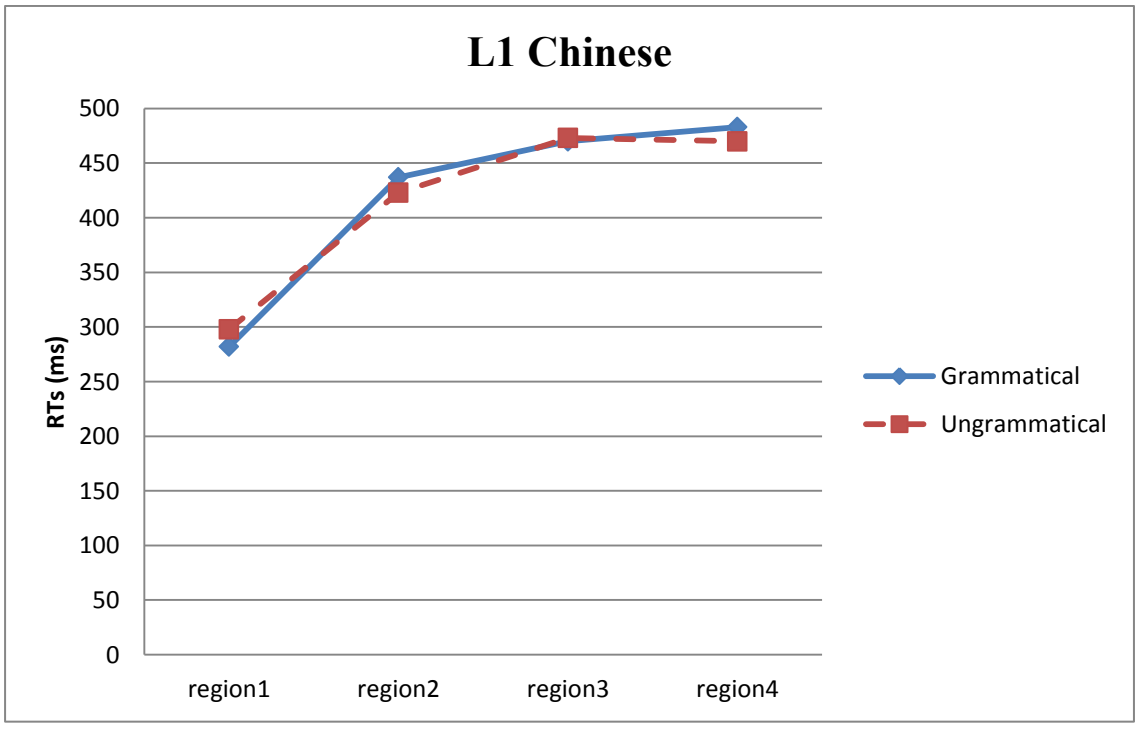


Figure 20. Mean RTs for Sentences Targeting Non-Syllabic Allomorph [d] for the Chinese Group



For the pre-critical region (region 1), the mixed-design ANOVA showed no effect of Group ($F_1(3, 81) = .54$, $p = .654$, $\eta^2_{part} = .02$; $F_2(3, 21) = 2.71$, $p = .071$, $\eta^2_{part} = .279$), no effect of Grammaticality ($F_1(1, 81) = .996$, $p = .321$, $\eta^2_{part} = .012$; $F_2(1, 7) = .016$, $p = .903$, $\eta^2_{part} = .002$), and no significant interaction between Group and Grammaticality ($F_1(3, 81) = .55$, $p = .652$, $\eta^2_{part} = .02$; $F_2(3, 21) = .98$, $p = .421$, $\eta^2_{part} = .123$).

For the critical region (region 2), the mixed-design ANOVA revealed a main effect of Group ($F_1(3, 81) = 5.19$, $p = .002$, $\eta^2_{part} = .161$; $F_2(3, 21) = 4.85$, $p = .01$, $\eta^2_{part} = .409$). No significant effect of Grammaticality was found ($F_1(1, 81) = .21$, $p = .645$, $\eta^2_{part} = .003$; $F_2(1, 7) = .2$, $p = .668$, $\eta^2_{part} = .028$), and the interaction between Group and Grammaticality was not significant either ($F_1(3, 81) = .54$, $p = .654$, $\eta^2_{part} = .02$; $F_2(3, 21) = 1.01$, $p = .407$, $\eta^2_{part} = .126$).

For the spillover region (region 3), there was a main effect of Group ($F_1(3, 81) = 7.66$, $p < .001$, $\eta^2_{part} = .221$; $F_2(3, 21) = 10.15$, $p < .001$, $\eta^2_{part} = .592$). However, there was no main effect of Grammaticality ($F_1(1, 81) = .12$, $p = .733$, $\eta^2_{part} = .001$; $F_2(1,7) = .042$, $p = .844$, $\eta^2_{part} = .006$) and no significant interaction between Group and Grammaticality ($F_1(3, 81) = .83$, $p = .483$, $\eta^2_{part} = .03$; $F_2(3, 21) = .72$, $p = .552$, $\eta^2_{part} = .093$).

For the post-spillover region (region 4), the ANOVA showed a main effect of Group ($F_1(3, 81) = 3.28$, $p = .025$, $\eta^2_{part} = .108$; $F_2(3, 21) = 6.83$, $p = .002$, $\eta^2_{part} = .494$). No significant effect of Grammaticality was found ($F_1(1, 81) = .74$, $p = .392$, $\eta^2_{part} = .009$; $F_2(1, 7) = .026$, $p = .877$, $\eta^2_{part} = .004$), and the interaction between Group and Grammaticality was not significant either ($F_1(3, 81) = 1.2$, $p = .316$, $\eta^2_{part} = .043$; $F_2(3,21) = 1.003$, $p = .411$, $\eta^2_{part} = .125$).

4.3.3 Past tense perception: Non-syllabic allomorph [t]

An overview of participants' mean RTs at each region for sentences targeting non-syllabic

allomorph [t] (e.g., *kissed*) is shown in Table 24. The mean RTs for each region across sentence types are plotted for the native control, Turkish, Korean and Chinese groups in Figure 21, 22, 23 and 24, respectively.

Table 24. *Mean RTs and Standard Deviations for Grammatical and Ungrammatical Sentences Targeting Non-Syllabic Allomorph [t] by Region and Group*

		Region			
L1	Sentence Type	1	2	3	4
English Group	Grammatical	284	268	297	300
(N=23)		(133)	(141)	(100)	(114)
	Ungrammatical	261	264	301	295
		(121)	(120)	(115)	(112)
Turkish Group	Grammatical	291	416	475	380
(N=18)		(131)	(181)	(290)	(180)
	Ungrammatical	284	422	383	444
		(145)	(207)	(186)	(220)
Korean Group	Grammatical	344	380	434	381
(N=21)		(128)	(201)	(159)	(177)
	Ungrammatical	299	440	424	449
		(108)	(185)	(191)	(243)
Chinese Group	Grammatical	306	421	370	426
(N=23)		(109)	(194)	(171)	(248)
	Ungrammatical	300	427	416	448
		(153)	(216)	(176)	(244)

Note. All RTs are given in milliseconds; standard deviations are in parentheses.

Figure 21. Mean RTs for Sentences Targeting Non-Syllabic Allomorph [t] for the English Group

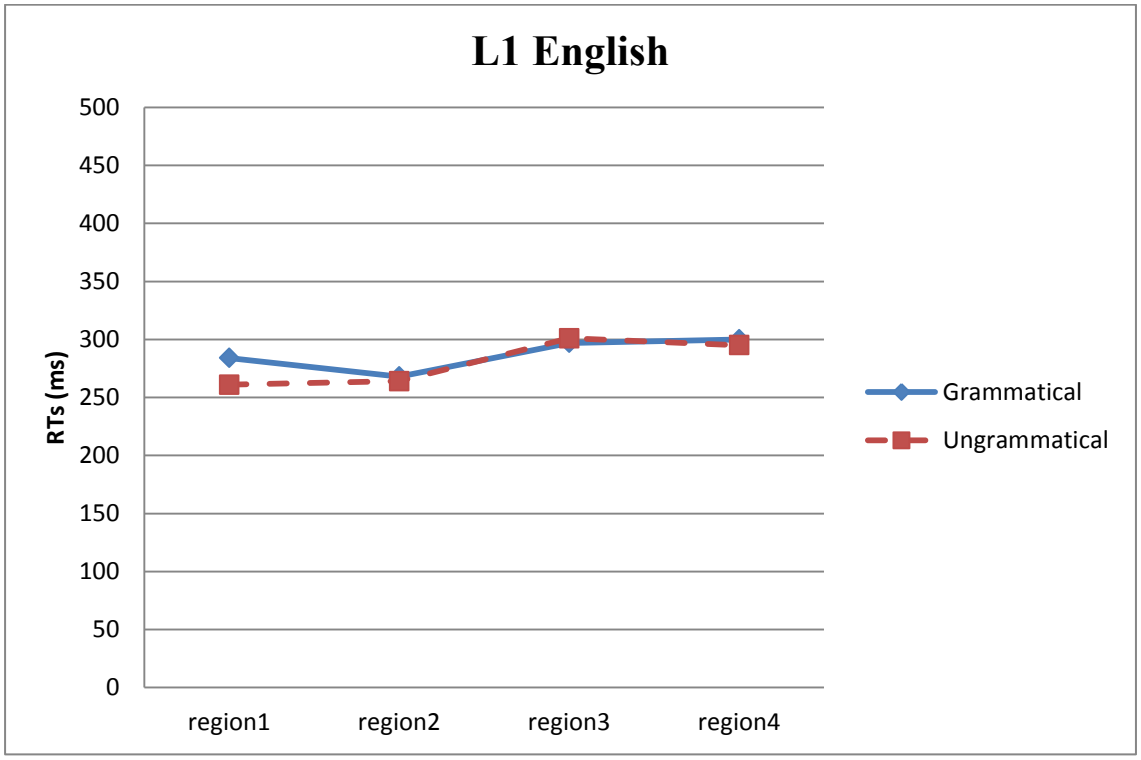


Figure 22. Mean RTs for Sentences Targeting Non-Syllabic Allomorph [t] for the Turkish Group

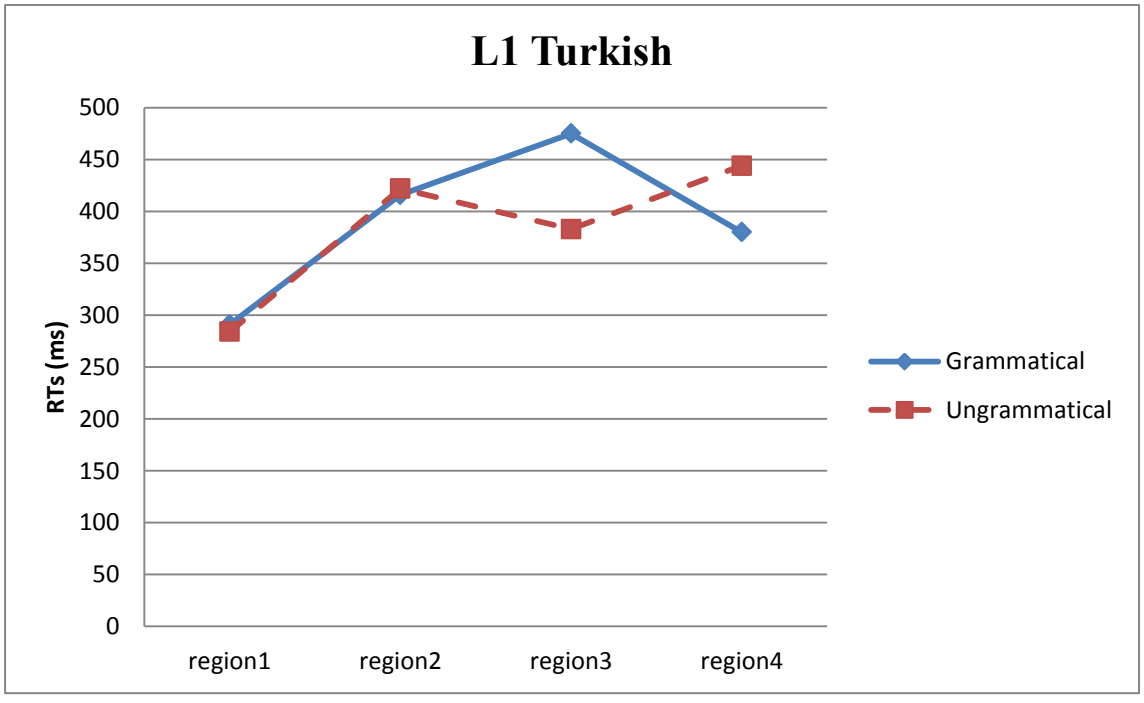


Figure 23. Mean RTs for Sentences Targeting Non-Syllabic Allomorph [t] for the Korean Group

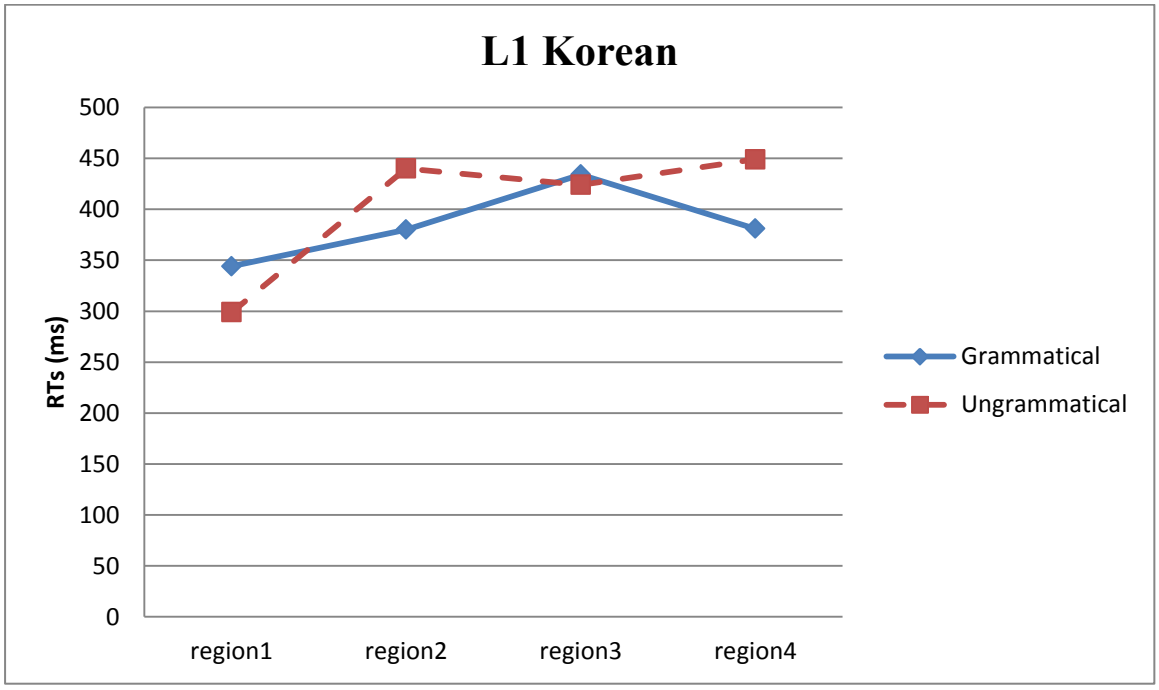
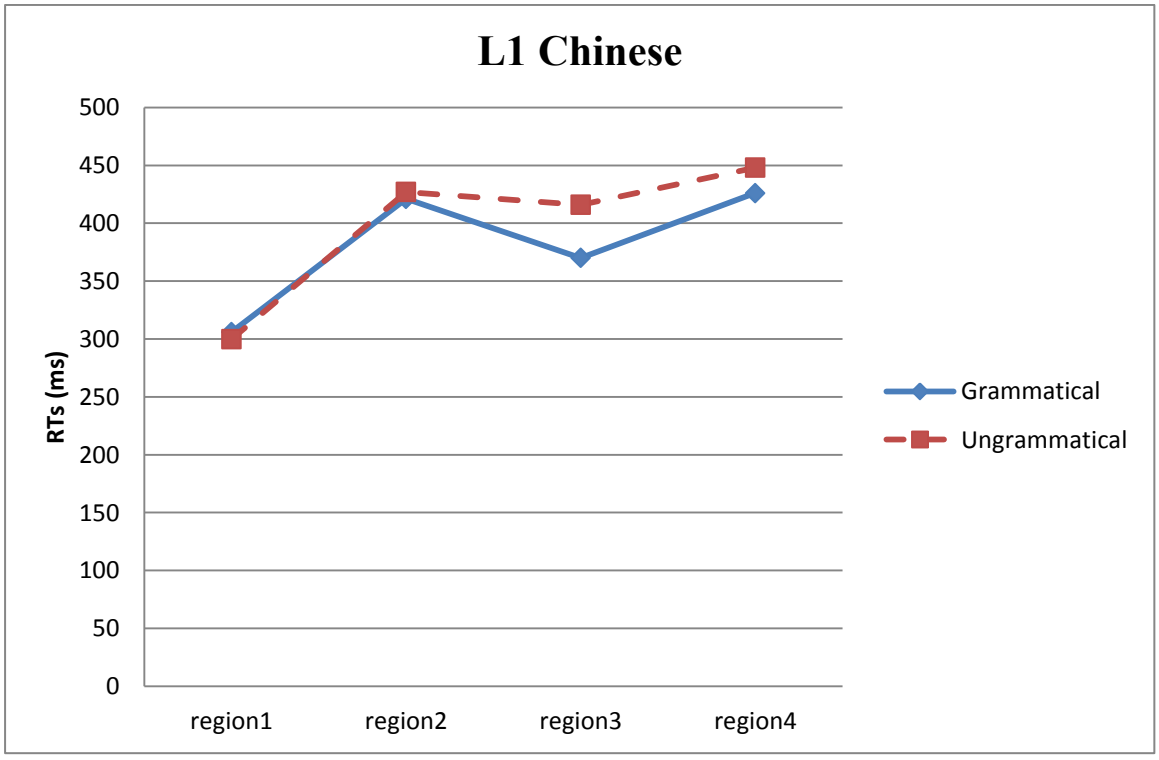


Figure 24. Mean RTs for Sentences Targeting Non-Syllabic Allomorph [t] for the Chinese Group



For the pre-critical region (region 1), the mixed-design ANOVA revealed a main effect of Group in the items analysis only ($F_1(3, 81) = .71$, $p = .252$, $\eta^2_{part} = .025$; $F_2(3, 21) = 3.36$, $p = .038$, $\eta^2_{part} = .324$). There was no effect of Grammaticality ($F_1(1, 81) = 2.66$, $p = .107$, $\eta^2_{part} = .032$; $F_2(1, 7) = .39$, $p = .552$, $\eta^2_{part} = .053$) and no significant interaction ($F_1(3, 81) = .51$, $p = .676$, $\eta^2_{part} = .019$; $F_2(3, 21) = .296$, $p = .828$, $\eta^2_{part} = .041$).

For the critical region (region 2), the analysis showed a main effect of Group ($F_1(3, 81) = 5.5$, $p = .002$, $\eta^2_{part} = .17$; $F_2(3, 21) = 6.78$, $p = .002$, $\eta^2_{part} = .492$). The main effect of Grammaticality was not significant ($F_1(1, 81) = .61$, $p = 437$, $\eta^2_{part} = .007$; $F_2(1, 7) = .15$, $p = .707$, $\eta^2_{part} = .021$) and did not interact with Group ($F_1(3, 81) = .45$, $p = .716$, $\eta^2_{part} = .016$; $F_2(3, 21) = .38$, $p = .767$, $\eta^2_{part} = .052$).

For the spillover region (region 3), there was a main effect of Group ($F_1(3, 81) = 3.27$, $p = .025$, $\eta^2_{part} = .108$; $F_2(3, 21) = 9.06$, $p < .001$, $\eta^2_{part} = .564$), but an effect of Grammaticality was not found ($F_1(1, 81) = .61$, $p = .435$, $\eta^2_{part} = .008$; $F_2(1,7) = .015$, $p = .905$, $\eta^2_{part} = .002$). There was a significant interaction between Group and Grammaticality in the subject analysis only ($F_1(3, 81) = 2.72$, $p = .05$, $\eta^2_{part} = .092$; $F_2(3, 21) = .962$, $p = .222$, $\eta^2_{part} = .121$). Subsequent pairwise comparisons using paired-samples t-tests revealed that this interaction was due to the fact that the Turkish group had significantly longer RTs in grammatical sentences compared to ungrammatical sentences ($t_1(17) = 2.065$, $p = .055$; $t_2(7) = .882$, $p = .207$), but the other three participant groups did not ($ps > .10$).

For the post-spillover region (region 4), the ANOVA revealed a main effect of Group ($F_1(3, 81) = 3.05$, $p = .033$, $\eta^2_{part} = .102$; $F_2(3, 21) = 7.52$, $p = .001$, $\eta^2_{part} = .518$). There was no significant effect of Grammaticality ($F_1(1, 81) = 2.93$, $p = .091$, $\eta^2_{part} = .035$; $F_2(1, 7) = .11$, $p = .749$, $\eta^2_{part} = .016$). The interaction between Group and Grammaticality was not significant

either ($F_1(3, 81) = .648$, $p = .586$, $\eta^2_{part} = .023$; $F_2(3,21) = .95$, $p = .437$, $\eta^2_{part} = .119$).

4.3.4 Past tense perception: Non-syllabic singleton [Vd]

Table 25 provides an overview of participants' mean RTs at each region for sentences targeting non-syllabic singleton [Vd] (e.g., *snowed*). The results from the native control, Turkish, Korean and Chinese groups are plotted in Figure 25, 26, 27 and 28, respectively.

Table 25. *Mean RTs and Standard Deviations for Grammatical and Ungrammatical Sentences Targeting Non-Syllabic Singleton [Vd] by Region and Group*

		Region			
L1	Sentence Type	1	2	3	4
English Group	Grammatical	261	229	283	301
(N=23)		(121)	(130)	(120)	(121)
	Ungrammatical	261	244	290	306
		(113)	(154)	(138)	(141)
Turkish Group	Grammatical	313	314	338	340
(N=18)		(142)	(137)	(162)	(141)
	Ungrammatical	306	324	353	345
		(166)	(144)	(186)	(176)
Korean Group	Grammatical	340	281	366	331
(N=21)		(138)	(124)	(176)	(140)
	Ungrammatical	317	398	399	388
		(105)	(248)	(199)	(240)
Chinese Group	Grammatical	316	360	339	299
(N=23)		(152)	(184)	(129)	(108)
	Ungrammatical	301	374	384	333
		(134)	(191)	(190)	(147)

Note. All RTs are given in milliseconds; standard deviations are in parentheses.

Figure 25. Mean RTs for Sentences Targeting Non-Syllabic Singleton [Vd] for the English Group

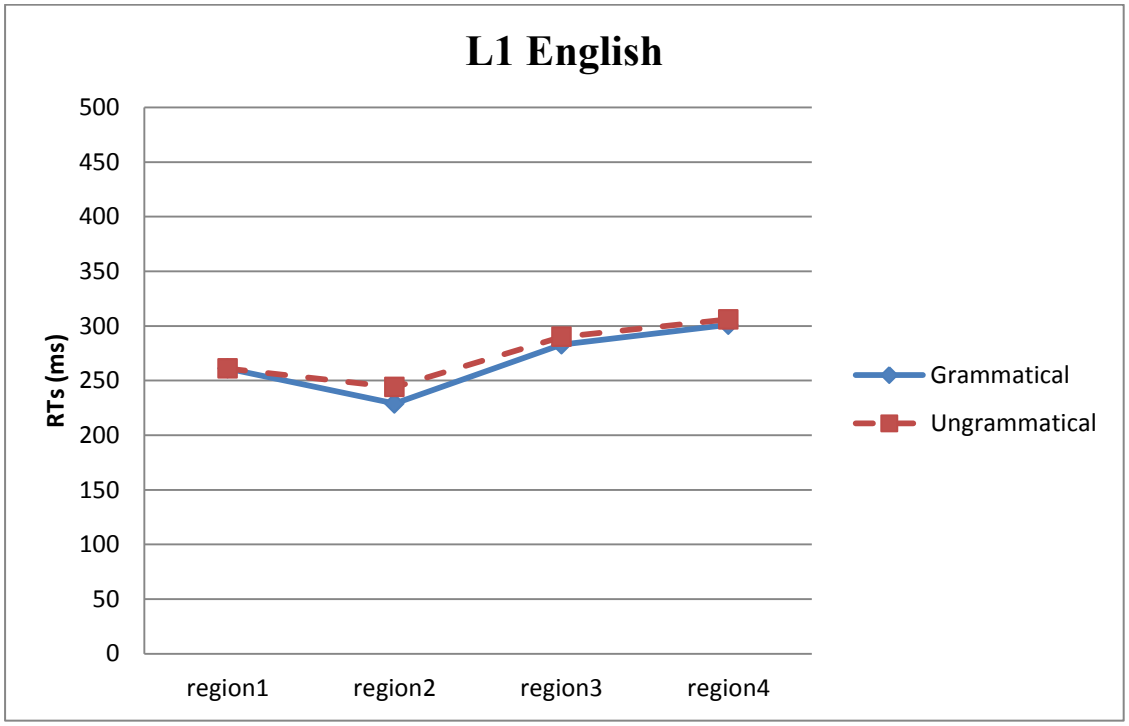


Figure 26. Mean RTs for Sentences Targeting Non-Syllabic Singleton [Vd] for the Turkish Group

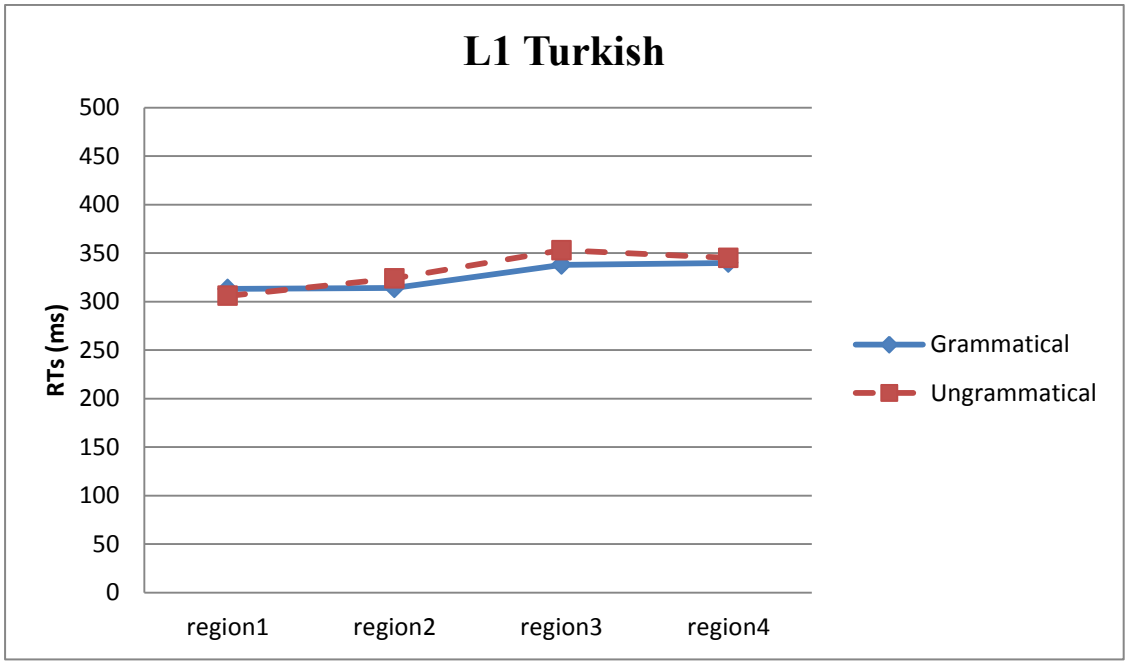


Figure 27. Mean RTs for Sentences Targeting Non-Syllabic Singleton [Vd] for the Korean Group

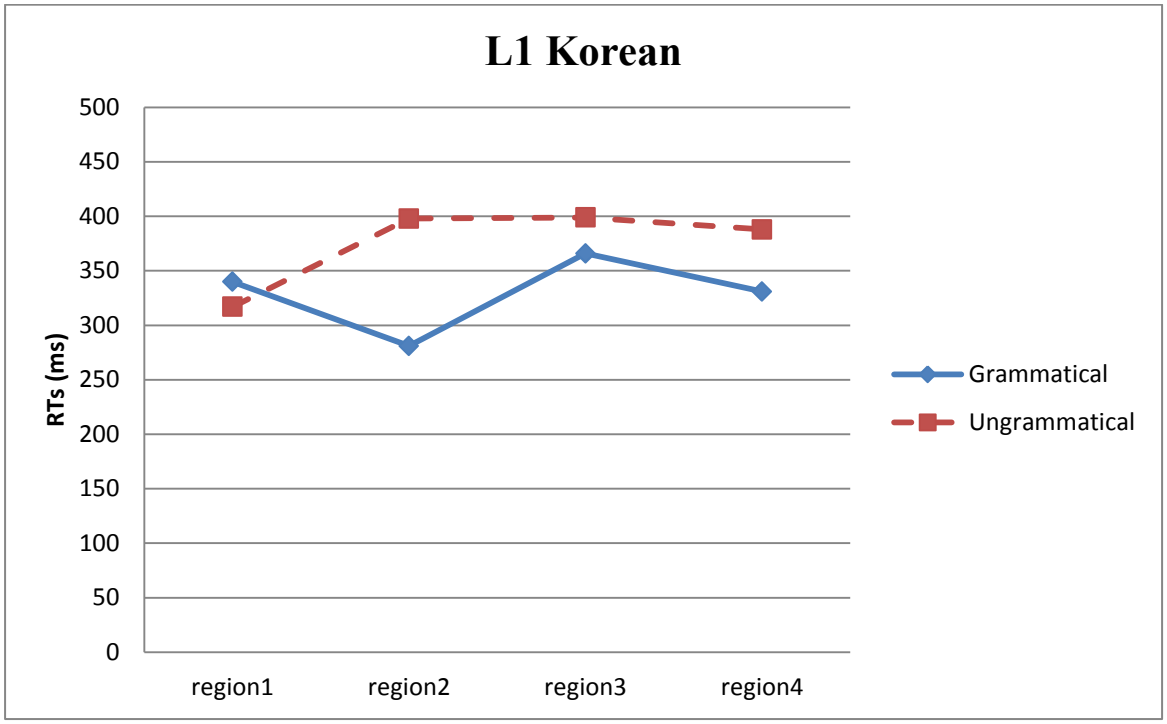
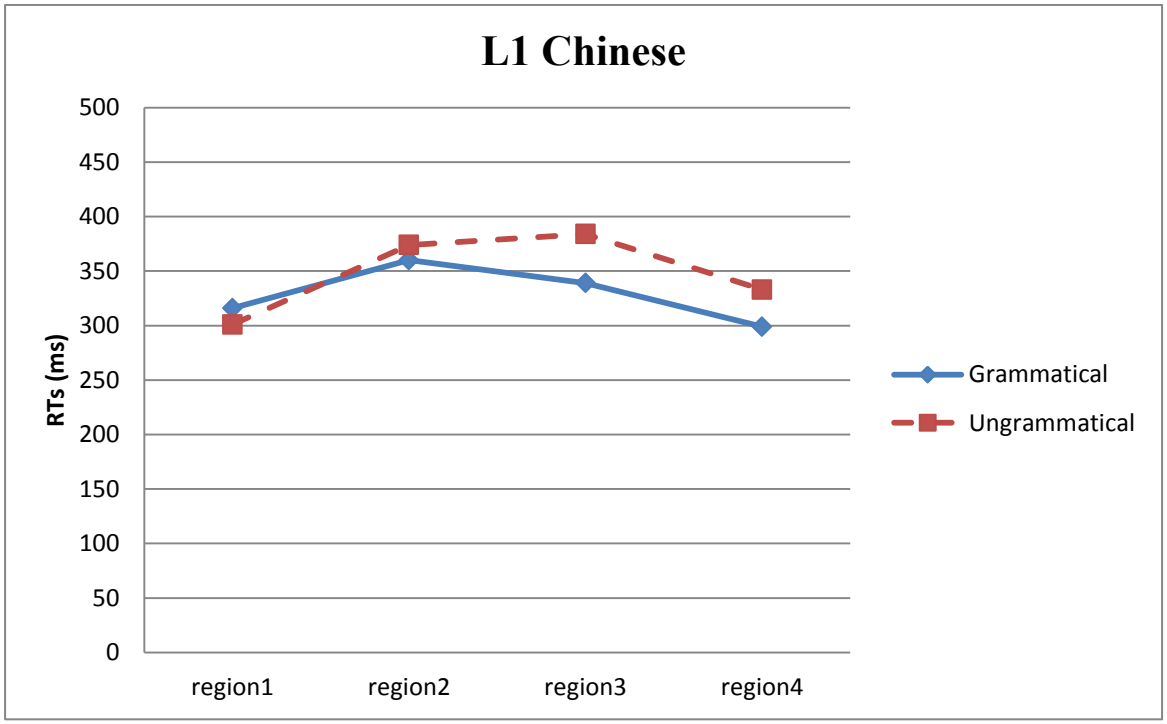


Figure 28. Mean RTs for Sentences Targeting Non-Syllabic Singleton [Vd] for the Chinese Group



For the pre-critical region (region 1), the mixed-design ANOVA showed an effect of Group in the items analysis only ($F_1(3, 81) = 1.32$, $p = .203$, $\eta^2_{part} = .047$; $F_2(3, 21) = 6.4$, $p = .003$, $\eta^2_{part} = .428$). There was no effect of Grammaticality ($F_1(1, 81) = .64$, $p = .426$, $\eta^2_{part} = .008$; $F_2(1, 7) = .44$, $p = .528$, $\eta^2_{part} = .059$) and no significant interaction between Group and Grammaticality ($F_1(3, 81) = .14$, $p = .938$, $\eta^2_{part} = .005$; $F_2(3, 21) = .91$, $p = .454$, $\eta^2_{part} = .115$).

For the critical region (region 2), there was a main effect of Group ($F_1(3, 81) = 4.57$, $p = .005$, $\eta^2_{part} = .145$; $F_2(3, 21) = 4.72$, $p = .011$, $\eta^2_{part} = .403$). No significant effect of Grammaticality was found ($F_1(1, 81) = .248$, $p = .119$, $\eta^2_{part} = .03$; $F_2(1, 7) = .15$, $p = .707$, $\eta^2_{part} = .021$), and the interaction between Group and Grammaticality was not significant either ($F_1(3, 81) = 1.11$, $p = .35$, $\eta^2_{part} = .039$; $F_2(3, 21) = 3.7$, $p = .176$, $\eta^2_{part} = .026$).

For the spillover region (region 3), the analysis revealed a marginally significant effect of Group in the items analysis ($F_1(3, 81) = 1.88$, $p = .14$, $\eta^2_{part} = .065$; $F_2(3, 21) = 2.97$, $p = .055$, $\eta^2_{part} = .298$). There was no main effect of Grammaticality ($F_1(1, 81) = 2.03$, $p = .158$, $\eta^2_{part} = .024$; $F_2(1,7) = .07$, $p = .8$, $\eta^2_{part} = .01$) and no significant interaction between Group and Grammaticality ($F_1(3, 81) = .25$, $p = .859$, $\eta^2_{part} = .009$; $F_2(3, 21) = 1.11$, $p = .368$, $\eta^2_{part} = .137$).

For the post-spillover region (region 4), the ANOVA showed no effect of Group ($F_1(3, 81) = .78$, $p = .511$, $\eta^2_{part} = .028$; $F_2(3, 21) = 1.76$, $p = .185$, $\eta^2_{part} = .201$), no effect of Grammaticality ($F_1(1, 81) = 2.13$, $p = .149$, $\eta^2_{part} = .026$; $F_2(1, 7) = .18$, $p = .684$, $\eta^2_{part} = .025$), and no significant interaction between Group and Grammaticality ($F_1(3, 81) = .53$, $p = .663$, $\eta^2_{part} = .019$; $F_2(3,21) = .39$, $p = .759$, $\eta^2_{part} = .053$).

4.4 Perception Judgment Task

As mentioned in 3.5.2, if a participant had had an accuracy rate lower than 80% for the

performance check sentences (n = 10), his or her data would have been excluded from further analysis. However, no participants were removed from subsequent analysis due to high error rates. The results showed that 21 of the 23 native English speakers, 13 of the 18 Turkish speakers, 15 of the 21 Korean speakers, and 18 of the 23 Chinese speakers had 100% accuracy rates. The rest of the participants all had 90% accuracy rates of the performance check sentences. These results suggest that the participants were paying attention to the task.

4.4.1 Past tense perception: Overall comparison

Mean percentages and standard deviations of correct responses on the experimental sentences are provided in Table 26. As shown, the native English controls accurately perceived the past tense morphology as expected (M = 98.62%). Among the learner groups, the Turkish group had the highest accuracy rates (M = 92.78%), followed by the Korean group (M = 91.84%), and the Chinese group seems to perform similarly to the Korean group (M = 91.07%).

Table 26. *Mean Percentages of Past Tense Perception in the Perception Judgment Task*

	English	Turkish	Korean	Chinese
Mean	98.62%	93.04%	91.24%	91.07%
SD	1.75%	3.3%	4.11%	4.92%

One-way ANOVA results indicated significant differences among groups, $F(3,81) = 20.471$, $p < .001$. Post-hoc analysis (Games-Howell test) showed that the differences were found between the native speaker and Turkish groups ($p < .001$), between the native speaker and Korean groups ($p < .001$), and between the native speaker and Chinese groups ($p < .001$). Among the L2 groups, no significant differences were revealed in the perception of English past tense morphology (ps > .10), suggesting similar performance among them.

4.4.2 Past tense perception: Cluster type (consonant cluster and non-cluster)

In order to examine whether there is an effect of L1 phonology on the perception of past tense morphology, performance on simple past forms with one-member codas (i.e., verbs ending in syllabic [əd] and non-syllabic singleton [Vd], e.g., *shouted* and *snowed*, respectively) was compared against that on simple past forms with two-member codas (i.e., verbs ending in non-syllabic allomorphs [d] and [t], e.g., *filled* and *missed*, respectively). Figure 29 represents the results of these comparisons (consonant cluster versus a single consonant).

Figure 29. Perception of Past Tense *-ed* Broken Down by Consonant Clusters and Single Consonants in the Perception Judgment Task

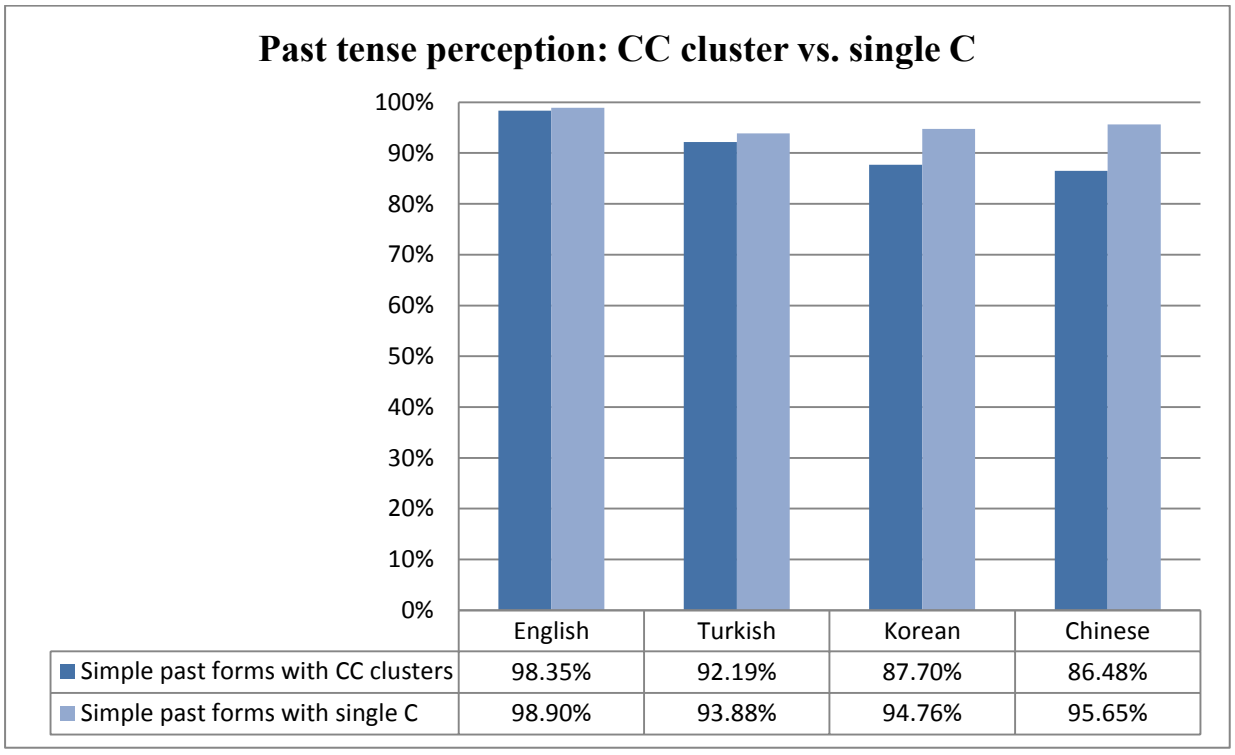


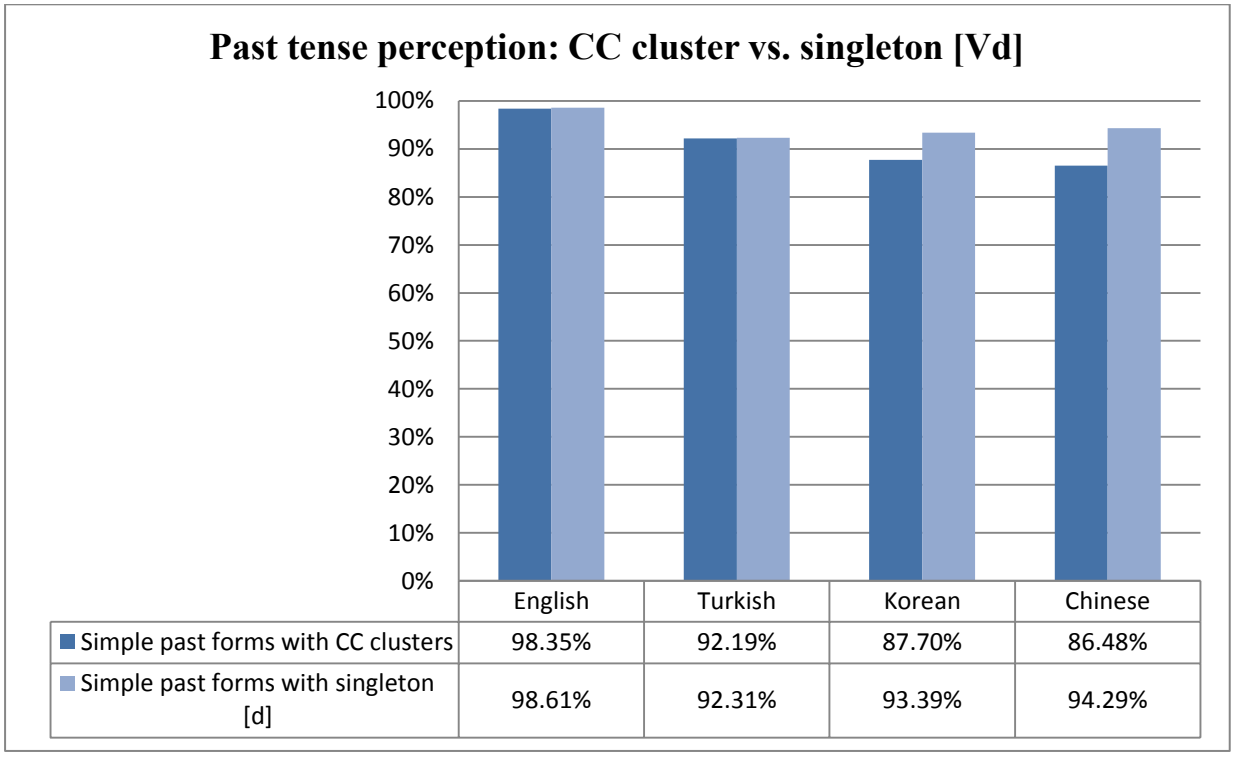
Figure 29 reveals that the native controls had a 98.35% accuracy rate in perceiving simple past forms ending in consonant clusters. Among the learner groups, the Turkish group also accurately perceived the *-ed* inflection in cluster contexts (92.19% accuracy). The Korean and

Chinese speakers' performances seem very similarly among themselves (87.7% and 86.48%, respectively). Results of the Kruskal-Wallis test showed significant differences among groups, $\chi^2(3) = 44.714$, $p < .001$. Post-hoc testing (Mann-Whitney tests) revealed that significance was found between the native speakers and the other three L2 groups (*p*s = .001). Among the L2 groups, the differences between the Turkish and Chinese group approached significance (*p* =.054). No significant differences were found between the Korean and Turkish or Korean and Chinese groups (*p*s > .10).

As Figure 29 shows, while both the native controls and the Turkish group demonstrated a similar degree of perception accuracy on verbs ending in consonant clusters and non-consonant clusters, both the Korean and Chinese groups showed higher accuracy on verbs ending in non-consonant clusters. To test for statistical significance, Wilcoxon signed rank tests were performed on the results of each group separately. The results indicated that accuracy on simple past forms ending in a single consonant was significantly higher than accuracy on simple past forms ending in consonant clusters for the Korean group ($Z = -3.242$, $p = .001$) and the Chinese group ($Z = -3.925$, $p < .001$). However, there were no significant differences in the perception of the *-ed* inflection in cluster and non-cluster contexts for the native controls ($Z = -.771$, $p = .441$) and the Turkish group ($Z = -.979$, $p = .328$).

Similar to the analysis applied to the results of the oral production tasks, additional comparisons were made between simple past forms with two-member codas and simple past forms ending in non-syllabic singleton [Vd] (e.g., *snowed*). Figure 30 shows these results.

Figure 30. Perception of Past Tense *-ed* Broken Down by Consonant Clusters and Non-Syllabic Singleton [Vd] in the Perception Judgment Task



	English	Turkish	Korean	Chinese
Simple past forms with CC clusters	98.35%	92.19%	87.70%	86.48%
Simple past forms with singleton [d]	98.61%	92.31%	93.39%	94.29%

As can be seen in Figure 30, while very small differences are observed between the perception of simple past forms ending in consonant clusters and simple past forms ending in non-syllabic singleton [Vd] in the performance of the native controls and the Turkish group, there are some differences between the two for the Korean and Chinese groups. This was tested and confirmed by the Wilcoxon signed rank tests, revealing that the Korean and Chinese group perceived simple past forms ending in non-syllabic singleton [Vd] more accurately than simple past forms ending in consonant clusters (the Korean group: $Z = -2.906$, $p = .004$; the Chinese group: $Z = -3.603$, $p < .001$). For the native controls and the Turkish group, accuracy on simple past forms taking singleton [Vd] was not significantly higher than accuracy on simple past forms ending in consonant clusters (the native controls: $Z = -.362$, $p = .717$; the Turkish group: $Z =$

-.313, p = .754).

To summarize, the results obtained from the comparisons between verbs with two-member codas and verbs with non-syllabic singleton [Vd] showed a pattern similar to the results from previous analysis comparing verbs ending in consonant clusters with verbs ending in a single consonant. The pattern observed is that unlike the Turkish learners, both Korean and Chinese learners exhibited more difficulties in perceiving the *-ed* inflection in cluster contexts than in non-cluster contexts.

4.4.3 Past tense perception: Allomorph type

In order to examine whether the phonetic form of the regular verbs affects the perception of English past tense morphology, the results of the perception judgment task were broken down by allomorph type of the *-ed* morpheme. Table 27 presents the mean percentages and standard deviations of the perception of the *-ed* morpheme in its four allomorphs.

Table 27. *Perception of Past Tense -ed by Allomorph Type in the Perception Judgment Task*

	English	Turkish	Korean	Chinese
Syllabic allomorph [əd]	99.18% (2.15%)	95.46% (4.71%)	96.11% (4.64%)	97.01% (3.71%)
Non-syllabic allomorph [d]	98.62% (2.67%)	91.32% (8.87%)	90.71% (7.57%)	84.64% (9.98%)
Non-syllabic allomorph [t]	98.08% (2.97%)	93.06% (4.74%)	84.66% (10.57%)	88.32% (9.48%)
Non-syllabic singleton [Vd]	98.61% (3.37%)	92.31% (7.28%)	93.39% (4.68%)	94.29% (5.93%)

Note. Standard deviations are in parentheses.

As Table 27 shows, the perception of the syllabic allomorph [əd] was higher than that of other allomorphs. To test for statistical significance, Friedman tests were performed on the accuracy scores for each participant group separately and the results showed the following:

- For the native controls, there were no significant differences in the perception of the past tense morpheme *-ed* across the four allomorphs ($\chi^2(3) = 2.407$, $p = .492$).
- For the Turkish group, there were no significant differences in the perception of the past tense morpheme *-ed* across the four allomorphs ($\chi^2(3) = 1.939$, $p = .585$).
- For the Korean group, there was a significant difference in the perception of the past tense morpheme *-ed* across the four allomorphs ($\chi^2(3) = 16.35$, $p = .001$). Post-hoc Wilcoxon signed rank tests (Bonferroni corrected) showed that the perception of the non-syllabic allomorph [t] was significantly lower than the perception of syllabic [əd] ($Z = -3.344$, $p = .006$) and the non-syllabic allomorph [d] ($Z = -2.748$, $p = .036$). There were no significant differences between the results of any of the other combinations ($ps > .10$).
- For the Chinese group, there was a significant difference in the perception of the past tense morpheme *-ed* across the four allomorphs ($\chi^2(3) = 24.685$, $p < .001$). Post-hoc Wilcoxon signed rank tests (Bonferroni corrected) showed that the perception of the non-syllabic allomorph [d] was significantly lower than the perception of the syllabic [əd] ($Z = -3.751$, $p = .001$) and the non-syllabic singleton [Vd] ($Z = -3.365$, $p = .006$). Moreover, the perception of the non-syllabic allomorph [t] was lower than the perception of syllabic [əd] and the non-syllabic singleton [Vd], significantly in the former ($Z = -3.342$, $p = .006$) and at the approaching significance level in the latter ($Z = -2.594$, $p = .054$). There were no significant differences between the results of any of the other combinations ($ps > .10$).

4.5 Correlations between L2 Perception and Production

To examine whether there is any significant relationship between second language perception and production of the regular past tense morpheme, separate Spearman's correlation tests were conducted for each learner group. Included in the correlation analyses were the data of the mean percentage accuracy scores on the perception judgment and sentence repetition tasks. The results indicated no statistical relationship between the perception and production of the regular past tense morpheme for any of the learner groups (the Turkish group: $r = .352$, $p = .152$; the Korean group: $r = .321$, $p = .156$; the Chinese group: $r = .377$, $p = .07$). The individual correlations within each of the four allomorphs were also examined. The results are displayed in Table 28-30. Most of the allomorphs from the two tasks were found to have no significant correlations.

Table 28. *Individual Correlation for the Turkish Group*

		Perception judgment task			
		[əd]	[d]	[t]	[Vd]
Sentence repetition task	[əd]	0.327			
	[d]		0.581*		
	[t]			-0.023	
	[Vd]				0.078

Note. *$p < .05$; [əd] = syllabic allomorph [əd]; [d] = non-syllabic allomorph [d]; [t] = non-syllabic allomorph [t]; [Vd] = non-syllabic singleton [Vd]

Table 29. *Individual Correlation for the Korean Group*

		Perception judgment task			
		[əd]	[d]	[t]	[Vd]
Sentence	[əd]	0.081			
repetition	[d]		0.25		
task	[t]			-0.009	
	[Vd]				-0.204

Note. [əd] = syllabic allomorph [əd]; [d] = non-syllabic allomorph [d]; [t] = non-syllabic allomorph [t]; [Vd] = non-syllabic singleton [Vd]

Table 30. *Individual Correlation for the Chinese Group*

		Perception judgment task			
		[əd]	[d]	[t]	[Vd]
Sentence	[əd]	0.156			
repetition	[d]		0.335		
task	[t]			0.409*	
	[Vd]				-0.042

Note. *$p < .05$; [əd] = syllabic allomorph [əd]; [d] = non-syllabic allomorph [d]; [t] = non-syllabic allomorph [t]; [Vd] = non-syllabic singleton [Vd]

4.6 Summary of Results

Descriptive statistics of the story completion, sentence repetition, and perception judgment tasks are summarized in Table 31. The overview of the results from these three tasks showed clear contrasts in the production of the past tense morpheme *-ed* in word-final cluster and non-cluster contexts. The effects of clustering also extend to perception; that is, perception accuracy was significantly higher in verbs ending with a single consonant than verbs ending in consonant clusters.

The phonetic form of the regular verbs was found to significantly influence the production and perception of the past tense morpheme *-ed,* with past tense forms ending in syllabic allomorph [əd] being produced and recognized at a higher accuracy rate. Moreover, the results from the SPL task also showed that the L2 learners as well as the native controls all demonstrated sensitivity to the mismatch between the fronted temporal adverbial "Right now" and the past tense marker only in the sentences targeting syllabic allomorph [əd], further confirming that the phonetic form of the verb played a role in the perception of the past tense morpheme.

The next chapter will discuss the research results in further depth and the role of L1 transfer in second language production and perception of English regular past tense morphology.

Table 31. *Combined Results of the Story Completion, Sentence Repetition, and Perception Judgment Tasks*

	Production						Perception		
	Story completion			Sentence repetition			Perception judgment		
	All	CC	C	All	CC	C	All	CC	C
English	97.58	96.73	98.62	98.51	97.55	99.46	98.62	98.35	98.9
Turkish	87.59	80.66	93.42	94.2	90.48	97.87	93.04	92.19	93.88
Korean	86.48	84.73	88.19	95.48	92.78	97.92	91.24	87.7	94.76
Chinese	68.83	59.68	76.81	91.78	86.88	96.72	91.07	86.48	95.65

	Production								Perception			
	Story completion				Sentence repetition				Perception judgment			
	[əd]	[d]	[t]	[Vd]	[əd]	[d]	[t]	[Vd]	[əd]	[d]	[t]	[Vd]
English	98.58	98.76	94.64	98.73	99.46	98.91	96.2	99.46	99.18	98.62	98.08	98.61
Turkish	95.04	83.08	78.49	92.03	97.92	94.15	86.81	97.92	95.46	91.32	93.06	92.31
Korean	85.88	90.84	79.91	90.79	98.21	95.24	90.22	97.62	96.11	90.71	84.67	93.39
Chinese	74.35	57.17	62.54	79.28	97.83	84.78	89.13	95.65	97.01	84.64	88.32	94.29

Note. Values given are mean percentages; All = all simple past forms combined; CC = a combination of non-syllabic allomorphs [d] and [t]; C = a combination of syllabic allomorph [əd] and non-syllabic singleton [Vd]; [əd] = syllabic allomorph [əd]; [d] = non-syllabic allomorph [d]; [t] = non-syllabic allomorph [t]; [Vd] = non-syllabic singleton [Vd]

CHAPTER 5: DISCUSSION

In this chapter, each of the research questions and hypotheses stated in the beginning of the dissertation will be addressed in turn and the research results will be discussed in light of other studies on the production and perception of functional morphology in the L2.

5.1 Research Question 1

The first research question for the present study was: Do L1 phonology and morphosyntax affect L2 learners' production of the English regular past tense morpheme across its four allomorphs? The study results indicate a complicated answer.

The results from the story completion task showed that none of the three L2 groups produced the regular past tense morpheme *-ed* at native-like levels. The Korean group performed similarly to the Turkish group (86% and 88%, respectively), and both groups were statistically more accurate than the Chinese group (69%). Recall that Turkish is a language that encodes tense morphologically and permits final consonant clusters; Korean also encodes tense morphologically but lacks final consonant clusters; the Chinese language does not mark tense and does not license final consonant clusters either. According to the Prosodic Transfer Hypothesis (PTH) (Goad et al., 2003), interlanguage performance on morphological production is constrained by the transfer of the L1 prosodic system. As predicted by the PTH, L1 constraints on prosodic structure will have a negative impact on the second language production of past tense that goes above and beyond any morphosyntactic transfer issues. Therefore, it was hypothesized that for native speakers of Turkish, L1 phonological transfer would play a positive or neutral role in their production of English past tense morphology, whereas for Korean and Chinese speakers, L1 phonological transfer would negatively affect their past tense marking in English. The present data confirmed

the prediction made for Turkish and Chinese speakers: the Turkish learners supplied past tense morphology 88% of the time, while the Chinese learners supplied past tense morphology only 69% of the time. However, the present data did not support the prediction that was made for Korean speakers: the Korean group was found to supply past tense morphology 86% of the time, which was not significantly different from that of the Turkish group. Moreover, as implicated by the PTH, it was also hypothesized that Turkish speakers would outperform Korean and Chinese speakers in the production of regular past forms ending in two-member codas (i.e., verbs taking non-syllabic allomorphs [d] and [t]). The results from the story completion task revealed that the Korean performance was comparable to that of the Turkish group in the production of regular past forms ending in two-member codas (85% and 81%, respectively), and both groups performed significantly better than the Chinese group (60%). Thus, the prediction was only partially supported in this study, as the results did not show that Turkish group surpassed the Korean group in their performance of regular past forms ending in two-member codas.

The different patterns of morphology suppliance by the three L2 groups cannot be easily accounted for by the PTH since it would be odd to claim that phonology played a role for the Chinese learners but not for the Korean learners. However, it is important to note that only the presence or absence of final consonant clusters was considered in the present study. Chinese phonotactics differ from Korean in some ways, and it is possible that those issues cause more pronunciation issues than they do for Korean. This specific issue could be explored further in future research.

The results from the story completion task seem to be more compatible with the Representational Deficit Hypothesis (RDH) (Hawkins, 2005; Hawkins & Liszka, 2003; N. Smith & Tsimpli, 1995). As discussed above (see section 2.1.1.1), the RDH suggests that adult L2

learners are restricted to functional feature inventories available in their L1s, and therefore are likely to have trouble with functional categories or features that are not present in their L1s (Hawkins & Chan, 1997). As predicted by the RDH, the main source of learners' errors appears to be morphosyntactic transfer issues in that the learners with tense marking in the L1 outperformed the learners whose L1 lacked tense marking. Nevertheless, the Chinese learners in this study are presumably not at end-state; most of them are at high-intermediate or advanced levels of English proficiency (mean TOEFL ibt scores: 99.7), which means they (as well as the Turkish and Korean learners) still have the opportunity to improve and perform like native English speakers. However, it is also possible that some Chinese learners can never overcome the morphosyntactic transfer issues, and therefore will continue to show persistent morphological errors. Future research can address this issue.

The performance of the Chinese group in this study seems to be similar to what has been reported in previous studies. As mentioned earlier (see section 2.1), the Mandarin Chinese speaker, Patty, in Lardiere (1998a, 1998b, 2000) supplied past tense morphology for thematic verbs at a low rate in obligatory contexts—34%. Moreover, the two Chinese speakers in Hawkins and Liszka (2003) produced regular past tense morphology in 63% of obligatory contexts in spontaneous oral production, compared to 92% for the five Japanese speakers (whose L1 has past tense markers but does not allow final consonant clusters). Furthermore, the 12 Mandarin speakers in Goad et al. (2003) marked regular verbs for simple past 57% of the time. Similarly, the 20 Chinese speakers in W.-H. Chen (2010, 2011) inflected regular verbs for simple past 51% of the time. In the present study, the 23 Chinese learners were found to supply past tense morphology for regular verbs in 69% of all obligatory contexts.

Considering the possibility that L2 learner's errors in past tense marking may be due to their

articulation problems, the present study included an additional oral production task—a sentence repetition task—in order to test whether L2 learners can accurately pronounce the past tense morpheme *-ed*. The results from the sentence repetition task showed that (a) the three L2 groups performed alike in their production of the *-ed* morpheme across its four allomorphs (over 90% for all learner groups) and also in their production of regular past forms ending in two-member codas (over 90% for the Turkish and Korean groups and around 87% for the Chinese group), and (b) only the Korean group performed in a way similar to the native control group in both conditions. These results suggest that although consonant clusters are not allowed in their L1s, the Chinese and Korean learners can accurately and consistently articulate the sounds of the *-ed* morpheme even when the *-ed* morpheme creates word-final consonant clusters, which implies that some of the Chinese learners' errors in tense marking cannot be readily explained by their articulation problems with consonant clusters.

To further examine the potential effect of L1 phonological constraints related to consonant clusters upon second language production of English regular past tense, comparisons were made between regular past forms with two-member codas (i.e., verbs taking non-syllabic allomorphs [d] and [t]) and regular past forms with one-member codas (i.e., verbs taking syllabic allomorph [əd] and non-syllabic singleton [Vd]). The results from the story completion task showed that for both the Turkish and Chinese groups, the accuracy rates were higher in regular past forms ending with one-member codas than with two-member codas. This trend is also observed in the Korean group, although no significant differences were found between these two conditions. The three L2 groups exhibited the same pattern in the sentence repetition task; regular past forms ending with one-member codas yielded significantly higher accuracy rates than regular past forms ending with two-member codas. Additional comparisons were made between regular past forms with

two-member codas and regular past forms taking non-syllabic singleton [Vd] in order to avoid the syllabicity effects of the syllabic allomorph [əd]. Both the story completion and sentence repetition tasks revealed that the learners in all three groups alike were more accurate with regular past forms taking non-syllabic singleton [Vd] than with regular past forms ending in two-member codas. Taken together, these results partially confirmed the prediction that Korean and Chinese speakers, but not Turkish speakers, would have higher accuracy rates for regular past forms with a simple coda than for regular past forms with a complex coda. In this study, the effects of clustering were consistently observed across tasks for each group of L2 learners. These findings are in line with previous research showing that consonant clusters in any position are challenging for some learners (e.g., Chan, 2006, 2007; Edge, 1991; Hansen, 2001). In sum, the present data suggest that second language production of English regular past tense morphology appear to be not significantly affected by learners' L1-transferred phonological constraints, but rather with a more general phonological constraint on the type of the cluster where the past tense morpheme occurs. It is possible that the number of consonants in the coda has an additive effect on the degree of difficulty in producing regular past forms.

If this is indeed the case, then one would expect to find similar proportions of *-t/-d* suppliance in past tense contexts and in monomorphemic words.

The results of the comparisons between regular past forms with two-member codas and monomorphemic words containing consonant clusters from the sentence repetition task supported the idea of a general phonological effect of final consonant clusters. The Chinese group was found to have similar suppliance rates of final *-t/-d* in regular past forms and monomorphemic words (87% and 92%, respectively). Likewise, the Korean group showed no differences in these two conditions: 93% suppliance of *-t/-d* in regular past tense contexts and 97%

suppliance in monomorphemic words. However, the suggestion that the number of consonants in the coda has an additive effect cannot account for why the Turkish group was more accurate with consonant clusters in monomorphemes (97%) than in regular past forms (90%). Alternatively, these results can be interpreted from the perspective of L1-transferred phonological constraints. As previously discussed in section 2.1.2.2, if tense morphology omission is due to constraints on consonant clusters in Chinese (as well as in Korean), one would find that the deletion rates of final *-t/-d* in past tense contexts should be the same as the deletion rates in monomorphemic words (Lardiere, 2003). The present data seem to correspond to this prediction. However, both the Chinese and Korean groups showed high levels of suppliance of final *-t/-d* in past tense contexts and monomorphemic words (both over 92% for the Korean group and both over 86% for the Chinese group), it seems that the performance of the Chinese and Korean speakers is not significantly affected by L1 phonological factors, at least in conditions where their focus is more on form than on meaning. To summarize, a general phonological effect of final consonant clusters rather than L1-transferred phonological constraints seem to be a more convincing explanation of the results of the suppliance rates of final *-t/-d* in past tense context and in monomorphemic words.

An interesting pattern was discovered in that all the learner groups did slightly better with monomorphemic words than past tense verbs, although the difference was significant only for the Turkish group. For Chinese speakers, this pattern might often be explained by the absence of past tense marking in Chinese; however, this account cannot explain why all three learner groups showed the same trend. The present data seem to suggest that there is something about morphological marking that is less likely to be marked in general, and this applies to L2 learners even if their L1 has that marking too. This is a worthwhile area for future research to explore.

The design of this study built upon the work of Hawkins and Liszka (2003). Both Hawkins and Liszka and the present study showed that Chinese speakers were less accurate in marking simple past tense in English than L2 learners whose L1s encode tense morphologically, such as Japanese and German speakers in the case of Hawkins and Liszka's study, and Korean and Turkish speakers in the current study. However, some of the results differ. Hawkins and Liszka found that their two Chinese learners supplied final *-t/-d* with monomorphemes more often than with regular past tense verbs (82% versus 63%, respectively). The reason for this discrepancy between Hawkins and Liszka's study and the present study may be due to the differences in learner-produced regular past tense contexts and monomorphemic words (40 and 11 in Hawkins and Liszka's study versus 731 and 723 in this study), and differences in the nature of the oral production tasks. The oral production tasks used in Hawkins and Liszka were retelling of a video clip and recounting of a happy or exciting experience, both of which measured learners' spontaneous production and were meaning-oriented in nature. However, the sentence repetition task in the present study focused more on form, thereby allowing participants more cognitive resources for articulation. It is not clear whether Chinese learners would perform the same on monomorphemic words if their focus is more on meaning, as in the story completion task. Indeed, the Japanese and German speakers in Hawkins and Liszka's study were slightly more accurate with monomorphemic words than past tense verbs (96% versus 92% for the Japanese speakers and 100% versus 96% for the German speakers). Thus, it might not just be Chinese speakers to show the trend of monomorphemic words being more accurate than past tense verbs in a more meaning-focused task. Additional research is required to examine these issues. Moreover, the results from the two oral production tasks in the present study suggest that Chinese leaners' suppliance of past tense marking vary in relation to task characteristics. It seems that it is during

meaning-oriented tasks that Chinese learners' performance on past tense may go down more than for speakers whose L1 marks tense overtly. Again, further investigation is needed.

The RDH does not really address the issue of to what extent learner's degree of focused attention to form, perhaps in response to the type of task, influences the performance in morphology suppliance; nevertheless, Hawkins and Liszka (2003) propose a possibility of operations of output checking on surface strings. In other words, Chinese speakers "monitor the ambient discourse for 'pastness' and insert V-ed forms when they are able to detect it" (p. 40). Because "pastness" is determined according to context, the monitoring processing is unstable. As a result, there are differences in the extent of past tense marking within the same individual based on the type of task. This explains why the Chinese speakers in Hawkins and Liszka's study were more accurate on the morphology test than on the oral production task, and Patty in Lardiere's (2003) study showed a higher rate of past tense marking in written than oral production. The PTH has little to say about the role of learners' focused attention to form according to particular tasks. Moreover, neither the PTH nor the RDH accounts for variance in performance according to the role of input or instruction for learners.

Taken together, the present data suggest that for Turkish and Korean speakers (who have past tense markers in their L1s), the production of English regular past tense morphology is influenced by a general phonological effect of final consonant clusters, whereas for Chinese speakers (whose L1 does not encode tense morphologically), the use of English regular past tense morphology is affected by both L1 morphosyntactic transfer and the general phonological effect of final consonant clusters. That is, Chinese speakers' performance on final consonant clusters is degraded even more when they have to express inflectional morphology.

To summarize, the present findings fit in with previous studies showing that inflectional

morphology is an area of particular difficulty for adult L2 learners (Parodi et al., 2004; Slabakova, 2013; Zobl & Liceras, 1994). The results from the story completion and sentence repetition tasks do not correspond to the predictions of the PTH. Rather, the present findings provide some evidence to support the RDH. According to the study results, morphosyntactic transfer from L1 might be an important factor in the production of English past tense morphology. In addition to the influence from L1 morphosyntax, the present study indicates that phonology might also play a role and contribute to learners' errors in tense marking. The present findings suggest that the number of consonants in the coda has an additive effect; thus, the more the number of consonants in the coda, the more difficult it becomes for L2 learners to produce the consonant clusters.

5.2 Research Question 2

The second research question for the present study was: Do L1 phonology and morphosyntax affect L2 learners' perception of the English regular past tense morpheme across its four allomorphs? Previous research has shown that adult L2 learners often have difficulties perceiving the sounds of a target language, especially when these sounds are not present in their L1 phonological inventory (e.g., Best, 1995; Flege, 1995; Strange, 1995). Moreover, as discussed in section 2.6, although so far the PTH has mainly been tested concerning production, it is argued that prosodic transfer effect should extend to comprehension as well as perception (Lieberman, 2012, 2013), under the assumption that speakers have a single prosodic grammar. It was thus hypothesized that Turkish speakers would outperform Korean and Chinese speakers in the perception of the regular past tense morpheme, especially in the case of simple past forms ending in two-member codas. It was also hypothesized that Korean and Chinese speakers, but not Turkish speakers, would perceive the *-ed* morpheme in non-cluster contexts more accurately than

the *-ed* morpheme in cluster contexts. Overall, the present findings were consistent with these predictions and suggest that the perception of the *-ed* morpheme is subject to influence from the L1 phonological system.

The results from the perception judgment task showed that none of the three L2 groups perceived the regular past tense morpheme *-ed* in a native-like manner. In addition, the three learner groups did not differ significantly from one another in their perception of the *-ed* morpheme across its four allomorphs. At first glance, it may seem that L1 phonology might not be at play, with the Korean and Chinese learners performing similarly to the Turkish learners. However, a closer examination of the perception accuracy on regular past forms ending in two-member codas revealed that the Korean group performed similarly to the Turkish group (88% and 92%, respectively) and the Chinese group (86.5%); however, the Turkish group was more accurate than the Chinese group. Thus, the prediction that Turkish speakers should have better performance than Chinese speakers was borne out by the results, indicating that second language perception is affected by L1 phonology (or to be more specific, L1 phonological constraints on consonant clusters). Although the present data did not show that Turkish speakers perceived regular past forms ending in two-member codas significantly better than the Korean group, there is a descriptive difference between the two groups, with the Turkish group being slightly more accurate than the Korean group. Additional research will be needed to verify this trend and/or find a possible explanation for it. However, such results did not exclude the possibility of the effect of L1 phonology on second language perception of English regular past tense morphology. As will be shown below, there are other pieces of evidence showing that Korean learner performance is also influenced by L1 phonological constraints on consonant clusters.

The comparisons between regular past forms with two-member codas (i.e., verbs taking non-syllabic allomorphs [d] and [t]) and regular past forms with one-member codas (i.e., verbs taking syllabic allomorph [əd] and non-syllabic singleton [Vd]) made it very clear that the perception of the *-ed* morpheme is influenced by L1 phonology. The study results showed that whereas the Turkish learners were equally accurate in perceiving regular past forms ending in consonant clusters and regular past forms ending in a single consonant, the Korean and Chinese learners showed higher accuracy on regular past forms with a single consonant. The exact same patterns were found in the results of the comparisons between regular past forms with two-member codas and regular past forms taking non-syllabic singleton [Vd]; while the presence of consonant clusters did not add difficulty to the perception of the *-ed* morpheme for the Turkish learners, performance of the Korean and Chinese learners was significantly affected by the effects of clustering, further confirming the influence from L1 phonology. Taken together, these results confirmed the prediction that Korean and Chinese speakers, but not Turkish speakers, will more accurately perceive the *-ed* morpheme in non-cluster contexts than the *-ed* morpheme in cluster contexts.

The present findings are in line with the results reported by Solt et al. (2004). They also found that L2 learners were less able to perceive the *-ed* morpheme in cluster contexts, although the participants in Solt et al.'s study were L2 learners from a variety of L1 backgrounds including Mandarin, Cantonese, Russian, Spanish, Turkish, Arabic, Ukrainian, and French, and thus did not inform if L1 transfer was involved. Moreover, as mentioned earlier (see section 2.2.2), Pugach et al. (2004) reanalyzed the data from Solt et al. (2004) and focused on the performance of Spanish and Chinese (who do not allow final consonant clusters in their L1s) and Russian speakers (who do). Their results also showed an effect of L1 phonology, although it was marginal.

Combined, the observed differences in perception accuracy among the participant groups and the two different patterns found for simple codas and complex codas in regular past forms by the Korean and Chinese groups cannot be readily accounted for in terms of L1 morphosyntactic transfer. Rather, these results are more easily explained by L1-transferred phonological constraints. Thus, the present findings lend support to the proposal that prosodic transfer effect applies to second language perception.

The present data suggest that English regular past tense morphology poses perceptual challenges for adult L2 learners, and the study results contribute to existing evidence showing that the challenge L2 learners encounter with functional morphology also extends to comprehension and processing and is not production-specific (e.g., L. Chen et al., 2007; Clahsen, Felser, et al., 2010; Clahsen, Martzoukou, et al., 2010; Grüter et al., 2012; Jiang, 2007; McCarthy, 2008). The past tense morpheme *-ed* is not consistently perceived by L2 learners, especially those with no final consonant clusters being allowed in their L1s. Such results provide evidence for L1influence and corroborate previous studies showing that adult L2 learners have difficulties perceiving phonetic segments or contrasts not present in their L1 (e.g., Best, 1995; Flege, 1995; Strange, 1995). In sum, the present findings suggest that L2 learner difficulties in perceiving past tense marking could affect the way that input is processed and make the acquisition of past tense marking more difficult.

5.3 Research Question 3

The third research question addressed the issue of the phonetic form of the regular verbs in second language production of English past tense morphology and its possible interaction with L1 phonology. Overall, the present data suggest that for Turkish, Korean, and Chinese learners of

English, the phonetic form of the regular verbs plays a role in their production of English past tense morphology.

For the Turkish group, the results from the story completion task showed that the production of the non-syllabic allomorph [t] was significantly less accurate than that of the syllabic [əd] and the non-syllabic singleton [Vd]. This pattern remained the same in the sentence repetition task. Moreover, in the story completion task, the Turkish learners were less likely to inflect regular verbs taking non-syllabic allomorph [d] for simple past than regular verbs taking syllabic [əd] and non-syllabic singleton [Vd], with the caveat that the differences in morphology suppliance only approached significance in both cases. Combined, these results suggest that for the Turkish learners, regular verbs ending in syllabic [əd] and non-syllabic singleton [Vd] are more likely to be marked for simple past than regular past tense verbs ending in consonant clusters. However, the Turkish learners' data did not support the syllabicity effect because no significant differences in performance were found between the syllabic [əd] and the non-syllabic singleton [Vd] in either of the oral production tasks. As described earlier (see section 2.6), it was hypothesized that Turkish speakers should show no significant differences in suppliance of past tense marking across its four allomorphs, because following the predictions of the PTH, the similarity of the phonology in the L1 (that is, the presence of consonant clusters) should mean that there is little to impede pronunciation of the various past tense forms. However, this prediction was not confirmed by the results.

For the Korean group, the results from the story completion task revealed that the production of the non-syllabic allomorph [t] was lower than that of the non-syllabic singleton [Vd], with the caveat that the difference only approached significance. The exact same pattern was shown in the results from the sentence repetition task, but again the differences in suppliance

rates between the non-syllabic allomorph [t] and the non-syllabic singleton [Vd] only approached significance. Furthermore, in the sentence repetition task, the Korean learners were significantly less accurate with regular verbs taking non-syllabic allomorph [t] than regular verbs taking syllabic allomorph [əd]. Taken together, these results suggest that the Korean learners are more likely to mark regular verbs ending in a single consonant (i.e., verbs taking syllabic [əd] and non-syllabic singleton [Vd]) for simple past compared to regular verbs ending in non-syllabic allomorph [t]. However, as with the results of the Turkish learners, the Korean learners' data did not support the syllabicity effect in either of the two oral production tasks.

For the Chinese group, the results from both the story completion and sentence repetition tasks showed that the production of the non-syllabic allomorph [d] was statistically less accurate than that of the syllabic [əd] and the non-syllabic singleton [Vd]. Moreover, accuracy on the non-syllabic allomorph [t] was significantly lower than that of the syllabic [əd] and the non-syllabic singleton [Vd] (in the sentence repetition task and the story completion task, respectively). Collectively, these results suggest that for the Chinese learners, regular verbs ending in a single consonant (i.e., verbs taking syllabic [əd] and non-syllabic singleton [Vd]) are inflected for simple past more often than regular past tense verbs ending in consonant clusters. However, similar to the results of the Turkish and Korean learners, no syllabicity effect was observed for the Chinese group.

The Korean and the Chinese group data confirmed the prediction that for Korean and Chinese speakers, the syllabic allomorph [əd] would be more accurately produced than the non-syllabic singleton [Vd], which, in turn, would be more accurately produced than the non-syllabic allomorphs [t]/[d]. However, the Korean and Chinese groups (as well as the Turkish group) showed no significant differences in their performance between regular verbs ending in

syllabic allomorph [əd] and regular verbs taking non-syllabic singleton [Vd].

Taken together, the learners in the three groups showed a similar pattern: regular verbs ending in a single consonant (i.e., verbs taking syllabic allomorph [əd] and non-syllabic singleton [Vd]) are more likely to be inflected for simple past than regular past forms ending in consonant clusters. This pattern was consistently shown in both the story completion and sentence repetition tasks. The similar pattern of results that emerge across tasks and language groups suggest that the production of English past tense morphology is affected by the phonetic form of the regular verbs, regardless of the L1 phonology. In other words, this does not appear to be an effect of transfer alone. That is, the variable suppliance rates among the four allomorphs are not easy to account for in terms of prosodic transfer effects, because there is no clear reason based on Turkish phonology to predict differences among the four allomorphs of the *-ed* morpheme.

The study results are in line with previous studies showing that a preceding vowel is more likely to induce past tense marking than a preceding liquid or obstruent (Bayley, 1994, 1996). Moreover, the present findings are in accordance with the results of Wolfram (1989) and run counter to Bayley (1994) by showing that regular verbs with syllabic allomorph [əd] were marked for simple past more often than regular verbs with non-syllabic allomorphs [t]/[d].

The role of the phonetic form of regular verbs in the use of English past tense morphology is under-researched in the field of SLA. This area is not usually considered in explaining learners' errors in past tense marking. The results reported in this study suggest that the phonetic form of the regular verbs is one of the factors influencing the suppliance of past tense morphology. Moreover, the observed differences in morphology suppliance among the four allomorphs of English repast past tense morpheme across language groups seem to indicate a general phonological effect on word-final consonant clusters. In other words, the presence of consonant

clusters increases the difficulty of the production of the *-ed* morpheme. That is, regular past tense forms ending in non-syllabic allomorphs [t]/[d] are universally harder to pronounce.

5.4 Research Question 4

The fourth research question examined the role of the phonetic form of the regular verbs in second language perception of English past tense morphology and its potential interaction with L1 phonology. Overall, the results of this study suggest that L2 learners' perception of English past tense morphology is influenced by a combination of L1 phonological constraints as well as the phonetic form of the regular verbs.

The results from the SPL task revealed that both native speakers and L2 learners were sensitive to grammatical errors targeting the syllabic allomorph [əd], as indicated by longer RTs when listening to ungrammatical sentences. However, neither native English speakers nor L2 learners showed reliable difference for sentences testing the non-syllabic allomorphs [t]/[d] and the non-syllabic singleton [Vd]. Considering that even native English speakers failed to show online sensitivity to grammatical errors involving these non-syllabic allomorphs, it seems that the SPL task was not sensitive enough to pick up on participants' reactions to ungrammaticalities in past tense morphology. Therefore, the majority of the data from the SPL task are not included in the discussion; rather, the results from the perception judgment task were used to answer the fourth research question.

In the perception judgment task, the Turkish learners were found to be equally accurate in perceiving the four allomorphs of the *-ed* morpheme. As discussed in section 2.6, if it is the case that L1 phonology plays a role in L2 learners' perception of the *-ed* morpheme, then Turkish speakers should show no significant differences in their perception of the *-ed* morpheme among

its four allomorphs, unless some forms are just universally harder to perceive. This prediction was borne out by the results of this study.

For the Korean group, the results from the perception judgment task showed that their perception of the non-syllabic allomorph [t] was significantly lower than that of the syllabic [əd] and the non-syllabic singleton [Vd]. No significant differences were found between the syllabic [əd] and the non-syllabic singleton [Vd]; thus, the syllabicity effect was not supported by the Korean group data. In short, these results suggest that Korean learners are more likely to accurately perceive regular past forms ending in one-member codas than regular past forms taking non-syllabic allomorph [t].

For the Chinese group, the results from the perception judgment task revealed that their perception of the non-syllabic allomorphs [d] and [t] was less accurate than that of the syllabic [əd] and the non-syllabic singleton [Vd]. As with the results of the Korean group, the Chinese group data did not support the syllabicity effect either. In brief, these results suggest that Chinese learners are more able to perceive the *-ed* inflection in non-cluster contexts than the *-ed* inflection in cluster contexts.

According to the criteria of perceptual salience (Goldschneider & DeKeyser, 2001), it was hypothesized that for Korean and Chinese speakers, the syllabic allomorph [əd] would be better perceived than the non-syllabic singleton [Vd], which, in turn, would be better perceived than the non-syllabic allomorph [d], which, in turn, would be better perceived than the non-syllabic allomorph [t]. The present data partially bore out the prediction. The results of this study showed no significant differences in perception accuracy between the non-syllabic allomorph [d] and the non-syllabic allomorph [t]. Moreover, the perception of the syllabic allomorph [əd] was not higher than that of the non-syllabic singleton [Vd] for either the Korean or Chinese groups. Note,

however, that although the syllabicity effect was not evident in the data from the perception judgment task, all groups demonstrated sensitivity to past tense marking only for the syllabic allomorph in the SPL task, which could indicate a syllabicity effect under some conditions. The syllabicity effect could be further investigated in future research.

Recall that the experimental design of the perception judgment task in this study largely followed the perception task used in Solt et al. (2004). The results of this study support and build on the findings of Solt et al., who similarly found that the syllabic allomorph [əd] was better perceived than the non-syllabic allomorphs [d] and [t] by L2 learners and that the non-syllabic allomorph [d] was not perceived more accurately than the non-syllabic allomorph [t]. Indeed, Solt et al. found that their high proficiency learners (though not the low proficiency learners) were significantly more accurate in perceiving the non-syllabic allomorph [t] than the non-syllabic allomorph [d]. The results of both Solt et al.' study and the present study contradict the prediction made based on the criteria of perceptual salience (Goldschneider & DeKeyser, 2001), according to which, voiced stops are more perceptually salient than voiceless stops. The current study, including an additional set of regular past forms ending in non-syllabic singleton [Vd], also found that the non-syllabic singleton [Vd] was better perceived than the non-syllabic allomorphs [d] and [t], which corroborates previous works that suggest that vowels are more perceptually salient than stops (e.g., Goad, 2011; Goldschneider & DeKeyser, 2001). Remember that vowels are on the top of the sonority scale (Hogg & McCully, 1987; Laver, 1994), which means they have more acoustic energy and greater perceptual salience.

So far, relatively little research has been examined second language perception of inflectional morphology. It remains unclear the extent to which the interplay between L1 phonology and the phonetic form of the regular verb forms can influence second language

perception of the past tense morpheme *-ed*. The present study contributes to the literature by showing that the variable perception of the four allomorphs of the past tense morpheme *-ed* is related to influence from L1 phonology. Moreover, the present data indicate that both Korean and Chinese learners show a systematic pattern of perceptual difficulties in relation to the phonetic form of the regular verbs, with errors confined mostly to the non-syllabic allomorphs [d] and [t]. In sum, second language perception of English regular past tense morphology is affected by a combination of L1 phonology as well as more general properties related to the phonetic form of the regular verbs.

5.5 Research Question 5

The final research question for the present study was: Does L2 learners' perception of the regular past tense morpheme correlate with how they produce it? Thus, this question is about the relationship between perception and production in the L2. As mentioned earlier (see section 2.3), current views on this question is controversial. Some researchers have reported positive, albeit moderate, correlations between L2 segmental perception and production (e.g., Bettoni-Techio et al., 2007; Flege et al., 1997; Flege et al., 1999; Flege & Schmidt, 1995; Schmidt & Flege, 1995). In contrast, other researchers have found either weak or no correlations between the perception and the production of phonetic segments in a L2 (e.g., Hattori & Iverson, 2010; Levy & Law, 2010; Peperkamp & Bouchon, 2011).

In the present study, the extent to which the perception of the regular past tense morpheme correlates with the production of this morpheme was determined through Spearman's correlation tests. The correlations that were calculated for the entire set of regular past forms in the sentence repetition and perception judgment tasks showed no statistical relationship between the

perception and production of the regular past tense morpheme for any of the learner groups. Additionally, the correlations within each of the four allomorphs were also found to be not significant.

As mentioned in section 2.6, it was predicted that there would be a positive correlation between learners' perception and production of the English regular past tense morpheme. This prediction is made based on the assumption that speakers have a single prosodic grammar. However, the present data did not confirm the prediction by showing that there were no correlations between the two modalities.

If it is the case that the same prosodic grammar is involved in language production and perception, then the results reported in this study suggest that presumably it is something about the mechanisms of producing or perceiving these sounds (i.e., something outside of the grammar) that causes a disconnect between the two. Related to this argument, previous research has shown that perception and production skills for L2 contrasts do not necessarily follow parallel developments. For example, L2 phonetic training studies reported that while perceptual training was effective for improving both perception and production abilities, the amount of gains in segmental perception did not always align with the amount of improvement in segmental production (e.g., Bradlow et al., 1999; Bradlow et al., 1997).

There are several possible explanations for the discrepancy between those studies that show a clear relationship between production and reception and those that do not, including this one. One possibility might be that in some studies, learners' performance was assessed at the segmental level focusing on certain phonetic segments or contrasts, whereas in the current study, learners were tested at the sentence level with a focus on the past tense morpheme. Indeed, some researchers (e.g., Hattori & Iverson, 2009) have argued that the correlation between second

language perception and production seems to be restricted to certain testing methods. For example, Hattori and Iverson (2010) examined the relationship between the perception and production of English /r/ and /l/ by L1 Japanese speakers. Their results showed that there was a moderate correlation between English /r/-/l/ identification (perception task) and production; however, other perceptual measurements (i.e., /r/-/l/ discrimination and /r/-/l/ best exemplars) were found to be poorly related to the production of /r/ and /l/. What remains to be explained is why a sentence level task showed less connection between perception and production than a different task. It is possible that during a sentence level task, other factors may come into play that could have other effects: that is, a focus on meaning, grammar, etc. Moreover, a sentence level task is, by its nature, more memory-demanding than a segmental level task, although the test sentences in both the perception judgment and sentence repetition tasks in this study were controlled for length. As a result, learners' performance on the perception and production tasks may be affected by some other factors in addition to their perception and production abilities, which makes the cross-modal comparisons complicated.

Another related explanation for the differential findings across studies might be the differences in test materials and scoring procedures (Flege et al., 1999) or individual variations (Bradlow et al., 1997). Many of the studies that examined the relationship between perception and production in the L2 have been informed by the data from perceptual tests of consonants in the syllable-initial (onset) position, whereas the present study focused on [t] and [d] in coda position. Previous research has shown that Chinese ESL learners' perception of stop contrasts was more accurate in onset position than in coda position (Flege, 1989). Thus, the lack of a significant correlation between perception and production found in previous studies may have been due to the positional differences.

Finally, it is important to keep in mind that the fundamental differences in the nature of the perception and production tasks make the cross-modal comparisons complex. As noted by Mack (1989), "tests of speech perception requires methodologies, task demands, and measurement and evaluation procedures that are inherently different from those used in tests of speech production" (p.189).

As stated previously, inflectional morphology, especially in the verbal domain, is an area of specific difficulty for adult L2 learners. Many attempts have been made to locate the source of the difficulties experienced by L2 learners. In regard to English past tense morphology, several factors influencing suppliance of past tense marking have been identified in the literature. These factors include the availability of Universal Grammar, L1 morphosyntactic transfer, L1 prosodic transfer, difficulties in syntax-morphology mapping, etc. Some researchers have proposed that the perceptual difficulties caused by the *-ed* morpheme may also contribute to learners' errors in past tense marking. For example, Solt et al. (2004) argue that L2 learners' inability to perceive the past tense morpheme consistently is a barrier for them to produce this morpheme in a native-like fashion. Similarly, Goad (2011) also suggest that L2 learners' omission of English past tense morphology may be due to their inability to reliably perceive it. However, as discussed in section 2.3, the research to date has showed no support for a strict position on whether perception precedes production. The present study did not directly address the possibility of whether learners' morphological errors can be attributable to their difficulties in perceiving the *-ed* morpheme consistently; nevertheless, the results from this study suggest that L2 learners' production of the *-ed* morpheme does not necessarily correlate with how they perceive it. More evidence is required to validate the results of the current study. It is important both theoretically and for pedagogical reasons to understand where tense errors originate, and additional research is

called for to further examine whether perceptual challenges created by the *-ed* morpheme are one of the causes.

CHAPTER 6: CONCLUSION

This chapter is organized into three parts. First, the major findings of the present study will be summarized. Next, the theoretical implications will be presented. This chapter will conclude with a brief discussion of limitations of the study and some possible future directions.

6.1 Summary of the Findings

In terms of second language production of inflectional morphology, the results of the present study suggest that the production of English regular past tense morphology by Turkish and Korean speakers (who encode tense morphologically in their L1s) is influenced by a general phonological effect of final consonant clusters, while for Chinese speakers (whose L1 does not have past tense markers), their use of English regular past tense morphology is affected by both L1 morphosyntactic transfer and the general phonological effect of final consonant clusters. Moreover, the study results showed that the learners in all three L2 groups were more accurate with regular verbs ending in a single consonant (i.e., verbs taking syllabic allomorph [əd] and non-syllabic singleton [Vd]) than regular verbs ending in consonant clusters (i.e., verbs taking non-syllabic allomorphs [t] and [d]), suggesting that the phonetic form of the regular verbs plays a role in the production of English regular past tense morphology, regardless of the L1 phonology.

With respect to second language perception of inflectional morphology, the present data revealed that while the Turkish learners showed no differences in their perception accuracy between regular verbs ending in a single consonant and regular verbs taking non-syllabic allomorphs [t] and [d], both Korean and Chinese learners were less accurate with regular verbs taking non-syllabic allomorphs [t] and [d]. These results suggest that second language perception

of English regular past tense morphology is influenced by a combination of L1 phonological constraints as well as more general properties related to the phonetic form of the regular verbs.

To conclude, the findings of the present study contribute to better understanding of the problems that non-native speakers have with inflectional morphology and the possible sources of learners' errors. No single approach or hypothesis can neatly explain all non-target-like performance. The present study suggest that in addition to L1 morphological transfer, which has been extensively investigated in the field of SLA, phonological factors (that is, a general phonological effect of final consonant clusters) and the phonetic form of the regular verbs also contribute to learners' errors.

6.2 Theoretical Implications

As discussed in chapter 5, the results from the two oral production tasks lend some support to the Representational Deficit Hypothesis (RDH) (Hawkins, 2005; Hawkins & Liszka, 2003; N. Smith & Tsimpli, 1995) by showing that L2 learners' production of inflectional morphology is affected by the influence from L1 morphosyntax, even at relatively advanced stages. On the other hand, the Prosodic Transfer Hypothesis (PTH) (Goad et al., 2003), which states that interlanguage performance on morphological production is constrained by L1 prosodic structure, cannot completely accommodate the current data, particularly the data from the Korean group. However, neither the PTH nor the RDH can neatly account for the results of the comparison made between regular past forms with two-member codas and regular past forms with one-member codas by the three learner groups. Apparently, L1 morphosyntactic transfer is not the only factor affecting the use of inflectional morphology, and a general phonological effect of final consonant clusters do also influence learner performance. In sum, performance of

functional morphology in a L2 is affected by several factors, and taking into consideration both morphosyntactic and phonological factors provide a better understanding of why functional morphology is challenging for L2 learners.

6.3 Limitations and Future Research

One limitation of the present study is that due to practical time constraints, no independent English proficiency test was administered. L2 learner proficiency levels were determined based on their self-reported TOEFL iBT scores. Testing dates varied among the participants; although most of the L2 participants took their tests within two years of this study (16 Turkish, 19 Korean, and 20 Chinese), a few of them took the tests three or four years before (2 Turkish, 2 Korean, and 3 Chinese). The possibility exists that some of the learners had made significant improvement between taking their tests and participating in this research, thus rendering their TOEFL scores inappropriate as proficiency indicators. Future researchers may want to find other ways to determine relative proficiency among study participants.

Another limitation is regarding the experimental design. In this study, two tasks assessed the perception of inflectional morphology: a self-paced listening (SPL) task (which predisposed participants to focus on meaning) and a perception judgment task (which was form-oriented in nature). However, the SPL task turned out to be not sensitive enough to pick up on participants' reactions to inflectional errors, which limits the usefulness of the data. Other tasks that may be better for measuring sentence comprehension as well as perception of inflectional morphology are picture verification tasks in which participants are presented with sets of pictures accompanied by aurally-presented sentences. Concerning the production of inflectional morphology, the present study included both a story completion task and a sentence repetition task to investigate

L2 learners' use of English regular past tense morphology. The sentence repetition task was designed in a way that the effects of articulation were examined in a semi-natural way; that is, participants were tested whether they could articulate the sounds under investigation in a relatively natural way without the influence of a text. It remains to be seen whether the same results would be obtained if word reading lists are used. There is clearly a need for additional research.

One goal of the present study was to address the link between speech perception and production by L2 learners. The study results showed no significant correlations between the perception and production of the English regular past tense morpheme for any of the learner groups. As discussed previously, unlike previous studies which examined learners' performance at the segmental level, learners in the current study were tested at the sentence level. It is possible that learners' performance on a sentence level perception or production task may be affected by some other factors in addition to their perception/production abilities, thereby making the cross-modal comparisons further complicated. To better evaluate the correlation between the perception and production of the *-ed* morpheme, future studies can use stimuli such as isolated words or three-word phrases (e.g., *waited in line*, *played at home*).

As previously mentioned, L2 learners of English have been found to resort to different strategies in producing final consonant clusters (e.g., Chan, 2006, 2007; Edge, 1991; Hansen, 2001). These include, among others, epenthesis, vowel reduction, substitution of sounds, omission of a sound, and the presence or absence of voicing. The present study focused on the suppliance of word-final *-t/-d* and analyzed the production data based on the broad transcriptions on the target words and the words immediately following them. Future research can perform a spectrographic analysis, which might reveal very subtle properties about the ways the target words are produced

that cannot be easily captured by a broad transcription, such as vowel reduction and lengthening of a sound. For example, if a learner has difficulties producing [d] in words such as *filled*, it is possible that this learner might lengthen the vowel and/or lengthen the liquid /l/ when producing this word.

The focus of the present study was on English regular verbs. It is unclear whether similar results would be found if all verbs were included in the analysis (i.e., copulas, auxiliaries, and irregular verbs). According to Bayley (1996) and Bayley and Longman (2004), Chinese learners are twice as likely to omit the past tense in progressive contexts (e.g., *was washing*) than in simple past contexts. Moreover, the inclusion of irregular past forms containing consonant clusters and comparing them to regular past forms ending in consonant clusters will provide some insights to further investigate any effect of phonological constraints on the perception and production of past tense morphology, as many irregular verbs contain consonant clusters in their simple past forms (e.g., *lose-lost* [st]) in a way comparable to some regular past forms (e.g., *kiss-kissed* [st]). Previous research has shown that the irregular past tense is used more consistently than the regular past by learners[21] (e.g., Bayley, 1994, 1996; W.-H. Chen, 2010, 2011; Hawkins & Liszka, 2003; Lardiere, 2003; Wolfram, 1985, 1989; Wolfram et al., 1986). Additional research is required to address these issues.

The present study was mainly concerned with past tense marking in L2 English. Different from previous research, this study teased apart phonological and morphosyntactic issues in order to better address the question of whether the challenge L2 learners face with English regular past tense morphology is due to the absence of tense marking in the L1, or rather due to the presence of consonant clusters in regular past tense with the /ed/ allomorph. The current study contributes to

[21] The differences between regular and irregular verbs have been widely discussed in terms of whether they are represented in the same way in the mental mechanism (e.g., Pinker, 1999; Pinker & Ullman, 2002; Prasada & Pinker, 1993).

SLA research by investigating whether the phonological problems (if there are) extend to both production and perception, because if they do, it implies that it is a "grammar of phonology" issue, rather than an issue that is solely due to pronunciation or solely due to perception. The phenomenon of omission and unsystematic use of functional morphology is also attested in other linguistic structures in English (e.g., verbal agreement) and other languages. The investigation of Chinese learners' use of regular past forms and the past participles in English is a promising research perspective in that many of the past participles are identical to the regular past forms (e.g., *is punished*) and Chinese grammar realizes perfective aspect. In sum, studies of other linguistic structures in English as well as structures in other languages are needed to extend the results reported in the present study for the purpose of providing a more comprehensive understanding of the source of learners' errors and the reason for persistent difficulties with functional morphology by L2 learners.

APPENDICES

Appendix A: Word Familiarity Rating Scale

ELC class_____ First Language _____

Please rate the following words based on how familiar you are with them.
Please circle your answer.

		I know this word	I've heard of this word, but don't know it well	I don't know this word
1.	vivid	1	2	3
2.	valid	1	2	3
3.	splendid	1	2	3
4.	rigid	1	2	3
5.	solid	1	2	3
6.	rapid	1	2	3
7.	stupid	1	2	3
8.	arid	1	2	3
9.	field	1	2	3
10.	brand	1	2	3
11.	sand	1	2	3
12.	wild	1	2	3
13.	mild	1	2	3
14.	trend	1	2	3
15.	gold	1	2	3
16.	mist	1	2	3
17.	list	1	2	3
18.	rest (n)	1	2	3
19.	belt	1	2	3
20.	draft	1	2	3
21.	adult	1	2	3
22.	bead	1	2	3
23.	speed	1	2	3
24.	side	1	2	3
25.	tide	1	2	3
26.	wide	1	2	3
27.	shade	1	2	3
28.	slide (n)	1	2	3
29.	doubt	1	2	3
30.	fade	1	2	3
31.	rate (v)	1	2	3
32.	vote	1	2	3

		I know this word	I've heard of this word, but don't know it well	I don't know this word
33.	faint	1	2	3
34.	rent (v)	1	2	3
35.	attend	1	2	3
36.	hand (v)	1	2	3
37.	trade	1	2	3
38.	note (v)	1	2	3
39.	prevent	1	2	3
40.	pretend	1	2	3
41.	land (v)	1	2	3
42.	fill	1	2	3
43.	claim	1	2	3
44.	pile (v)	1	2	3
45.	mail (v)	1	2	3
46.	cause (v)	1	2	3
47.	scan	1	2	3
48.	blame	1	2	3
49.	smell (v)	1	2	3
50.	explain	1	2	3
51.	fail	1	2	3
52.	produce	1	2	3
53.	impress	1	2	3
54.	press	1	2	3
55.	smash	1	2	3
56.	punish	1	2	3
57.	brush	1	2	3
58.	introduce	1	2	3
59.	express	1	2	3
60.	promise	1	2	3
61.	dress	1	2	3
62.	flash	1	2	3
63.	flush	1	2	3
64.	fry (v)	1	2	3
65.	spray	1	2	3
66.	apply	1	2	3
67.	carry	1	2	3
68.	pray	1	2	3
69.	lie	1	2	3
70.	dry	1	2	3
71.	rely	1	2	3

Appendix B: Story Completion Task

Instructions:

Read each incomplete story. Your job is to complete each story using ideas that you create and using the **verbs** underneath each story. You can take all the time you need to finish the story, but do not spend too much time on any particular story. There are 8 stories to complete.

Note: *dress (v.)* means that remember to use *dress* as a verb.

Story: New US experience

A. Joe has lived in Los Angeles for several years. Last summer, his cousin, Sam, came to visit him. It was Sam's first time to travel to the United States. Sam was very excited but he did not speak English well.

   What did Sam do to improve his English? (attend)

   Where did Sam live during his visit in the U.S.? (rent (v.))

   What else did Sam do during his visit in the U.S.? (plan (v.))

   How long did Sam stay in the U.S. ? (stay (v.))

B. There was a shopping mall near where Sam lived.

   What did Sam do? (try on)

C. Joe helped Sam a lot during his visit in the U.S.

   What did Sam do? (express (v.))

Story: New cups

Mary's younger brother Andy is eight years old and he is a very naughty boy. Last month, Mary bought a new set of cups at a department store. Last week, Andy kicked a ball at home.

What happened? (smash into)

What did Mary do? (shout / blame (v.) / punish)

Story: House-warming party

A. Last month, Jessica moved to a new apartment. She invited her friends to her place to have a house-warming party last weekend.

   What did Jessica do? (show (v.))

B. Too many people went to her place. Jessica had to make some more food.

   What did Jessica make? (fry (v.))

   What happened? (smell (v.))

Story: My beloved pet!

When Lucy was five years old, her parents bought her a puppy as a birthday gift. She named her Angel. She was Lucy's best friend.

What did Lucy do with Angel? (play (v.) / dress (v.) / brush (v.))

What happened? (die)

Story: Jack-O-Lantern!

Anna and her boyfriend, Alex, went to a farm around Halloween time last year. The farm offered six pumpkin patches for visitors. (*patch* means a small area for planting pumpkins.) There was also a pumpkin carving competition. Anna was eager to join the carving activity, but she was not artistic at all. Alex was good at sketching people.

What/Who did Anna rely on? (rely on)

What did Anna and her boyfriend do? (paint / vote (v.) / kiss (v.))

Story: Workshop

A. Rachel teaches at a community college in New York. This year the school required all teachers to use a web-based course management system. She had no idea about how to use it. Last Friday, she went to a one-day workshop.

   What happened at the workshop? (introduce / explain)

   What did Rachel do at the workshop? (practice (v.))

B. After the workshop, Rachel went to the bus station to take a bus home. However, there was a severe thunderstorm later that day.

   What happened? (cause (v.))

   How long did Rachel wait? (wait)

Story: Flea market

Last month, Mark went to a flea market. There were so many buyers out there. Mark had an old guitar and he didn't need it anymore. He needed some bowls and plates.

What did Mark do? (carry / smile (v.) / trade (v.) / hand (v.))

Story: Dental insurance

Last year, Peter didn't have dental insurance. He searched on the internet and found some online.

He downloaded some application forms from the company's website.

What did Peter do? (fill out / mail (v.))

Appendix C: Test Items Used in the Sentence Repetition Task

(Sentences in bold indicate that they were presented for 3.5 seconds during test administration.

An asterisk indicates the sentence was presented for 4 seconds)

1. syllabic allomorph [əd]

doubted	I doubted all the answers.
faded	The noise faded away.
rated	I rated a lot of books.
noted	**He noted a problem with my work.**
fainted	She fainted at work.
prevented	**A policeman prevented a crime.**
pretended	**He pretended everything was fine.**
landed	The plane landed on water.

2. non-syllabic allomorph [d]

killed	A man killed a lot of people.
scanned	I scanned a book chapter.
claimed	She claimed a lot of money.
spelled	He spelled out every word.
piled	**He piled a lot of books into his car.**
trained	**Mother trained us to be honest.**
failed	She failed an exam.
paused	He paused in the doorway.

3. non-syllabic allomorph [t]

missed	I missed a call from her.
produced	**The factory produced a lot of cars.**
impressed	**The movie impressed us quite a bit.**
promised	I promised a gift to everyone.
pressed	He pressed a red button.

flashed	She flashed a smile at me.
finished	We finished our new house.
flushed	She flushed a toilet.

4. non-syllabic singleton [Vd]

snowed	It snowed a lot.
married	He married a girl from Texas.
prayed	I prayed a special prayer.
lied	She lied about her past.
cried	My daughter cried a lot.
dried	Parts of the river dried out.
sprayed	Oil sprayed out of the pan.
applied	**I applied a new cream to my face.**

5. monomorphemic words

vivid	*It was a vivid and emotional painting.
valid	This is not a valid address.
splendid	This is a splendid argument!
rigid	**He has a rigid exercise routine.**
solid	He would talk for a solid hour.
rapid	She has a rapid eye movement.
stupid	There are no stupid answers.
arid	This is an arid area.

field	***She is interested in the field of law.***
brand	This is a good brand of tea.
sand	She loves the sand and waves.
wild	**These animals are wild and free.**
mild	Some like a mild onion flavor.
trend	*The trend of wearing skirts is fading.
gold	**He found lots of gold and silver.**

cold	It is cold in Japan.
mist	**There was a bit of mist in the city.**
test (n)	The test is very easy.
best	My boss gave me the best offer.
list	I made a list of words.
rest (n)	**The rest of us went to the cinema.**
belt	**I bought a belt and suspenders.**
draft	**This is the second draft of my book.**
adult	An adult owl flew away.
road	**I went to the Silk Road in China.**
bead	There is a bead on the table.
speed	The speed is too fast.
side	**A man sat on the side of the road.**
tide	The tide is high right now.
wide	There is a wide avenue.
shade	He sat in the shade of a tree.
slide (n)	A slide excited the students.

Appendix D: Test Items Used in the Self-Paced Listening Task

(An asterisk indicates an ungrammatical form. ＋ indicates that a positive answer is expected and － indicates that a negative answer is required.)

Presentation List 1

(arranged by category)

1. syllabic allomorph [əd]

shouted	Last night / the mother shouted / angrily / in the room.
	＋Is this sentence about a parent?
waited	Yesterday / the man waited / an hour to vote.
	＋Is this sentence about an election?
pretended	*Right now / the child pretended / a stick / was a sword.
	＋Is this sentence about a kid?
traded	*Right now / the man traded / an apple / for three pears.
	＋Is this sentence about fruit?
noted	Yesterday / the man noted / a problem / with my paper.
	－Is this sentence about grocery shopping?
prevented	Last week / the man prevented / a crime / from occurring.
	－Is this sentence about a pencil box?
painted	*Right now / the man painted / a room / in the house.
	－Is this sentence about drinking?
landed	*Right now / the pilot landed / a plane / in the water.
	－Is this sentence about an oven?

2. *non-syllabic allomorph [d]*

piled	Yesterday / the man piled / a lot of logs / on the corner.
	＋Is this sentence about wood?
planned	Last week / the woman planned / a party / for her husband.

＋Is this sentence about a wife?

caused *Right now / the girl caused / a lot of issues / in her family.

＋Is this sentence about an unhappy experience?

trained *Right now / the firm trained / its workers / on its policies.

＋Is this sentence about a company?

filled Yesterday / the man filled / a glass / with beer.

－Is this sentence about the Pacific Ocean?

claimed Last year / the man claimed / Indian food / is good.

－Is this sentence about shopping?

mailed *Right now / the woman mailed / a letter / to Paris.

－Is this sentence about breakfast?

spelled *Right now / the student spelled / every word / correctly.

－Is this sentence about a mirror?

3. *non-syllabic allomorph [t]*

produced Last year / the company produced / a lot / of printers.

＋Is this sentence about electronics?

practiced Last year / the student practiced / a lot / of English.

＋Is this sentence about language learning?

punished *Right now /the teacher punished/ a student / for cheating.

＋Is this sentence about a punishment?

missed *Right now / the man missed / a call / from his mom.

＋Is this sentence about a son?

smashed Last night / the boy smashed / a plate / against the wall.

－Is this sentence about a car accident?

impressed Last week / the man impressed / everyone / with his knowledge.

－Is this sentence about walking a dog?

pressed *Right now / the man pressed / a button / to start the car.

－Is this sentence about painting?

brushed *Right now / the woman brushed / a cat / at home.

－Is this sentence about a microwave?

4. *non-syllabic singleton [Vd]*

died Last week / some people died / in the storm / in Texas.

＋Is this sentence about death?

snowed Yesterday / it snowed / a lot / in west Michigan.

＋Is this sentence about weather?

married *Right now / the woman married / a rich man / in China.

＋Is this sentence about marriage?

fried *Right now / the man fried / an egg / and bacon.

＋Is this sentence about cooking?

played Last week / the boy played / a video game / at home.

－Is this sentence about a piano?

sprayed Yesterday / the girl sprayed / a little water / on the flowers.

－Is this sentence about a boy?

applied *Right now / the man applied / a simple theory / in class.

－Is this sentence about taking a shower?

tried *Right now / the woman tried / a new recipe / at home.

－Is this sentence about wine?

5. fillers: plurality

The man / noticed / a few of his friends / in an image.

＋Is this sentence about a picture?

The teacher / remembers / all of his students / in his class.

＋Is this sentence about a male teacher?

The visitor / took / several of the rare coins / in the cabinet.

+ Is this sentence about money?

The tornado / damaged / many of the houses / in the town.

+ Is this sentence about a disaster?

*The group / decided to / discontinue / all of their project.

＋Is this sentence about the termination of the projects?

*The man / discovered / one of the elephant / was dead.

＋Is this sentence about animals?

*The man / persuaded / all of the visitor / to taste the pizza.

+Is this sentence about food?

*The woman / liked / some of the ring / on sale there.

+ Is this sentence about jewelry?

The child / was watching / some of the rabbits / in the room.

－Is this sentence about horses?

The fire / damaged / a lot of the books / in the library.

－Is this sentence about a park?

The girl / could recognize / none of the teachers / in the room.

－Is this sentence about taking a shower?

The couple / decided to buy / both of the pictures / by the artist.

－Is this sentence about laptops?

*The visitors / could see / a few of the ship / in the harbor.

－Is this sentence about airplanes?

*The school board / agreed that / one of the gym / should be fixed.

－Is this sentence about computer labs?

*The professor / wrote / a few of the article / in this issue.

－Is this sentence about dogs?

*The husband / repaired / all of the chair / in the living room.

－Is this sentence about a kitchen?

6. fillers: subcategorization

Everyone agreed / the team / should proceed / with the project.

＋Is this sentence about the continuation of a project?

The father / didn’t let his son / drive the car / that day.

＋Is this sentence about a parent and a child?

Headquarters / decided to / order the crew / to come back.

＋Is this sentence about a decision?

This sofa / cost / the owner / several thousand dollars.

＋Is this sentence about furniture?

* The couple / had to / consider their daughter / to daycare.

＋Is this sentence about parents?

*The kids / read this book / more interesting / than the other one.

＋Is this sentence about children?

*All the professors / wondered / the plan / was unreasonable.

＋Is this sentence about a poor plan?

*The man's boss / supposed him / to be there / as early as possible.

＋Is this sentence about a boss and his expectations?

The man / introduced the speaker / to everyone / in the room.

－Is this sentence about garage sale?

The man said / he did not allow / anyone / to enter the building.

－Is this sentence about a video game?

An attempt / was made / to persuade the board / to change the policy.

－Is this sentence about rabbits?

The parents / had done little / to make their children / happy in life.

－Is this sentence about a department store?

*The mother / showed her son / not to hurt himself / while cooking.

－Is this sentence about a conference?

*The boy / contacted his teacher / a letter / explaining his absence.

－Is this sentence about bottled water?

*The police / would not stop / the couple / to leave the scene.

－Is this sentence about taking a final exam?

*The doctor / picked the patient / the prescription / and then left.

－Is this sentence about a swimming pool?

Presentation List 2

(arranged by category)

1. syllabic allomorph [əd]

shouted	*Right now / the mother shouted / angrily / in the room.
	＋Is this sentence about a parent?
waited	*Right now / the man waited / an hour / to vote.
	＋Is this sentence about an election?
pretended	Last night / the child pretended / a stick / was a sword.
	＋Is this sentence about a kid?
traded	Last week / the man traded / an apple / for three pears.
	＋Is this sentence about fruit?
noted	*Right now / the man noted / a problem / with my paper.
	－Is this sentence about grocery shopping?
prevented	*Right now / the man prevented / a crime / from occurring.
	－Is this sentence about a pencil box?
painted	Last weekend / the man painted / a room / in the house.
	－Is this sentence about drinking?
landed	Yesterday / the pilot landed / a plane / in the water.
	－Is this sentence about an oven?

2. non-syllabic allomorph [d]

piled	*Right now / the man piled / a lot of logs / on the corner.
	＋Is this sentence about wood?
planned	*Right now / the woman planned / a party / for her husband.
	＋Is this sentence about a wife?
caused	Last year / the girl caused / a lot of issues / in her family.
	＋Is this sentence about an unhappy experience?
trained	Last month / the firm trained / its workers / on its policies.
	＋Is this sentence about a company?

filled	*Right now / the man filled / a glass / with beer.
	－Is this sentence about the Pacific Ocean?
claimed	*Right now / the man claimed / Indian food / is good.
	－Is this sentence about shopping?
mailed	Yesterday / the woman mailed / a letter / to Paris.
	－Is this sentence about breakfast?
spelled	Yesterday / the student spelled / every word / correctly.
	－Is this sentence about a mirror?

3. non-syllabic allomorph [t]

produced	*Right now / the company produced / a lot / of printers.
	＋Is this sentence about electronics?
practiced	*Right now / the student practiced / a lot / of English.
	＋Is this sentence about language learning?
punished	Last Friday / the teacher punished / a student / for cheating.
	＋Is this sentence about a punishment?
missed	Yesterday / the man missed / a call / from his mom.
	－Is this sentence about missing a bus?
smashed	*Right now / the boy smashed / a plate / against the wall.
	－Is this sentence about a car accident?
impressed	*Right now / the man impressed / everyone / with his knowledge.
	－Is this sentence about walking a dog?
pressed	Yesterday / the man pressed / a button / to start the car.
	－Is this sentence about painting?
brushed	Last night / the woman brushed / a cat / at home.
	－Is this sentence about a microwave?

4. non-syllabic singleton [Vd]

died	*Right now / some people died / in the storm / in Texas.

＋Is this sentence about death?

snowed *Right now / it snowed / a lot / in west Michigan.

＋Is this sentence about weather?

married Last year / the woman married / a rich man / in China.

＋Is this sentence about marriage?

fried Yesterday / the man fried / an egg / and bacon.

＋Is this sentence about cooking?

played *Right now / the boy played / a video game / at home.

－Is this sentence about a piano?

sprayed *Right now / the girl sprayed / a little water / on the flowers.

－Is this sentence about a boy?

applied Yesterday / the man applied / a simple theory / in class.

－Is this sentence about taking a shower?

tried Last weekend / the woman tried / a new recipe / at home.

－Is this sentence about wine?

5. fillers: plurality

*The man / noticed / a few of his friend / in an image.

＋Is this sentence about a picture?

*The teacher / remembers / all of his student / in his class.

＋Is this sentence about a male teacher?

*The visitor / took / several of the rare coin / in the cabinet.

+ Is this sentence about money?

*The tornado / damaged / many of the house / in the town.

+ Is this sentence about a disaster?

The group / decided to / discontinue / all of their projects.

＋Is this sentence about the termination of the projects?

The man / discovered / one of the elephants / was dead.

＋Is this sentence about animals?

The man / persuaded / all of the visitors / to taste the pizza.

+Is this sentence about food?

The woman / liked / some of the rings / on sale there.

+ Is this sentence about jewelry?

*The child / was watching / some of the rabbit / in the room.

－Is this sentence about horses?

*The fire / damaged / a lot of the book / in the library.

－Is this sentence about a park?

*The girl / could recognize / none of the teacher / in the room.

－Is this sentence about taking a shower?

*The couple / decided to buy / both of the picture / by the artist.

－Is this sentence about laptops?

The visitors / could see / a few of the ships / in the harbor.

－Is this sentence about airplanes?

The school board / agreed that / one of the gyms / should be fixed.

－Is this sentence about computer labs?

The professor / wrote / a few of the articles / in this issue.

－Is this sentence about dogs?

The husband / repaired / all of the chairs / in the living room.

－Is this sentence about a kitchen?

6. fillers: subcategorization

*Everyone permitted / the team / should proceed / with the project.

＋Is this sentence about the continuation of a project?

*The father / didn't show his son / drive the car / that day.

＋Is this sentence about a parent and a child?

*Headquarters / decided to / put the crew / to come back.

＋Is this sentence about a decision?

*This sofa / used / the owner / several thousand dollars.

＋Is this sentence about furniture?

The couple / had to / send their daughter / to daycare.

＋Is this sentence about parents?

The kids / found this book / more interesting / than the other one.

＋Is this sentence about children?

All the professors / thought /the plan / was unreasonable.

＋Is this sentence about a poor plan?

The man’s boss / expected him / to be there / as early as possible.

＋Is this sentence about a boss and his expectations?

*The man / refused the speaker / to everyone / in the room.

－Is this sentence about garage sale?

*The man said / he did not warn / anyone / to enter the building.

－Is this sentence about a video game?

*An attempt / was made / to give the board / to change the policy.

－Is this sentence about rabbits?

*The parents / had done little / to provide their children happy / in life.

－Is this sentence about a department store?

The mother / asked her son / not to hurt himself / while cooking.

－Is this sentence about a conference?

The boy / wrote his teacher / a letter / explaining his absence.

－Is this sentence about bottled water?

The police / would not permit / the couple / to leave the scene.

－Is this sentence about taking a final exam?

The doctor / handed the patient / the prescription / and then left.

－Is this sentence about a swimming pool?

Appendix E: Test Items Used in the Perception Judgment Task

1. syllabic allomorph [əd]

doubted	They doubted all of the claims.	They doubt all of the claims.
faded	The sounds faded away.	The sounds fade away.
rated	I rated a lot of films as three stars.	I rate a lot of films as three stars.
voted	They voted against the law.	They vote against the law.
fainted	Some girls fainted at school.	Some girls faint at school.
rented	I rented a room for a friend.	I rent a room for a friend.
attended	I attended a meeting.	I attend a meeting.
handed	I handed a card to her.	I hand a card to her.

2. non-syllabic allomorph [d]

killed	They killed a lot of people.	They kill a lot of people.
scanned	I scanned a document.	I scan a document.
blamed	They blamed it on her weight.	They blame it on her weight.
smelled	The dog smelled a cat.	The dog smell a cat.
smiled	They smiled at me.	They smile at me.
explained	He explained it to me.	He explain it to me.
failed	She failed every oral test.	She fail every oral test.
paused	He paused a lot of times.	He pause a lot of times.

3. non-syllabic allomorph [t]

kissed	I kissed a girl on the street.	I kiss a girl on the street.
introduced	I introduced a new student.	I introduce a new student.
expressed	He expressed a desire to work with me.	He express a desire to work with me.
promised	I promised a book to Shawn.	I promise a book to Shawn.
dressed	She dressed in black.	She dress in black.
flashed	I flashed a light at John.	I flash a light at John.
finished	I finished off the cake.	I finish off the cake.

flushed	I flushed a tissue down the toilet.	I flush a tissue down the toilet.

4. non-syllabic singleton [Vd]

showed	I showed a lot of photos.	I show a lot of photos.
carried	I carried a lot of money.	I carry a lot of money.
prayed	They prayed all the time.	They pray all the time.
lied	I lied about my age.	I lie about my age.
cried	I cried a lot when reading the book.	I cry a lot when reading the book.
dried	The streams dried up in summer.	The streams dry up in summer.
stayed	They stayed in the army.	They stay in the army.
relied	We relied on our own expertise.	We rely on our own expertise.

5. fillers: plural -s

	I bought two skirts and a bag.	I bought two skirt and a bag.
	I drank two cups of water.	I drank two cup of water.
	Many handbags are on sale there.	Many handbag are on sale there.
	I saw two boys in the park.	I saw two boy in the park.
	One of the cakes is gone.	One of the cake is gone.
	I had two apples and an egg.	I had two apple and an egg.

6. fillers: third person singular -s

	She wants to buy two oranges.	She want to buy two oranges.
	Everyone loves comic books.	Everyone love comic books.
	Bob works in a restaurant.	Bob work in a restaurant.
	He usually walks to school.	He usually walk to school.
	He needs to check in now.	He need to check in now.
	My sister plans a trip.	My sister plan a trip.

7. fillers: progressive -ing

	They are reading their books.	They are read their books.
	I am eating an apple.	I am eat an apple.

He is working in his office.	He is work in his office.
We are playing a game.	We are play a game.
Eric is wearing a t-shirt.	Eric is wear a t-shirt.
I was listening to music.	I was listen to music.

8. *fillers: comparative -er*

She is taller than her sister.	She is tall than her sister.
My sweater is older than yours.	My sweater is old than yours.
Sue is smarter than her brother.	Sue is smart than her brother.
Your pencil is longer than mine.	Your pencil is long than mine.
I come earlier than you.	I come early than you.
New York is bigger than Boston.	New York is big than Boston.

9. *fillers: performance check*

I have finished my courses.	I have finished the book.
She has corrected my mistakes.	She has corrected my errors.
Luke has cleaned his room.	Luke has cleaned his office.
I have turned in my paper.	I have turned in my homework.
I have eaten Mexican food.	I have eaten Indian food.
Mary has washed her car.	Mary has washed her t-shirt.
I have visited many countries.	I have visited Los Angeles.
I have danced for a long time.	I have danced for several years.
She has written a book.	She has written a paper.
She has cooked dinner.	She has cooked lunch.

Appendix F: Language Learning Background Questionnaire for L2 Learners

1. Age: _____

2. Gender: ___ Male ___ Female

3. Mother tongue (First language):_____

4. Year in college:

   Freshman Sophomore Junior Senior MA PhD Other_____

5. a. Major field of study: _____

   b. Minor (if applicable): _____

6. English Proficiency Test Score Name of test: _____ (e.g., TOEFL iBT)

   Test Year: _____ Total Score: _____

7. Please circle your proficiency level for English in the following areas.

	Beginning					Advanced
Reading	1	2	3	4	5	6
Writing	1	2	3	4	5	6
Listening	1	2	3	4	5	6
Speaking	1	2	3	4	5	6

8. At what age did you begin learning English at school or in private institutes? _____

9. How long have you been studying English? _____years_____months

10. At what age did you start living in an English-speaking environment? _____

11. How long have you been staying in English-speaking countries?

    _____years_____months

12. Have you ever visited an English-speaking country **besides your current stay in the US**?

_____ Yes _____ No

If yes, where and for how long?

Age	Location	Length of Visit	Purpose (i.e., study)
Example: 19	US	2 months	summer school

13. Please list any other languages that you have previously studied or been exposed to:

Language	Length of Study
Example: Spanish	1 year

Language	Length of Study

14. Outside of class, how many hours per week do you spend using English?

	Description	Use of time
Reading	Newspaper, magazine, book (including textbooks), academic journal, and any other types of reading activities in English	_____ hours per week
Writing	Homework assignment, essay, diary, English chatting (including electronics), and any other types of writing activities in English	_____ hours per week
Listening	Pop music (in English), lecture, TV, radio, and any other types of listening activities in English	_____ hours per week
Speaking	Conversation with friends, in-class discussions, and any other types of speaking activities in English	_____ hours per week

Appendix G: Language Learning Background Questionnaire for Native English Speakers

1. Age: _____

2. Gender: ___ Male ___ Female

3. Mother tongue (First language):_____

4. Year in college:
   Freshman Sophomore Junior Senior MA PhD Other_____

5. a. Major field of study: _____
   b. Minor (if applicable): _____

6. Please list any other languages that you have previously studied or been exposed to:

Language	Length of Study or Exposure

Is there anything else you would like to mention about your language background?

Thank you!

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