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Input Factors in Child ESL Acquisition of the Past Tense

by

Dorothy Anna Pawlina Pinto ©

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Abstract

Various dual- and single-route models have been proposed to account for the storage and processing of morphologically complex forms. This thesis evaluates the predictions of Bybee's single-route, Usage-based model (1995, 2001) with respect to the role of type and token frequency in the input and the acquisition of the English past tense. Data for this study were collected from a larger longitudinal study of 17 ESL children. At each of three testing rounds, a spontaneous language sample was recorded and a standardized elicitation task and receptive vocabulary size measure were administered. The frequencies of regular, irregular, and regular allomorph past tense forms in the input and the children's accuracy in the production of these forms were examined at each testing Round. The implications of these results for predictions of the Usage-based model as well as for the dual- vs. single-route processing debate are discussed.

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Chapter 1 – Introduction

Linguistic research has long focused on how language is processed and the nature of the underlying structure and organization of the mind. Investigations have sought to determine what speakers store in their mental lexicons, the nature of the information they store, and how this information is accessed and processed. In particular, many researchers have been interested in how we acquire and represent morphologically complex forms, specifically the productive and non-productive morphological patterns we encounter in our linguistic input, and how we then generalize these patterns to novel forms. Inflectional morphology has served as a starting point of research as it is obligatorily marked by adult speakers and can be elicited. Recent literature in the field of morphological processing has focused on past tense formation in English, with some cross-linguistic, second language, and bilingual investigation. Acquisition research has contributed to this field of inquiry by providing a means of observing how these linguistic systems develop and the factors that influence their development. The stages of acquisition and the types of errors that children make can aid us to better understand the underlying mechanisms by which language is stored and processed.

Two accounts of linguistic processing have stemmed from the literature: a dual- and a single-route model of processing. Proponents of the dual-route model claim that the regularities and irregularities of language are processed by separate mechanisms (Stemberger & MacWhinney, 1986; Marcus, Pinker, Ullman, Hollander, Rosen, & Xu, 1992; Kim, Marcus, Pinker, Hollander, & Coppola, 1994; Pinker & Ullman, 2002).

Irregular, idiosyncratic forms are claimed to be stored in the mental lexicon, whereas predictable patterns are extracted from the lexicon and stored separately as symbolic rules. Regular forms are claimed to be formed by applying these symbolic rules to base forms, thereby reducing the amount of redundancy in the mental lexicon resulting from the storage of predictable information (Chomsky and Halle, 1968). Some dual-route researchers have conceded that morphologically complex, high frequency regular forms may be stored in the lexicon, but that such storage is not necessary (Stemberger and MacWhinney, 1986; Pinker and Ullman, 2002). Other researchers have proposed single-route models in which a single mechanism is responsible for the processing of both regular and irregular forms (including Bybee 1995, 2001; Marchman and Bates, 1994; McClelland & Patterson, 2002). These models claim that the observed differences in their acquisition and production can be attributed to input factors, rather than symbolic rules. In such models, observed morphological patterns, or *schemas*, are claimed to be emergent from the lexicon. Morphologically complex forms are thus the units of storage and schemas are directly linked to these stored forms. Although the specific features of single-route models vary, they are generally highly complementary in their predictions and findings.

The morphological processing debate has mainly centered on inflectional morphology and the dual- and single-route processing models. This thesis will explore these two accounts of linguistic processing with particular emphasis on the predictions they make for the acquisition of the regular past tense allomorphs in English. This chapter will provide a general outline of the dual- and single-route processing models (Sections 1.1 and 1.2 respectively), with a more detailed examination of the specific single-route account being evaluated in this thesis in Section 1.3: the usage-based model proposed by Bybee (1995, 2001). An overview of past tense inflection in English and the dual-route and usage-based predictions for past tense acquisition are discussed in Sections 1.4 and 1.5. What previous research has discovered through cross-linguistic, bilingual, and L2 studies (Section 1.6) and the importance of studying L2 populations in particular (Section 1.7) are then presented. Finally, the research questions this thesis will address are outlined in Section 1.8.

1.1 The Dual-route Model of Linguistic Processing

Models of linguistic processing agree that irregular forms are stored in the mental lexicon as whole units. However, these models differ with respect to their accounts of the storage and processing of multimorphemic words formed through productive, predictable patterns. Are these forms decomposed into their constituent parts? Are these regular complex forms stored as whole units if their forms are predictable from their bases?

The dual-route model addresses these questions by claiming that morphologically complex forms are decomposed and that predictable elements are then abstracted away from forms in the mental lexicon and stored separately as symbolic rules. The mental lexicon remains, then, as a store of idiosyncratic forms, base forms, and grammatical information, *e.g.* irregular past tense forms are stored whole with the [PAST] feature listed in their lexical entries. In this way, the dual-route model aims to reduce the amount of redundancy present in the mental lexicon. The impetus for proposing these symbolic rules was the observed productivity of regular inflection in English. Speakers were observed to apply regular inflectional patterns in nonce word experiments (Berko, 1958) and diachronically, irregular forms in languages have been observed to regularize. In addition to these observations, children commonly form over-regularization (OR) errors, *i.e.* irregular past tense forms with regular past tense suffixes, during the process of language acquisition, thereby demonstrating overapplication of the regular past tense pattern (see Marcus et al., 1992, for a detailed examination of these errors from a dual-route perspective).

The symbolic rules outlined in the dual-route model are source-oriented, *i.e.* they dictate the process by which an output form is to be derived from a base representation. In the case of past tense formation, this is achieved through the concatenation of an abstract suffix to the verb base. The productivity of the regular past tense rule is attributed to its ability to apply to all forms in the lexicon that are marked as verbs and whose lexical entries lack the grammatical category [PAST]. Marcus et al. (1992) term this restriction on regular past tense application the 'blocking hypothesis.' It is thus a form's irregularity itself that blocks the regular rule from applying. If a speaker cannot access a morphologically complex form of a verb in their mental lexicon, *i.e.* an irregular or a highly frequent regular past tense form, due to production factors or because no such entry exists, the appropriate symbolic rule is accessed as a default and applied to the base form of the verb. The mechanism by which the past tense rule is extracted from the input and then abstracted into a symbolic rule and stored separately from the lexicon, however, is not made clear, a concern raised by Bybee (1995, p. 449).

The actual phonetic identity of the final output form resulting from the application of a rule is claimed not to be established in the morphology, but rather to be determined by a phonological filter (Marcus et al., 1992). Because they are stored separately from the lexicon, symbolic rules are predicted to be insensitive to factors such as frequency of past tense forms in the input, distribution frequencies in the mental lexicon, lexicon size, phonology, and semantics. All regular past tense forms are thus predicted to be formed by the same process, regardless of input factors. Another important feature of the dual-route model is its claim that symbolic rules are sensitive to abstract grammatical notions such as regular vs. irregular or base vs. derived distinctions (Kim et al. 1994; Oetting and Horohov, 1997). These predictions have been tested in the literature with various results. Many findings have not borne out the predictions of the dual-route model or can be re-interpreted and better accounted for by the single-route model. In addition to these symbolic rules, the model proposes a role for analogy to account for the limited productivity observed with irregular past tense forms.

1.2 Single-route Models of Linguistic Processing

In terms of the storage and processing of morphologically complex forms, alternate models of linguistic processing have been proposed which, in opposition to the dual-route model, claim that a single underlying mechanism is responsible for the storage and processing of multimorphemic words. These models claim that the processing of unpredictable, irregular patterns is subject to the same factors as the processing of predictable, regular patterns; the interactions of factors such as frequency in the input and phonological and semantic similarity contrive to differentiate regular and irregular forms in terms of their accessibility and productivity. Although other single-route models have been proposed in the literature, including a rule-based model dependent on structural similarity (Albright and Hayes, 2003), connectionist models (including Marchman and Bates, 1994; McClelland and Patterson, 2002), and Ramscar's analogical model (2002), this thesis will test the claims made by Bybee's Usage-based model (1995, 2001).

Usage-based models have been increasingly discussed in the literature and have been applied to the areas of phonology, morphology, and syntax. These models propose common processing mechanisms across language domains and, indeed, across other domains of cognitive processing (Kemmer and Barlow, 2000). This contrasts with dual-route models which uphold a modularized view of language with morphology being separate from phonology, etc. Usage-based models, a term first introduced by Langacker (1987), share a number of features, including a focus on the effects of language usage (*i.e.* comprehension and production) and frequency in the structuring of linguistic systems, an emergent view of linguistic representations and schemas, a central role for learning and experience, an understanding of the interconnectedness of language usage with synchronic variation and diachronic change, and an acknowledgement of the similarity of linguistic and non-linguistic cognitive systems (Kemmer and Barlow, 2000).

Bybee's Usage-based model (1995, 2001) will be adopted here because of its clear, testable predictions with respect to the acquisition of multimorphemic words. Longitudinal data from children acquiring English as a second language will be considered in light of Bybee's claims, particularly those of frequency effects in the input on the emergence of lexical representations and schemas.

1.3 Bybee's Usage-based Model of Linguistic Processing

1.3.1 Lexical representations.

In contrast with the dual-route model, Bybee's model (1995, 2001) claims that the development of lexical representations and schemas is shaped through language usage and experience. The units of lexical representation are *words*, including multimorphemic words. These representations are based on actual tokens of use and include all phonological and semantic detail from the input, *i.e.* predictable features are not abstracted away, a claim maintained by all usage-based models (Kemmer & Barlow, 2000, p. ix; Bybee, 2001, pp. 20-21). Evidence has been found in the literature to support not only the storage of irregular forms, but also of regular morphologically complex forms (Stemberger and MacWhinney, 1986; Pinker and Ullman, 2002; Bybee, 2000). These representations are strengthened in a speaker's lexicon each time they are accessed, both during production and in comprehension of linguistic input. Highly frequent forms more easily establish lexical representations and these are, in turn, easier to access in the mental lexicon due to their strength.

1.3.2 Role of frequency in linguistic processing.

Frequency will be discussed here in terms of both token and type frequency as defined by Bybee (1995, 2001). Token frequency in Bybee's model refers to the number of occurrences of an individual form (whether monomorphemic or multimorphemic) in a specified amount of language data. In the British National Corpus (BNC) Spoken All corpus, for example, the token frequency of the form 'jumped' is 152 tokens, 'walked' is 575 tokens, and 'kicked' is 127 tokens (British National Corpus, 2001). It should be noted that the token frequency of a *schema* can also be calculated and refers to the total number of occurrences of a pattern in a selected amount of language data. The token frequency of the [t] past tense allomorph schema, for example, would refer to the number of past tense forms with the [t] allomorph encountered in a specified amount of linguistic input. Type frequency, on the other hand, refers to the number of different forms to which a pattern or schema applies. For example, type frequency could be used to refer to the total number of verbs which follow regular past tense inflection, the number of different verbs which take the [t] past tense allomorph, or the number of different verbs which follow irregular past tense inflection. In this case, 'jumped', 'walked' and 'kicked' represent three instances of the [t] past tense allomorph *type*, but 854 [t] allomorph *tokens*. According the Bybee's model, token frequency serves to strengthen individual lexical representations. Type frequency, on the other hand, serves to strengthen schemas, *i.e.* the more forms a schema applies to, the more often it is accessed, and the stronger it becomes. Accessing one member of a schema serves to strengthen the entire schema and it is the strength of a schema that accounts for much of its productivity.

Bybee's Usage-based model clearly outlines the effects of frequency on linguistic processing. With repeated exposure to a form, *i.e.* with greater token frequency, its lexical representation is strengthened and becomes increasingly resistant to change. It is for this reason that highly frequent irregular forms are maintained in a language and less frequent forms will be susceptible to regularization over time (Bybee, 2001: 113-116). In fact, particularly high levels of token frequency are predicted to lead to the *autonomy* of lexical representations, *i.e.* the weakening of phonological and semantic associations with other representations. This autonomy is the result of a form being so easily accessed in the lexicon that it becomes subject to less internal analysis through the formation of associations with other lexical representations. Type frequency, on the other hand, is claimed to play a central role in the emergence and strengthening of schemas. The effects of type frequency are discussed in more detail below.

1.3.3. Generalizations, schema emergence, and gang effects.

As outlined above, lexical representations are claimed to be stored in the lexicon along with phonological and semantic details from the input. Associations are established among these lexical representations based on phonological and semantic similarities (Bybee, 2001; Albright and Hayes, 2003; Ramscar, 2002). Bybee notes that semantic relations take primacy over phonological ones and in this way accounts for suppletive relations, *i.e.* 'go' and 'went' are clearly associated but do not share phonological features (Bybee, 2001, p. 98). Ramscar (2002) also found evidence for semantic effects which resulted in nonce words being inflected *irregularly*. When semantic and phonological associations form in parallel, the internal structure of multimorphemic words emerges (Bybee, 2001, pp. 23-24). In this way, associations among lexical representations reveal morphological relations and the internal structures of multimorphemic forms. These associations can form at multiple levels of abstraction and thus result in layered representations and redundancy (Bybee, 2001, p.32). A form may be stored whole, its internal structure unanalyzed and autonomous, or it may have formed multiple associations, revealing how its component segments, syllables, and morphemes are all structured and related to other stored forms, essentially showing how it is embedded in the lexicon, a complementary view to that of connectionism. Redundancy, then, is present in the mental lexicon and is an important feature of all usage-based models (Kemmer & Barlow, 2000).

The Usage-based model hypothesizes that once a sufficient number of types of a pattern, such as the regular past tense, are acquired and associations have been formed among them and strengthened with use, a *schema* for the pattern emerges from the speaker's lexicon. Marchman and Bates (1994) propose that a minimum number of verbs must be acquired in the verb lexicon for a schema to emerge, termed the 'critical mass hypothesis.' Bybee's model does not explicitly include the critical mass hypothesis as such, but the two are complementary. The Usage-based model predicts that a schema will emerge once sufficient *types* of a specific pattern have been acquired, rather than just verb lexicon size, and associations have formed among them. Thus, we would expect various patterns to emerge asynchronously, *i.e.* as each individual pattern amasses sufficient types for a productive schema to become established.

Once a schema has emerged from a speaker's internalized lexicon, it is further strengthened by type frequency, *i.e.* the number of forms which demonstrate the pattern. The acquisition of mid to low frequency forms especially serves to strengthen a schema as these forms are by their nature subject to more analysis and are more likely to form associations with other lexical representations (Bybee, 2001, p. 120). As discussed earlier, very high frequency forms are more likely to be stored whole and autonomously, *i.e.* are less likely to form associations with other forms which would reveal their internal structure. Every time a regular form is accessed, both the lexical representation of the form itself and the forms with which it is associated in a schema are strengthened. Regular schemas are thus strengthened by type and token frequency. Irregular forms, however, are strengthened mainly through token frequency, as they do not participate in large, productive schemas.

Irregular forms participate in schemas to the extent that they can be categorized with similar irregular forms in the lexicon. If a form has a very high token frequency, it achieves a certain amount of autonomy and may not form associations with other forms in the lexicon. It is precisely for this reason that irregular forms are maintained in languages. However, small classes of irregular forms whose members share phonological features and who undergo a similar pattern of inflection may demonstrate limited productivity. The patterns demonstrated by such 'gangs' of irregular forms may be productively applied to novel forms which are highly similar phonologically and semantically to the other members of the class. This is termed a 'gang effect' and this analogical mechanism has been observed to demonstrate productivity in English in spite of the presence of a strong regular schema. Evidence of such an effect was found by Ramscar (2002) as well as by Bybee and Moder (1983).

1.3.4. Source- and product-oriented schemas.

The Usage-based model proposes that associations are formed between base forms and their derived forms, resulting in source-oriented schemas. This is reminiscent of the dual-route claim that regular past tense forms are formed from source-oriented symbolic rules. However, the Usage-based model further claims that associations also form among the derived forms themselves as these are also stored in the lexicon, resulting in product-oriented schemas (Bybee, 2001; Albright & Hayes, 2003). Product-oriented schemas define the features of output forms (*i.e.* family resemblances or prototypicality), without describing the processes needed to form them. This latter schema type has no equivalent in the dual-route model. Evidence for product-oriented schemas has been found in studies examining zero-marking (or no-marking) errors in past tense formation (Stemberger and MacWhinney, 1986; Marchman, Wulfeck, & Ellis Weismer, 1999). Marchman et al. (1999) found that verbs which already ended in alveolars were more likely subject to zero-marking errors. Although this study did not attribute this result to a product-oriented schema, Albright & Hayes (2003) and Bybee (2001) would both claim that the higher likelihood of alveolar-final verbs being zero-marked is due to the fact they resemble regular past tense forms, which as a family are defined as ending in alveolars: [t], [d], and [-əd].

1.3.5 Gradient productivity of schemas.

As the number of lexical representations being acquired increases and multiple associations are formed among them, schemas emerge which can themselves be accessed and productively extended to other forms. The likelihood of a schema being extended to a novel form is determined by the defining properties of its members, *i.e.* the phonological and semantic features shared by the schema members, and the strength of the schema itself as determined by type frequency (Bybee, 1995:430). This interaction between phonological and semantic similarity of a novel form to existing lexical representations and schema strength results in the gradient productivity of schemas. In terms of past tense inflection, for example, it is expected that there will be gradable variation in the past tense forms speakers produce for a novel form. The regular past tense schema in English is the strongest past tense schema and most likely to apply to novel forms due to its high type frequency; however, phonological and semantic similarity to an irregular form or a 'gang' of irregular forms may, in a sense, override the strength of the regular schema and result in the production of a novel irregular past tense form by speakers. In this way, even patterns of inflection associated with a small number of forms can demonstrate semi-productivity. Gradient productivity of schemas is a feature of other single-route models (Albright & Hayes, 2003; Ramscar, 2002; McClelland & Patterson, 2002). Gradient and context-sensitive productivity has also been observed in cross-linguistic studies, where multiple inflectional patterns may exist in a language (Nicoladis, Palmer, & Marentette, 2007; Orsolini, Fanari, & Bowles, 1998).

1.4 The English past tense.

In English, the past tense is an inflectional category obligatorily marked in past tense contexts. Verbs are most commonly inflected for this feature through a highly productive concatenative suffixation process. Verbs which are marked for the past tense in this way are termed regular past tense verbs and take one of three regular past tense allomorphs:

[t], *e.g.* walk**ed**, jump**ed**, rak**ed**;

[d], *e.g.* climb**ed**, clean**ed**, ti**ed**; or

[-əd], *e.g.* paint**ed**, skat**ed**, plant**ed**.

These allomorphs vary in their type and token frequencies, *i.e.* the number of verbs they each apply to and how often they occur in language. Their frequencies in English, as calculated from the British National Corpus (BNC) are examined in Chapter 3. Bybee's Usage-based model makes specific predictions with respect to the acquisition of the regular past tense allomorphs based on input frequencies. For this reason, allomorph frequencies were also calculated from the children's spontaneous language production in Chapter 3.

A much smaller number of verbs in English are inflected for the past tense through means other than the suffixation of one of the regular past tense allomorphs. These include vowel change (*e.g.* SEE=saw, DRIVE= drove, DRINK= drank), zero-change (*e.g.* PUT= put, HURT= hurt), suppletion (*e.g.* BE= was, were; GO= went, EAT= ate), as well as other irregular means (*e.g.* FEEL=felt, BUILD=built, HEAR=heard). Although there are fewer irregular than regular past tense verbs in English, they occur with a higher token frequency in speech, as discussed in Chapter 3. For the most part, irregular past tense verbs do not demonstrate productive patterns that are then extended to novel forms unless they belong to a 'gang' of phonologically similar forms inflected the same way for the past tense. Phonological similarity in terms of morphological and phonological processes is operationalized differently. Bybee (2001) defines phonological similarity in morphology as being holistic, *i.e.* less concerned with natural phonetic classes and more with family resemblances and comparison to a class exemplar (p. 130). As discussed earlier, such 'gangs' may demonstrate semi-productivity. An example of such a gang is: CLING=clung, STRING=strung, SWING=swung, FLING=flung (Bybee, 2001: p. 126-127).

1.5 Predictions of the Dual-route and Usage-based Models

The dual-route and Usage-based models are distinct in their processing claims. In the dual-route model, how forms are processed hinges on their structure, *i.e.* if they are regular or irregular, and this information is claimed to be included as part of their lexical entry (Marcus et al., 1992; Kim et al., 1992; Oetting and Horohov, 1997; Pinker and Ullman, 2002). On the other hand, the Usage-based model claims that the factors affecting processing are analogy, *i.e.* phonological and semantic similarity, as well as input factors such as frequency and number of types acquired in the lexicon (Bybee, 2001; Ramscar, 2002; Albright and Hayes, 2003). As a result, the two models make distinct predictions for morphological acquisition of the past tense in English.

1.5.1 Predictions for regular and irregular past tense acquisition.

The dual-route model and Bybee's Usage-based model differ in terms of the underlying mechanisms they claim are responsible for the acquisition of regular and irregular past tense forms. Both models predict that accuracy of regular past tense verbs production will generally emerge earlier than that of irregular past tense forms, although certain very high frequency irregulars may be accurately produced due to rote memorization. Dual-route models attribute this earlier accuracy with regular verbs to the presence of a symbolic rule for regular past tense formation. Bybee's Usage-based model, on the other hand, attributes this to a single mechanism and the interaction of input factors.

Both models agree that irregular past tense verbs are idiosyncratic and must be stored whole in speakers' mental lexicons. Irregular forms are thus sensitive to token frequency, *i.e.* they are acquired through repeated instances of occurrence in the input. It is expected that a speaker will require time to amass enough tokens of a particular irregular form before it is learned and stored in their lexicon.

As previously discussed, with respect to the acquisition of regular past tense inflection, the dual-route model claims that regular past tense forms are formed through the application of a symbolic past tense rule to a base form in the lexicon. Since it is stored apart from the lexicon, the past tense rule proposed by the dual-route model is not affected by input factors such as type and token frequency, which affect the lexicon itself. Bybee's Usage-based model, on the other hand, claims that regular and irregular past tense forms are stored in the lexicon. Associations form among these lexical representations and schemas then emerge from these associations, remaining directly linked to the lexicon. For this reason, lexical representations and schemas are claimed to be affected by input factors, particularly type and token frequency distributions of regular and irregular forms in the lexicon and the size of the lexicon itself (Bybee, 2001; Marchman and Bates, 1994). Bybee would predict that the emergence of regular past tense formation and its accuracy in production will be correlated with lexicon size and in particular the type frequency of regular past tense verbs in speakers' verb lexicons, *i.e.* what the speaker has internalized from their external linguistic input. Once a sufficient number of types of the regular past tense schema are acquired, speakers should demonstrate accuracy and productivity in regular past tense production. In conclusion, although both models predict a role for input frequency for irregulars, specifically token frequency, they contrast in terms of the role they attribute to the input in regular past tense processing.

1.5.2 Predictions for allomorph acquisition.

As described in Section 1.4, the regular past tense inflectional morpheme in English has three allomorphs: [t], [d], and [-əd]. The dual-route model makes no predictions with respect to the order and rate of acquisition of these allomorphs. According to the dual-route model, a regular past tense form is produced through the concatenation of a symbolic past tense suffix to a base verb by means of a symbolic rule. The final phonetic form of the output is determined by a phonological filter, outside of the morphology, and it is there that the appropriate regular past tense allomorph is claimed to be selected (Marcus et al., 1992). The final selection of the allomorph is claimed to be inconsequential to the morphology due to the clear distribution criteria for the regular past tense allomorphs: [d] affixes to verbs ending in voiced segments, [t] to verbs ending in voiceless obstruents, and [ed] only to verbs ending in alveolar stops. Therefore, the symbolic rule that adds the regular suffix is outside of the mental lexicon and the phonological output mechanism is beyond the morphology. For these reasons, dual-route models claim that the acquisition of the regular past tense allomorphs should not be influenced by input factors such as type and token frequencies in the input. Asynchronous allomorph schema emergence would not be predicted by a dual-route model.

On the other hand, Bybee's Usage-based model makes specific predictions with regards to the acquisition of the English past tense allomorphs. As shown in Chapter 3, the three allomorphs vary in their respective type frequencies in the input, and of the three allomorphs, the [d] allomorph is the most frequent in both type and token. Bybee's model would predict that due to its relatively high type frequency, the [d] past tense allomorph would be the easiest to acquire. Semantic and phonological associations would form among the multiple [d] allomorph past tense forms in the lexicon and the morphological relation of this allomorph as a past tense marker would then emerge as a schema once sufficient exemplars of the [d] allomorph are acquired. The model would predict the acquisition of the other allomorphs to be boosted by the acquisition of the first allomorph schema. This is made possible by the semantic association that holds among all the past tense suffixes, regardless of their phonological features: [PAST]. It is in this way that speakers encode the [d], [t], and [ed] past tense suffixes as allomorphs of the regular past tense morpheme.

Although the allomorphs may seem to be phonologically conditioned in that the allomorph is highly predictable from the stem ending, their relationship as allomorphs of the same morpheme must be learned from the input. According to the Usage-based model, the extension of the regular past tense to novel forms is not due to the application of an abstract rule and the selection of the appropriate allomorph by the phonology, but rather the selection of the appropriate past tense allomorph schema due to the phonological similarities of the novel forms to existing forms in these same schemas.

There has been some evidence in the literature of the non-uniform acquisition of the past tense allomorphs. Oetting and Horohov (1997) examined past tense production in spontaneous and elicited data in a study of children with and without specific language impairment (SLI). It was found that past tense productivity for children with SLI was influenced by the phonological features of the stem, *i.e.* stems ending in vowels and liquids were more frequently inflected for the past tense. Although Oetting and Horohov claimed their study supported a dual-route account, their results can be accounted for by Bybee's model using frequency. Stems ending in vowels and liquids take the [d] past tense allomorph, which of the three allomorphs has the highest type frequency. Bybee's model predicts that schemas with high type frequencies are first to emerge and are easier to access, accounting for the greater accuracy of children with this allomorph. In fact, Oetting and Horohov's findings run counter to the dual-route model, which attributes allomorphy to the phonology and predicts that their acquisition should be uniform.

1.6 Previous L2 Research

Second language (L2) and bilingual acquisition studies can greatly contribute to the past tense debate by testing some of the predictions of the dual and single-route models. In English past tense production, as discussed above, there is one dominant productive pattern of past tense formation and some smaller classes of irregular patterns or "gangs" which exhibit highly limited productivity. In other languages, however, there may be multiple regular and irregular patterns, each with differing type and token frequencies, demonstrating graded productivity. As discussed in Section 1.3.5, first language (L1) acquisition studies for languages other than English have observed the interactions of input factors and resulting graded productivity. Such studies permit us to test the dual-route hypothesis that productivity is diagnostic of symbolic regular rules, which apply categorically as defaults and are insensitive to frequency in the input. As well, we can determine the role of input factors in schema acquisition and productivity as purported by single-route theories.

There has been little previous research, however, on L2 populations and past tense acquisition, although there have been a handful of cross-linguistic and bilingual studies. Bilingual studies have tested claims of the single and dual-route models and what has been found for these populations to date has provided support for a single-route model of linguistic processing. Nicoladis et al. (2007) examined the role of type and token frequency in the acquisition of the past tense and the production of overregularization (OR) errors by French-English bilingual children. Bilingual studies are an ideal way to test cross-linguistic predictions because the speakers serve as their own controls for each language group. Nicoladis et al. found that bilinguals were less accurate than monolinguals in their regular and irregular inflection and this was attributed to the fact they had had less input in both languages. It was also found that OR errors were not attributable to high type frequency alone. As in the Italian L1 acquisition study conducted by Orsolini et al. (1998) (see Section 1.3.5), it was found that the bilingual speakers tended not to generalize regular patterns onto irregular base forms in French. This was found to occur because the five irregular inflectional patterns in French are highly predictable from the phonological features of the base form, even if the regular pattern has a high type frequency. Nicoladis et al. proposed four stages for developmental progression. These phases are driven by type and token frequency as well as by the achievement of a critical mass before the extension of patterns with a high type frequency to novel forms can occur. These phases would fit within Bybee's Usage-based model. Bilingual studies have also found evidence for the critical mass hypothesis (Marchman, Martínez-Sussman, & Dale, 2004). Marchman et al. (2004) compared the growth of vocabulary and grammatical measures through parental report data and spontaneous speech of English-Spanish bilingual children and observed an increase in grammatical complexity measures once a certain vocabulary size was achieved.

There have been even fewer studies examining the acquisition of the past tense within L2 populations. Murphy (2004) extended Prasada and Pinker's (1993) nonce word study with L2 adult speakers and compared them with two control groups: L1 adults and L1 children. Providing the subjects with only phonological cues for past tense inflection, similarity effects were found for both regular and irregular verbs, supporting a single-route model. Most importantly, however, there were no significant differences between the L1 and L2 populations, suggesting that the underlying mechanism for past tense inflection does not differ fundamentally in L2 acquisition.

Previous L2 and bilingual studies have tested claims made by the dual and single-route processing models with respect to lexicon size and accuracy in production (Marchman et al., 2004; Nicoladis et al., 2007), as well as phonological factors (Murphy 2004). These studies have employed various methods to test these claims, including the use of spontaneous language data (Marchman et al., 2004; Nicoladis et al., 2007), interviews and parental report (Marchman et al., 2004), and nonce word elicitation tasks (Murphy, 2004). Nicoladis et al. (2007) draw attention to some of the weaknesses of their own study, particularly the need for a systematic vocabulary measure, a robust measure of production accuracy with controlled target verbs, and longitudinal data. These are, however, common weaknesses of previous morphological processing studies conducted not only with L2 and bilingual populations, but also those with monolingual subjects. Marcus et al. (1992) and Marchman & Bates (1994), for example, critique each other's methods for relying solely on naturalistic data (Marcus et al., 1992) and parental report (Marchman et al., 1994). This study will test the claims of Bybee's Usage-based model by examining longitudinal data from three testing rounds in which not only was a spontaneous language sample collected, but a standardized vocabulary measure and a standardized past tense elicitation task were also conducted with all participants. In addition, a corpus of English was used to establish the frequency distributions of regular, irregular, and regular allomorph past tense forms in speakers' external input. Taken together, these measures allow us to examine the effects of frequency and lexicon size over time and how these are reflected in the participants' past tense production accuracy.

1.7 Second Language Acquisition

This thesis will examine data from children acquiring English as a second language to determine if the data supports predictions made by Bybee's Usage-based model in terms of their acquisition of irregular and regular past tense forms, as well as of the regular past tense allomorphs. Having already acquired a first language, L2 learners are cognitively more mature and have a greater metalinguistic awareness than age-matched monolingual children. For this reason, it would be expected that they should be better prepared for the task of acquiring the past tense inflectional system in their L2, having already acquired inflectional systems in their L1. The L2 data also provides us with the unique opportunity to examine English past tense production by children with limited exposure to the language. Bybee's Usage-based model, as discussed above, makes claims with regards to the process of past tense acquisition based on input frequencies. The past tense elicitation task is not possible to administer with monolingual children less than about 3;0 (year ; month) to 3;6 years of age. The Test of Early Grammatical Impairment (TEGI), for example, has been normed for children starting at age 3;0 to 8;11 (Rice & Wexler, 2001). At Round 1, the average months of exposure (MOE) of the children in this study was 9.47 months whereas their average chronological age (CA) 64.47 months (or 5;4). The L2 population is thus old enough to do an elicitation task at Round 1, and yet has had very little exposure to the target language, allowing us to see the effects of limited exposure on English past tense acquisition.

The Usage-based model makes many predictions based on frequency in the input and L2 children have had less input in their two languages as compared with age-matched monolinguals. The same can be observed of the bilingual population. Nicoladis et al. (2007) found that bilinguals were generally less accurate in their past tense inflection than age-matched monolinguals and attributed this to their having had less input in both their languages. This finding can be extended to predict that L2 speakers will be less accurate with past tense inflection at the early stages of their acquisition. This effect should be most evident in a past tense elicitation task where the child must supply a past tense form for a particular target verb. In such a task, we would expect L2 children to score below age-matched monolinguals. This effect may be less obvious in spontaneous language samples where children may employ various avoidance strategies to compensate for their difficulties with the past tense, a behaviour Nicoladis et al. observed with bilingual children in their study. With patterns that are sufficiently high in type and token frequency, L2 learners may be found to pattern with monolinguals, as Nicoladis et al. observed in bilinguals with the French regular past tense, which is high in both token and type frequency.

This study will examine data from children acquiring English as a second language from a variety of L1 backgrounds. With such a population, there may be concerns of L1 interference. The children could possibly demonstrate differences in their past tense acquisition due to their respective L1s and this may confound other factors considered here, such as input frequency. Studies with simultaneous bilinguals have shown that children acquiring two languages are able to differentiate their two languages early on in acquisition and that the two continue to develop independently of one another (Nicoladis et al., 2007; Marchman et al., 2004). However, the population under consideration here is composed of sequential bilinguals and it is thus possible that there may be evidence of L1 transfer at the initial stages of L2 acquisition. This interference may be phonological in nature, which is of some concern if phonological sensitivity is, indeed, a factor in processing as claimed by Bybee's model. It is possible that L1 interference could make English phonology more difficult to acquire. Paradis (2005) addressed the issue of possible phonological interference with the subjects examined in this study. The TEGI norming test includes a phonological probe to ensure that the children can produce word final obstruents and therefore should be able to produce the past tense suffixes. There does not seem to be any evidence that L2 acquisition is fundamentally different from L1 acquisition. Murphy (2004) did not find any significant differences between adult L1 and L2 speakers in terms of processing. O'Brien (2005) examined data from the same participants considered in this study and determined that L1 did not play a significant role in their English past tense acquisition.

There are also applied reasons for studying L2 speakers. Normed language tests are designed for monolingual speakers and the listed standard scores are based on the data collected from these monolingual speakers. Children acquiring English as a second language, however, have had less exposure to the language than their age-matched peers. Their resulting standard scores are thus biased. Although they may be scoring below their age-matched peers, this is not necessarily because they are not typically developing, but may be due to their limited exposure to English. It is important to conduct detailed and accurate comparisons of L2 learners with chronologically age-matched children as well as with children with language impairments to better evaluate their language abilities.

1.8 Research Questions

This thesis will examine three research questions stemming from the literature to evaluate the predictions made by Bybee's Usage-based model that contrast with those of dual-route models.

Chapter 3 considers frequency of past tense forms in the input, a central feature of Bybee's model. Specifically, the analyses address the following research questions:

1) a. What are the type and token frequency distributions of regulars, irregulars, and regular allomorphs in English, *i.e.* the children's *external input*?

   b. What are the frequency distributions of regulars, irregulars, and regular allomorphs in the children's lexicons, *i.e. internalized input*, at each round?

Chapter 4 addresses another of Bybee's hypotheses: the role of lexicon size, and specifically type frequency in the lexicon, in the acquisition of regular and irregular past tense production. The research question is formulated as follows:

2) Is lexicon size a factor in the acquisition, *i.e.* in the accuracy of production, of regular and irregular past tense verbs?

Chapter 5 examines the Usage-based claim that phonology plays a role in schema emergence, a claim that directly contrasts with the those of the dual-route model, as formulated below:

3) Is allomorphy a factor in the accuracy with which children produce the regular past tense? That is, are the three regular past tense allomorphs acquired simultaneously or consecutively?

Chapter 6 provides an overview of how the acquisition of the past tense in English progresses with reference to the input factors that drive it and the L2 data.

Chapter 2 – Methodology

2.1 Participants

The participants in this study were children learning English as a second language (L2) in western Canada. The data were collected as part of a larger longitudinal study with three testing rounds at 12-month intervals. Participants selected for the study spoke a minority first language (L1), had a mean age of 64.47 months (*i.e.* 5;4, years;months), and had had one and half years or less exposure to English. Of these participants, 17 were chosen for the present study. The subset of participants selected for this study was the same as that examined by O'Brien (2005). Table 1 outlines the language background, age of arrival (AOA), age of exposure to English (AOE), and chronological age (CA) in months at each round for each of the 17 participants, as well as the means and standard deviations for these measures.

A detailed parental questionnaire was administered to obtain information about each child's AOA, AOE, amount of English exposure in the home and school/daycare environments, and general L1 development, among other background variables. The children were also administered the Columbia Mental Maturity Scale (CMMS; Burgemeister, Hollander Blum, & Lorge, 1972). Children for whom there were no parental or school-based concerns with regards to their language development and who scored within normal range on the CMMS were considered to be typically developing and thus met the inclusion criteria for this study.

As can be observed in the table below, five of the children were born in Canada, but were not exposed to significant amounts of English until they were older. The rest of the children came from families who had recently immigrated to Canada.

Table 1

Participant Identification Codes and Background Information

Participant	L1	AOA	AOE	CA			MOE		
				R1	R2	R3	R1	R2	R3
CHRS27	Romanian	69	69	74	89	101	5	20	32
CNDX25	Mandarin	73	73	81	93	105	8	20	32
DNLN36	Cantonese	1	48	62	73	86	14	25	38
DNNC29	Mandarin	53	55	64	75	89	9	20	34
DNNS35	Mandarin/Cantonese	42	47	54	67	79	7	20	32
DVDC05	Spanish	67	67	75	87	99	8	20	32
JNNH18	Mandarin	53	53	71	83	95	18	30	42
LLKC08	Arabic	1	47	58	70	82	11	23	35
MRSS24	Mandarin	56	56	60	72	84	4	16	28
RNL28	Cantonese	1	40	56	68	80	16	28	40
SBST17	Spanish	45	46	61	73	86	15	27	40
SHHN32	Farsi	64	66	78	90	102	12	24	36
SMNS22	Spanish	60	60	66	79	89	6	19	29
THRJ33	Farsi	37	39	50	62	74	11	23	35
TNYN20	Mandarin	68	70	77	89	103	7	19	33
TRRK11	Arabic	1	42	50	61	79	8	19	37
YSSF12	Arabic	1	57	59	70	83	2	13	26
M		40.71	55.00	64.47	76.53	89.18	9.47	21.53	34.18
SD		28.12	11.05	9.91	10.22	9.79	4.43	4.33	4.39

Note. L1= First language; AOE= Age of Arrival in months; AOE= Age of Exposure in months; CA= Chronological Age in months; MOE= Months of Exposure of English (MOE); R1, R2, and R3= Rounds 1, 2, and 3

2.2 Procedures

2.2.1 Spontaneous language sample.

Thirty-minute samples of the children's spontaneous language production were collected from video-recorded freeplay sessions between each child and an interviewer. These transcripts were transcribed and coded by a number of research assistants using CHAT (Codes for the Human Analysis of Transcripts) formatting, a standardized system for coding conversational transcripts developed for the Child Language Data Exchange System Project (CHILDES; MacWhinney, 2000). The interview transcripts were then coded by research assistants for a number of features including past tense contexts, *i.e.* utterances in which a past tense verb is required by the discourse context. Interrater reliability for transcription and coding was calculated for ten percent of the corpus. Two research assistant independently transcribed and coded the same transcripts and these transcripts were then compared for discrepancies in transcribed words and coding. Interrater reliability for transcription at Round 1 was 91-98% for words in transcription, 91-93% for coding; Round 2 was 90-97% for words in transcription, 87-93% for coding; Round 3 was 95-96% for words in transcription, 85-92% for coding.

2.2.2 Peabody Picture Vocabulary Test (PPVT).

The Peabody Picture Vocabulary Test (PPVT; Dunn & Dunn, 1997), a measure of overall receptive vocabulary, was administered to the children at each round as a measure of lexicon size. In this test, the child is presented with four pictures and is asked to point to the picture corresponding to the word provided by the investigator, *e.g.* 'Show me panda', 'Point to coming', etc. This is admittedly not a fine-grained verb vocabulary measure as it assesses the children's abilities to identify pictures of target items that include nouns, verbs, and adjectives. Therefore, the PPVT does not directly measure types and tokens of regular and irregular verbs in each child's vocabulary. Intuitively, however, a child with a larger receptive vocabulary, as compared to a child with a smaller receptive vocabulary, has acquired more past tense verbs. In this study, then, the PPVT receptive vocabulary score is taken as a measure of the size of a child's internalized input or lexicon.

The PPVT results are provided as raw scores rather than standardized scores. This test has been normed for monolingual English speakers and a child's standard score is calculated based on their age. As compared with their monolingual age mates, the children in this study have had considerably less exposure to English. This is due both to their later ages of exposure to English and also to the presence of their L1 in the home. Therefore, the use of standard scores for these children constitutes inappropriate norm referencing for age-based expectations.

2.2.3 Elicited past tense probe – TEGI PTP.

The Test of Early Grammatical Impairment (TEGI: Rice & Wexler, 2001) past tense probe (PTP) provides a controlled measure in which all the children were presented with the same target verbs at all three rounds. In the TEGI PTP, children are presented with two pictures: the first illustrates a character in the process of carrying out an action (*e.g.* raking, skating, jumping, climbing, etc.) and the second illustrates the completion of the action. The examiner describes the activity being undertaken by the character in the first picture (*e.g.* 'Here the boy is raking. Now he is done.') The child is then prompted to describe the second picture showing the end state of the action (*e.g.* 'Tell me what he did'). The children's responses are prompted to be provided in full sentences so as to unambiguously establish a context in which adult speakers would require a past tense verb (Rice & Wexler, 2001: p.53). Responses provided without a subject were unscorable. Other responses considered to be unscorable were those which did not include an attempt at a past tense verb, those with verbs whose past tense forms are ambiguous with respect to their present tense forms (*e.g.* PUT, HURT), those which included the verb provided in the prompt (*i.e.* DO), and those responses which the child provided for more than three different targets (*e.g.* use of 'he finished' for multiple targets as a response strategy). Targets for which the child did not respond were scored as 'no response'. Unscorable items and items for which there was no response were excluded from the denominator for scoring purposes, rather than assigned zero scores.

The target items for the past tense probe were 'selected for familiarity, ease of naming, and ease of visual depiction' from spoken words compiled by Hall, Nagy, & Linn (1984) from children aged 4;05-5;00 (Rice and Wexler, 2001). The TEGI PTP test items are thus controlled for frequency in the sense that the target items selected are known to occur frequently in child speech. The targets were also selected to provide an adequate sample of both regular and irregular verbs with 10 and 8 target forms respectively. The regular target verbs were chosen to represent the three past tense allomorphs: 3 [d] targets (*cleaned, climbed,* and *tied*); 4 [t] targets (*brushed, kicked, jumped,* and *picked*); and 3 [ed] targets (*painted, planted,* and *lifted*). The irregular targets include *caught, made, wrote, rode, dug, ate, blew,* and *gave* .The TEGI PTP thus provides us with a basis for comparing accuracy in the production of regular and irregular verbs across all children and across all three rounds.

2.3 Additional Data Sources

2.3.1 British National Corpus (BNC).

Bybee's Usage-based model attributes a primary role to frequency effects in the input on the development of the linguistic processing system. Previous studies have often cited the results of Francis and Kučera's (1982) frequency analysis of the Brown Corpus of Standard American English, a corpus of approximately 1 million words collected from materials printed in the United States in 1961, for frequencies of particular word forms or lemmas. The present study, however, will employ the British National Corpus (BNC) as it is not only a larger corpus, but also has a substantial spoken language subcorpus and search tools which facilitate accurate frequency counts based on part of speech (British National Corpus, 2001).

The British National Corpus is a principled corpus, *i.e.* there are specified inclusion criteria for language samples, and is comprised of both spoken and written samples of English for a total of 100 million words (British National Corpus, 2005). All words in the BNC corpus are automatically coded and tagged with part of speech tags (POS-tags). These tags are assigned to each word based on its specific grammatical word class, *e.g.* plural common nouns (NN2), lexical present participle verbs (VVG), and, as relevant to this analysis, lexical past tense verbs (VVD). The University of Alberta has access to the BNC as well as the BNCweb interface (Lehmann, Hoffman, & Schneider, 2002), which provides the user with multiple search tools and the ability to restrict searches to specified subcorpora as defined by demographic factors, region, interaction type, etc. Although it is possible to search by POS-tag using the BNCweb Frequency Lists option, such searches are restricted to the whole corpus or to either the entire

Written or Spoken subcorpora. Using the BNCweb interface, it is not possible to restrict the POS-tag search to user-defined subcorpora.

For this reason, an interface for the BNC developed by Mark Davies, Variations in English Words and Phrases (VIEW), was used (Davies, 2005). This interface is freely accessible to the public and permits the user to search by POS-tags in user-defined subcorpora. Search results include all words coded by the specified POS-tag, their token frequencies in the subcorpus, their tokens/million words (*i.e.* the average number of times that the search string is expected to occur in a one million word sample of the specific subcorpus searched), as well as a link to the text in which the word occurred. Tokens per million is thus a measure which is sensitive to the size of the corpus, allowing for frequency comparisons across corpora to the extent that the corpora being compared are truly representative of their respective genre/register/etc.

Corpus searches were conducted on the Spoken All subcorpus, which is comprised of transcripts from all the spoken language samples in the BNC and contains 10, 334, 947 words. A smaller subcorpus of classroom speech from classrooms with students aged nine years to college age (Spoken Classroom: 429, 970 words) was also selected as likely to be more representative of the speech children encounter to determine if speech in this domain in terms of past tense production is qualitatively different from spoken English in general. The Spoken Classroom subcorpus is available as a predefined subcorpus in the VIEW interface.

2.4 Analyses and Predictions

2.4.1 Frequency distribution in external and internal input.

Input frequencies were calculated using the spoken subcorpora of the British National Corpus using the VIEW interface to determine the distribution of regulars, irregulars, and regular allomorphs in the input. The two subcorpora, Spoken All and Spoken Classroom, were searched by a research assistant for all instances of lexical past tense verb forms (VVD). The maximum number of hits to be returned from the corpus must be specified and as per personal communication with Mark Davies, the research assistant set this to 10, 041 in order to capture all instances of this POS-tag (Sorenson, 2006: p.32). The search results were exported into an Excel spreadsheet and the verb forms were identified by a research assistant as instances of irregular or regular past tense forms. The regular verb forms were then further sorted by allomorph: [t], [d], or [ed]. Certain forms were excluded from these counts, such as those which were identified as having been incorrectly coded as lexical past tense verbs, *e.g.* 'zed', and those without a unique past tense form, *e.g.* PUT, HURT, etc. See Appendices A and B for all irregular past tense verbs from the BNC Spoken All and Spoken Classroom subcorpora.

To confirm that the children's lexicons develop towards having the same distributions as those found in the external input, their spontaneous language production was examined at all three rounds to calculate their type and token frequencies of regular and irregular verbs, as well as the type and token frequencies of each of the regular past tense allomorphs. This was done by extracting all past tense contexts from the spontaneous language samples using the Computerized Language Analysis (CLAN) program. CLAN was specifically designed to conduct automatic analyses such as frequency counts, word searches, and morphosyntactic analyses using CHAT files and is made available on the CHILDES website (MacWhinney, 2000). All verbs produced in past tense contexts were listed by lemma, *i.e.* the verb the child attempted to produce, and coded as regular, *i.e.* those verbs that take the regular past tense suffix, or irregular, *i.e.* those verbs for which the past tense is formed by means other than adding the past tense suffix, including vowel change, zero change, or suppletion. The regular verb forms were further coded by allomorph, *i.e.* [d], [t], or [ed]. The token frequency, *i.e.* number of occurrences, was then calculated for each lemma.

Each lemma was listed with its total token frequency, total tokens correct production, and the number of children who attempted to produce the lemma in a past tense context. As with the BNC analyses, only lexical verbs were counted, *i.e.* verbs functioning as modals or auxiliaries were omitted. All instances of BE, DO, and HAVE verbs were excluded as these often function as auxiliaries. In addition, forms in which the past tense and present tense forms of a verb are indistinguishable, *e.g.* PUT, HURT, etc. were also omitted since an accurate judgement as to whether the child had produced a correct past tense verb or a commission error could not be made. See Appendices C, D, and E for past tense verbs from Rounds 1-3 of the children's spontaneous language samples.

2.4.2 Lexicon size and accuracy.

As described in Chapter 1, Bybee's Usage-based account claims that lexical representations and schemas *emerge* from the input. This coincides with Marchman and Bates' (1994) critical mass hypothesis, namely that a certain amount of input is required before a morphosyntactic pattern is acquired, or as Bybee would claim, a certain number of types must be acquired for a schema to emerge. This contrasts with the dual-route approach for regulars, but not for irregulars. As outlined in Section 2.2.2, lexicon size was estimated at all rounds using the PPVT and accuracy was calculated for both regular and irregular targets on the TEGI PTP. T-tests were conducted at each round to determine if regular accuracy scores differed significantly from irregular accuracy scores. A Pearson correlation was conducted to determine how the children's PPVT raw scores interacted with their percent correct production of regular and irregular past tense production on the TEGI PTP. In another approach to this research question, the same methodology was employed to determine if each individual child's raw token frequencies of regular and irregular verbs in their spontaneous language samples were correlated with their accuracy scores on the TEGI PTP. See Appendix F for a list of the TEGI target verbs and their frequencies in the BNC Spoken subcorpora.

2.4.3 Allomorphy and accuracy.

As discussed in Chapter 1, Bybee's Usage-based model and the dual-route model make opposite predictions with respect to the acquisition of the regular past tense allomorphs:[t], [d], and [ed]. Accuracy of regular past tense allomorph production was calculated using the spontaneous language samples. The TEGI PTP contains only three [d] and [ed] targets and four [t] targets and cannot be used to see how the type and token frequencies of each allomorph increase over the three testing rounds. Bybee's model predicts that the acquisition of the regular past tense allomorphs should occur at different rates and be driven by their type frequencies in the input. The spontaneous data thus provided a better method in which to test these predictions. Each child's token correct regular past tense verb productions were tallied at each round, sorted by allomorph, and their means and standard deviations calculated. Three, one-way ANOVAs were conducted to determine if the mean correct tokens for the three allomorphs were significantly different from each other over the three rounds. If the ANOVA results were significant, pairwise comparisons were then conducted between [t] and [d], [d] and [ed], and [t] and [ed] to determine which pairs demonstrated significant differences in accuracy.

Chapter 3 – Input Frequency

In order to determine how frequency affects the acquisition of regular and irregular past tense verbs as well as the acquisition of the regular past tense allomorphs, the distributions of regulars, irregulars, and regular allomorphs in the input must first be established. Analyses examining their frequencies in the external input were conducted using the British National Corpus (BNC) and the VIEW interface as described in Section 2.3.1. Bybee's model also makes specific claims regarding schema emergence from the learner's lexicon, therefore, frequency was also examined in the children's spontaneous language productions as described in Section 2.2.1. Section 3.1 examines the frequencies of regular and irregular past tense verbs in both the external input and in children's spontaneous language productions at all testing rounds. Regular past tense allomorph frequency distributions in the external input and in the children's spontaneous data are examined in Section 3.2.

3.1 Regular and Irregular Past Tense Frequencies in the BNC

Two subcorpora were selected from the BNC for this analysis: all spoken transcripts (Spoken All – 10 334 974 words) and spoken classroom transcripts (Spoken Classroom – 429 970 words). A search was conducted for all verbs tagged VVD in the subcorpora (see Section 2.3.1). In this way, the type and token frequencies of regular and irregular verbs in the Spoken All and Spoken Classroom subcorpora were compiled, as well as their tokens/million words, a measure sensitive to the size of the corpus searched so that comparisons can be made across corpora. The results are summarized in Tables 1 and 2.

Table 2

Frequencies and Frequency Ratios from the BNC Spoken All Subcorpus

	Types	**Tokens**	**Tokens/million words**
Regular	2317	37666	3646
Irregular	167	257176	24884.05
Ratio	**14:1**	**1:7**	**1:7**

Table 3

Frequencies and Frequency Ratios from the BNC Spoken Classroom Subcorpus

	Types	**Tokens**	**Tokens/million words**
Regular	291	1102	2563.61
Irregular	77	2278	5298.08
Ratio	**4:1**	**1:2**	**1:2**

Both subcorpora show that regular past tense forms have a greater type frequency than irregular forms, but that irregular forms on average have higher token frequencies. This difference is especially pronounced in the Spoken All subcorpus. The input learners are exposed to appears to have many tokens of individual irregular verbs, but also provides substantial evidence of a regular past tense *schema.* Speakers frequently encounter regular past tense verbs in their external inputs, even if on average the token frequency of any individual regular past tense form is low.

Bybee's Usage-based model proposes that it is type frequency that drives productivity, and ultimately, acquisition. From these results, we would expect that learners would acquire and demonstrate productive and accurate use of regular past tense verbs before they are accurate with irregular past tense verbs. As discussed in Chapter 1, the acquisition of the regular past tense is aided by both type and token frequency in the input. Irregular past tense verbs, on the other hand, must be memorized; the only source of input for most irregulars is token frequency, although gang effects may contribute the productivity of some irregular verbs.

3.2 Regular and Irregular Past Tense Frequencies in Spontaneous Language Samples

The BNC provides us with a measure of regular and irregular frequencies in spoken English in the external input, as we cannot determine the exact nature of each individual child's input. Bybee's Usage-based model, however, states that schemas are emergent from each individual's lexicon, *i.e.* their internalized input. The children's frequency of regular and irregular past tense production in their spontaneous language samples were calculated at each round as described in Section 2.4.1 as a measure of what they have internalized from their external input. This is an uncontrolled language measure, therefore comparison could not be made across transcripts for specific verbs due to the variety in past tense contexts and verbs employed. To parallel the BNC distributional analysis in Section 3.1, past tense contexts from all transcripts were combined at each round. The results of this analysis are provided in Table 4 below.

Table 4

Frequencies and Frequency Ratios from the Spontaneous Language Samples

	Type			Token			Difference Type		Difference Token	
	R 1	R 2	R 3	R 1	R 2	R 3	R2-R1	R3-R2	R2-R1	R3-R2
Regular	39	65	89	114	186	216	26	24	72	30
Irregular	36	40	54	264	410	461	4	14	146	51
Ratio	**1.1 : 1**	**1.6 : 1**	**1.6 : 1**	**0.4 : 1**	**1 : 2.2**	**1 : 2.1**				

Results in Table 3 show that the children's combined past tense productions at all three rounds generally reflect the same trend observed in the BNC subcorpora, namely that regular verbs demonstrate a higher type frequency than irregular verbs and that irregular verbs on average demonstrate higher token frequencies than regular verbs. Although the types of regular and irregular verbs are similar at Round 1 with a ratio of 1.1 to 1, the proportion of regular to irregular types increases over the three testing rounds, attaining a ratio of 1.6 : 1 at Round 3. In terms of token frequency, the irregular verbs are approximately twice as frequent in the children's verb lexicon than regular verbs at all three testing rounds.

It can also be observed from the verb lexicon that regular past tense *type* frequency demonstrated greater increases at each round than the irregular verbs, for which the type frequency changed gradually from round to round. We can compare increases of 26 and 24 types at Rounds 2 and 3 respectively for regulars as opposed to increases of only 4 and 14 types and Rounds 2 and 3 for irregulars. The *token* frequency of irregular past tense verbs, on the other hand, increased at a greater rate than the token frequency of regular past tense verbs. Irregular tokens increased by 146 and 51 tokens compared with increases of 72 and 30 tokens of regular verbs at Rounds 2 and 3 respectively.

It is probable that the differences between regular and irregular type and token frequencies in these children's lexicons will become more pronounced and more reflective of the external input if we examine language production beyond the age range examined here. From the Table above, it is apparent that the children's verb lexicons are developing according to the trend observed in the BNC data: both the regular and irregular verbs are increasing in both type and token frequency over time; regular verbs demonstrate a higher level and greater growth in type frequency than irregular verbs; and irregular verbs exceed regular verbs in level and growth of token frequency. The children's lexicons appear to be approaching the distributions observed in the external input. However, as the Usage-based model predicts that each individual's linguistic processing system develops based on the composition of their mental lexicon, predictions for acquisition will be made based on the frequency distribution results of the spontaneous language samples.

3.3 Allomorph Frequency Distributions in the British National Corpus (BNC)

As described in Chapter 2, two subcorpora of the BNC were selected to determine type and token frequencies in the external input: Spoken All (10 334 974 words) and Spoken Classroom (429 970 words). The results of the BNC corpus searches for type and token frequencies of regular past tense lemmas categorized according to the past tense allomorphs they take are provided in Tables 5 and 6 below.

Table 5

Regular Past Tense Allomorph Frequencies in BNC Spoken All

Allomorph	Type	Token	Tokens/million words
-t	502	9953	963.3
-d	1207	18762	1816.3
-ed	608	8951	866.4

Table 6

Regular Past Tense Allomorph Frequencies in BNC Spoken Classroom

Allomorph	Type	Token	Tokens/million words
-t	81	288	669.99
-d	144	479	1114.35
-ed	66	335	779.27

Both subcorpora reflect a two-way distribution in the type and token frequencies of the regular past tense allomorphs, where d >> t, ed. The past tense [d] allomorph has both the highest type and token frequencies in both subcorpora. The two remaining allomorphs, [t] and [ed], are comparable in terms of their type and token frequencies. From the corpus searches, it is observed that approximately half of the regular past tense forms that a child encounters in their linguistic input are marked with the [d] past tense allomorph. We would expect children to first acquire and be most accurate with past tense forms requiring the [d] allomorph, as their input provides the greatest evidence for this schema both in terms of how often they hear [d] forms and in terms of the variety of contexts in which they encounter them.

3.4 Allomorph Frequency Distributions in the Spontaneous Language Samples

Following the same procedure as that used for regular and irregular verbs and as described in Section 2.4.1, the type and token frequencies of the regular past tense lemmas in the spontaneous language samples were calculated and categorized according to the allomorph they would take, regardless of whether the child actually produced the allomorph. The results of this analysis are provided in Table 7 below.

Table 7

Allomorph Frequency Distributions in Spontaneous Language Samples

Allomorph	**Type**			**Token**		
	Round 1	Round 2	Round 3	Round 1	Round 2	Round 3
-t	18	28	33	51	65	73
-d	16	25	38	46	91	105
-ed	5	12	18	17	30	38

The spontaneous data was also found to demonstrate an unequal distribution of the past tense allomorphs in terms of their type and token frequencies, but one that differs from that observed from the BNC subcorpora. The [ed] allomorph was observed to have the lowest type and token frequencies at all three Rounds. As for [t] and [d], [t] had the highest type and token frequency at Round 1, but by Round 3, there has been shift in the nature of the children's lexicons and [d] has the greatest type and token frequency.

In order to supplement the analysis based on absolute frequencies and determine if the observed difference in allomorph frequencies were significant, statistical analyses were conducted on children's individual frequencies for each allomorph type. The children's individual allomorph type frequencies are presented in Table 8 below and their token frequencies in Table 9, in addition to their means and standard deviations.

Table 8

Regular Allomorph Type Frequencies in Spontaneous Language Samples

Participant	**Round 1**			**Round 2**			**Round 3**		
	-t	**-d**	**-ed**	**-t**	**-d**	**-ed**	**-t**	**-d**	**-ed**
CHRS27	3	5	3	4	2	2	8	9	4
CNDX25	3	5	1	6	3	4	5	8	3
DNLN36	2	2	0	4	3	2	3	3	0
DNNC29	3	1	0	2	1	1	2	3	2
DNNS35	4	5	1	3	5	3	2	4	4
DVDC05	0	2	0	5	5	0	7	11	7
JNNH18	0	1	0	2	5	1	5	1	1
LLKC08	5	2	0	0	3	0	1	2	0
MRSS24	2	4	0	3	5	2	4	3	2
RNL28	1	0	1	2	1	0	1	0	0
SBST17	1	0	2	1	1	0	3	10	3
SHHN32	3	2	1	1	2	0	3	4	2
SMNS22	1	1	0	9	4	4	3	4	1
THRJ33	0	1	0	1	3	0	2	3	0
TNYN20	4	2	0	2	5	1	4	4	0
TRRK11	3	0	0	0	0	1	0	1	0
YSSF12	1	2	0	2	0	1	4	2	1
M	**2.12**	**2.06**	**0.53**	**2.76**	**2.82**	**1.29**	**3.35**	**4.24**	**1.76**
SD	**1.54**	**1.71**	**0.87**	**2.31**	**1.81**	**1.36**	**2.09**	**3.27**	**1.95**

Table 9

Regular Allomorph Token Frequencies in Spontaneous Language Samples

Participant	**Round 1**			**Round 2**			**Round 3**		
	-t	**-d**	**-ed**	**-t**	**-d**	**-ed**	**-t**	**-d**	**-ed**
CHRS27	3	7	5	6	3	3	10	10	6
CNDX25	4	5	2	7	8	4	5	11	4
DNLN36	2	3	0	5	3	3	4	5	0
DNNC29	10	3	0	3	1	1	2	3	2
DNNS35	5	5	6	4	9	3	2	5	6
DVDC05	0	4	0	6	8	0	8	22	7
JNNH18	0	2	0	3	6	2	8	3	2
LLKC08	8	2	0	0	4	0	1	2	0
MRSS24	2	7	0	5	9	3	5	5	2
RNL28	2	0	1	2	1	0	1	0	0
SBST17	1	0	2	1	1	0	3	18	4
SHHN32	3	2	1	2	10	0	4	6	3
SMNS22	1	1	0	16	11	7	4	4	1
THRJ33	0	1	0	1	5	0	4	4	0
TNYN20	4	2	0	2	12	1	5	4	0
TRRK11	5	0	0	0	0	2	0	1	0
YSSF12	1	2	0	3	0	1	7	3	1
M	**3.00**	**2.71**	**1.00**	**3.88**	**5.35**	**1.76**	**4.29**	**6.24**	**2.24**
SD	**2.81**	**2.23**	**1.84**	**3.77**	**4.08**	**1.92**	**2.76**	**5.91**	**2.39**

Three repeated measures ANOVAs were conducted, one at each round, with children's individual frequencies of the verb allomorph *types* as the within-subjects factor. The ANOVA at Round 1 was significant ($F(2,32) = 9.193, p= .001$), with pairwise comparisons showing that [d] vs. [ed] (2.06 vs. 0.53, $p = .01$) was significant, and [t] vs. [ed] was significant (2.12 vs. 0.53, p=.002), but there was no difference between [t] and [d] (2.12 vs. 2.06, p=.798). The ANOVA at Round 2 was also found to be significant ($F(2,32)$=6.755, p=.004, with pairwise comparisons showing that [d] vs. [ed] (2.82 vs. 1.29, p= .004) was significant and [t] vs. [ed] was significant (2.76 vs. 1.29, p=.001). No difference was found between [t] and [d] (2.76 vs. 2.82, p=.917). Similarly at Round 3, the ANOVA was found to be significant ($F(2,32)$=12.411, p=.000. Pairwise comparisons showed that [d] vs. [ed] (4.24 vs. 1.76, p=.000) was significant, [t] vs. [ed] (3.35 vs. 1.76, p=.001) was significant, but [t] vs. [d] was not significant (3.35 vs. 4.24, p=.152).

Three repeated measures ANOVAs, one at each round, were also conducted with the children's individual frequencies of the verb allomorph *tokens* as the within-subjects factor. The ANOVA at Round 1 was significant ($F(2,32) = 4.563, p= .018$), with results from pairwise comparisons showing that [d] vs. [ed] (2.71 vs. 1.00, p=.004) was significant, [t] vs. [ed] (3.00 vs. 1.00, p=.020) was significant, but that [t] vs. [d] (3.00 vs. 2.71, p=.725) is not significant. At Round 2, the ANOVA was also found to be significant ($F(2,32)$=8.968, p=.001) and pairwise comparisons showed that [d] vs. [ed] was significant (5.35 vs. 1.76, p=.001), [t] vs. [ed] (3.88 vs. 1.76, p=.002) was significant, but no difference was found between [t] and [d] (3.88 vs. 5.35, p=.157). The ANOVA conducted at Round 3 was likewise significant ($F(2,32)$=7.455, p=.002). As in previous testing rounds, pairwise comparisons showed that [d] vs. [ed] was significant

(6.24 vs. 2.24, p=.002), and [t] vs. [ed] was significant (4.29 vs. 2.24, p=.006), but that [t] and [d] were not significantly different (4.29 vs. 6.24, p=.152).

In summary, the mean type and token frequencies for the [t] and [d] regular past tense allomorphs were not significantly different at any round. Although the [t] and [d] allomorphs were not found to be significantly different from each other, both differed significantly with [ed] past tense verb production at all rounds. Therefore, there is a statistically significant two-way distribution of allomorphs in the children's spontaneous language samples: t, d > ed.

3.5 Discussion

The allomorph type and token distributions in children's external input and in their spontaneous language productions, both indicated that the [t] and [d] allomorphs have the highest type and token frequency and the [ed] allomorph has the lowest type and token frequency.

The allomorph distributions in the external input, as calculated from the BNC subcorpora, were not paralleled in what the children internalized from their external linguistic input, as reflected in their production. The BNC subcorpora indicated that the [t] allomorph patterned with [ed]: d >> t, ed. In the spontaneous language samples, on the other hand, the allomorph distribution was found to be: t, d >> ed. The lack of a significant difference between [t] and [d] in the spontaneous language samples is possibly explained by the great amount of variation observed in the spontaneous language samples. The semi-structured nature of the freeplay session resulted in variation in the number of past contexts produced in each sample. With larger language samples and more contexts, it is possible that a statistical difference between [t] and [d] would be observed, since there was a trend in that direction in the mean scores. Possible factors that could account for this difference include dialect (British vs. Canadian English) and register (general spoken vs. classroom).

There are a few dialect-specific verb forms, which take the [t] allomorph in British English and the [d] allomorph in Canadian English (*e.g.* 'learnt'/'learned'). These forms were not numerous in the transcripts and would not affect the allomorph distributions significantly. The children's lexicon compiled from the spontaneous transcripts contained only three such forms: DREAM, SPILL, and LEARN. Correcting for these forms in the BNC results by counting them as instances of [d] allomorphs as they would appear in Canadian English, however, would not result in a two-way distinction such as that observed in the spontaneous data, but would only serve to further strengthen the statistical difference observed between [d] and [t] frequencies.

It is also possible that the BNC transcripts are not entirely representative of the register of speech that younger children are exposed to in their linguistic environments. The children in this study ranged in age from 50 months (4;2) to 105 months (8;9). The spoken classroom transcripts were recorded in classes where the ages of students ranged from nine years to college age. Without a representative corpus of the speech input of children of the age range in this study, this cannot be confirmed.

3.6 Conclusion

The allomorph frequency distributions in the external input was not entirely aligned with the internalized input, as reflected in the children's spontaneous past tense production. It is possible that with more time and linguistic input, the significant difference between [t] and [ed] will diminish and [d] will become significantly different from [t] in the children's productions and will reflect the distributions observed in the BNC. The children are still acquiring the adult system and therefore these distributions may change with time. This would, however, only occur if a fixed adult system indeed exists. Usage-Based models claim that a speaker's linguistic system emerges from their lexicon. In this way, schemas emerge from what each individual has internalized from their own linguistic environment and this will not necessarily demonstrate the same distributions as those calculated in the BNC. The linguistic environments of the children in this study vary in the registers they are exposed to, their amount of exposure to English, and which verbs they have acquired. What was observed in both the BNC and spontaneous language distributions is that the [d] allomorph occurs with the highest type and token frequency and the [ed] allomorph has the lowest type and token frequency.

The frequency results from this chapter serve as a basis from which to make predictions with respect to the acquisition of regulars, irregulars, and regular past tense allomorphs. Based on the frequencies calculated here, children would be expected to first acquire and demonstrate accuracy with the regular past tense, and specifically the [t] and [d] allomorphs, due their high type frequency, before [ed] allomorphs.

Chapter 4 –The Role of Lexicon Size in Past Tense Acquisition

Dual and single-route theories both predict that irregular past tense verbs will be sensitive to token frequency. Accuracy in irregular production is predicted to increase over the three testing rounds as the learners amass tokens of usage of these verbs and their lexical representations are strengthened. It is with respect to regular past tense acquisition that the two routes differ in their predictions. As discussed in Chapter 1, the single-route, usage-based model proposes that the regular past tense is formed, not through the application of a symbolic rule, but through the access of a regular past tense *schema*. Bybee defines schemas as "organizational patterns that emerge from the way that forms [*i.e.* lexical representations] are associated with one another in a vast complex network of phonological, semantic, and sequential relations" (2001: p.21). Schemas, being networks of associations among lexical representations, are thus inextricable from these same lexical representations. The emergence and acquisition of schemas are predicted to be influenced by input factors as these directly affect the lexicon.

Bybee's model would predict that the regular past tense schema emerges as learners acquire regular past tense verbs and begin to form associations between lexical representations based on semantic and phonological similarities. As the lexicon increases in size and more tokens and types of regular past tense verbs are amassed, the learner is predicted to become increasingly accurate in their regular past tense production. Marchman and Bates (1994) similarly claim that a minimum number of verbs, or a *critical mass*, is a necessary requirement for past tense acquisition and therefore, that verb lexicon size is a predictor of regular and irregular past tense production accuracy.

This proposed interdependence of the learner's lexicon size and morphological acquisition is termed the critical mass hypothesis.

Bybee's Usage-based model predicts that lexicon size, and specifically the number of regular verb types acquired, will be predictive of accuracy in regular past tense production. The dual-route model, on the other hand, does not attribute such a predictive role to type frequency. To test Bybee's predictions, the following analyses were conducted on the longitudinal L2 data. Section 4.1 presents the results of the measures of children's lexicon size (*i.e.* PPVT raw scores) and production accuracy (*i.e.* proportion correct scores on the TEGI PTP). Section 4.2 compares regular and irregular production accuracy at each round using t-tests to measure statistical significance. Section 4.3 presents a correlational analysis of lexicon size and accuracy to determine when, if at any point, the regular past tense schema emerges and to measure if lexicon size is, indeed, predictive of regular past tense accuracy. This correlational analysis of lexicon size and accuracy was repeated with data from the spontaneous language samples in Section 4.4. Section 4.5 discusses the results of these analyses in light of single and dual-route model predictions.

4.1 Lexicon Size and Accuracy at Rounds 1-3

The measures chosen to evaluate the single-route claim that lexicon size and accuracy in morphological production are interdependent were the Peabody Picture Vocabulary Test (PPVT) and the Test of Early Grammatical Impairment (TEGI) Past Tense Probe (PTP). As described in Chapter 2, the PPVT is a measure of receptive vocabulary size and as such, can provide an indication of verb lexicon size. The TEGI PTP was chosen as a measure of past tense production accuracy. This probe includes ten regular past tense targets and eight irregular past tense targets, therefore, accuracy was calculated separately for the regular and irregular verbs. The children's percent correct regular and irregular TEGI PTP scores and raw PPVT scores are provided in Table 10 below from Rounds 1-3, with means and standard deviations. The PPVT scores are presented as raw, rather than standardized, scores, for reasons described in Section 2.2.2. The TEGI accuracy scores are listed as proportion correct scores, which were calculated as the number of correct productions out of the total number of *scorable* items, *i.e.* responses in which a past tense structure was attempted. Unscorable items were excluded from the denominator rather than assigned zero scores, therefore Table 10 demonstrates a number of missing data points where there was a lack of scoreable responses for a participant at a specific testing round.

Table 10

TEGI PTP Proportion Correct and PPVT Raw Scores from Rounds 1-3

Participant	TEGI PTP R1		R2		R3		PPVT R1	R2	R3
	REG	IRREG	REG	IRREG	REG	IRREG			
CHRS27	0.00	0.00	1.00	0.50	1.00	1.00	67	118	111
CNDX25	0.00	0.00	1.00	0.63	1.00	1.00	63	87	135
DNLN36	0.56	0.00	0.80	0.00	0.90	0.50	87	79	87
DNNC29	0.00	0.00	0.44	0.25	1.00	0.63	43	79	93
DNNS35	—	—	0.80	0.13	1.00	0.88	29	82	119
DVDC05	0.00	0.00	0.70	0.63	0.91	1.00	56	82	144
JNNH18	0.00	0.00	1.00	—	1.00	0.63	63	75	102
LLKC08	0.80	0.25	—	1.00	—	—	19	35	55
MRSS24	—	0.33	0.22	0.00	0.80	0.25	38	74	84
RNL28	0.00	0.00	0.00	0.00	0.50	0.00	41	47	79
SBST17	0.13	0.00	1.00	0.00	0.71	0.50	47	57	78
SHHN32	0.33	0.33	0.50	0.13	0.60	0.50	34	47	61
SMNS22	0.00	0.25	0.80	0.00	1.00	0.43	65	96	114
THRJ33	0.00	0.00	0.00	0.00	1.00	0.00	9	47	64
TNYN20	1.00	—	0.70	0.00	0.50	0.38	41	86	122
TRRK11	0.00	0.17	0.50	0.29	0.91	0.00	26	46	77
YSSF12	0.67	0.33	1.00	0.50	1.00	0.33	56	66	76
M	**0.233**	**0.111**	**0.654**	**0.254**	**0.864**	**0.502**	**46.12**	**70.76**	**94.18**
SD	**0.350**	**0.146**	**0.347**	**0.310**	**0.185**	**0.345**	**19.87**	**21.76**	**26.34**
N	**15**	**15**	**16**	**16**	**16**	**16**	**17**	**17**	**17**

4.2 Accuracy of Regular and Irregular Past Tense Production from Rounds 1-3

In general, it can be observed from Table 10 that the children were more accurate in their production of regular than irregular verbs in past tense contexts. Paired two-tailed t-tests at each round between regulars and irregulars showed that there was no statistically significant difference between the two at Round 1 ($t(13) = 1.296, p = .218$). At Round 2 ($t(14) = 5.234, p = .000$) and Round 3 ($t(15) = 4.472$), $p = .000$), however, children were significantly more accurate with regular than irregular verbs. The lack of a significant difference at Round 1 may be attributed to the fact that the children have not had sufficient input to gain a level of accuracy with either regular or irregular past tense verb production.

Furthermore, at Rounds 2 and 3, we see that the children are quite accurate with their regular verb production, attaining over 0.86 accuracy by Round 3. This indicates that the children have achieved a level of productivity with their regular verbs. Irregular verb production, however, shows a decidedly different trend. The children demonstrate low accuracy with these verbs throughout all three rounds, attaining an accuracy score of only 0.50 with irregular verbs at Round 3.

These acquisition patterns provide support for both single and dual-route models since irregular past tense acquisition is hypothesized by both models to be sensitive to token frequency in the input. From the above analysis, regular past tense verb acquisition is observed to begin earlier and to attain productivity sooner than irregular past tense acquisition. The dual-route model would attribute this to the speaker accessing a symbolic past tense rule, whereas the single-route model would attribute the same observed results to the emergence of a regular past tense schema upon acquisition of sufficient regular past tense types. Therefore, earlier accuracy and productivity with regular past tense verbs than irregular past tense verbs can be accounted for by both the dual-route and single-route models.

4.3 Correlations Between Lexicon Size and Accuracy from Rounds 1-3

As previously mentioned, single-route models contrast with dual-route models in their prediction that accuracy in the production of regular morphology is predicted by the size and composition of an individual's lexicon, as it is from this internalized input that schemas emerge. A correlational analysis was conducted to assess if this single-route prediction is supported in the L2 longitudinal data and if the point at which the children have had sufficient input to become productive with regular past tense production can be determined.

To determine whether children's lexicon size was correlated with accuracy in regular and irregular verb production, Pearson correlations were conducted at each round for the PPVT raw scores and TEGI PTP percent correct regular and irregular scores. The results are provided below.

Table 11

Correlation coefficients for TEGI PTP and PPVT scores for regular verbs

		PPVT		
		R1	**R2**	**R3**
TEGI PTP	**R1**	-.070	-.161	-.220
	R2	.659**	.568*	.474
	R3	.222	.395	.240

Note. R1, R2, R3 = Round 1, Round 2, Round 3; ** $p < 0.01$; * $p < 0.05$

Table 12

Correlation coefficients for the TEGI PTP and PPVT scores for irregular verbs

		PPVT		
		R1	**R2**	**R3**
TEGI PTP	**R1**	-.270	-.266	-.418
	R2	-.011	-.028	.102
	R3	.501*	.718**	.739**

Note. R1, R2, R3 = Round 1, Round 2, Round 3; ** $p < 0.01$; *$p < 0.05$

Pearson correlations between lexicon size and irregular verb accuracy demonstrate that lexicon size at all rounds is associated with accuracy with irregular verbs at Round 3. The correlations between lexicon size and regular verb accuracy indicated that lexicon sizes at Rounds 1 and 2 were only significantly associated with regular verb accuracy at Round 2.

4.4 Correlations between Individuals' Regular and Irregular Frequency in Spontaneous Transcripts and Accuracy from Rounds 1-3

In order to determine whether children's regular and irregular token frequencies in their spontaneous language productions as a measure of verb lexicon size were correlated with their accuracy on the TEGI past tense elicitation task, Pearson correlations were conducted at each round for the raw token frequency scores from the spontaneous transcripts and the TEGI PTP proportion correct scores for both regulars and irregulars. The descriptive statistics are provided in Table 13 below. Responses in which a past tense verb was not attempted were labelled *unscoreable* rather than assigned zero scores. Missing data points therefore appear in Table 13 where no scoreable responses were made on the TEGI PTP. The results of the Pearson correlations are presented in Tables 14 and 15.

Table 13

Participant Token Frequencies in Spontaneous Language Samples and Proportion Correct Scores from TEGI PTP

Participant	REG						IRREG					
	Token			TEGI PTP			Token			TEGI PTP		
	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3
CHRS27	15	12	26	0	1	1	40	42	67	0	0.5	1
CNDX25	11	19	20	0	1	1	18	42	25	0	0.63	1
DNLN36	5	11	9	0.56	0.8	0.9	25	29	16	0	0	0.5
DNNC29	13	5	7	0	0.44	1	36	25	31	0	0.25	0.63
DNNS35	16	16	13	—	0.8	1	22	19	20	—	0.13	0.88
DVDC05	4	14	37	0	0.7	0.91	9	28	55	0	0.63	1
JNNH18	2	11	13	0	1	1	13	39	47	0	—	0.63
LLKC08	10	4	3	0.8	—	—	19	6	6	0.25	1	—
MRSS24	9	17	12	—	0.22	0.8	32	43	59	0.33	0	0.25
RNL28	3	3	1	0	0	0.5	3	10	6	0	0	0
SBST17	3	2	25	0.13	1	0.71	12	16	69	0	0	0.5
SHHN32	6	12	13	0.33	0.5	0.6	3	72	29	0.33	0.13	0.5
SMNS22	2	34	9	0	0.8	1	6	64	35	0.25	0	0.43
THRJ33	1	6	8	0	0	1	1	14	14	0	0	0
TNYN20	6	15	9	1	0.7	0.5	51	11	37	—	0	0.38
TRRK11	5	2	1	0	0.5	0.91	10	17	18	0.17	0.29	0
YSSF12	3	4	11	0.67	1	1	5	28	22	0.33	0.5	0.33

Table 14

Correlation coefficients for token regular verbs from spontaneous language samples and TEGI PTP scores from Rounds 1-3

		TEGI PTP		
		R1	**R2**	**R3**
Token	**R1**	.022	.183	.240
	R2	-.110	.243	.197
	R3	-.268	.505*	.185

Note. R1, R2, R3 = Round 1, Round 2, Round 3; * $p < 0.05$

Table 15

Correlation coefficients for token irregular verbs from spontaneous language samples and TEGI PTP from Rounds 1-3

		TEGI PTP		
		R1	**R2**	**R3**
Token	**R1**	-.176	-.006	.324
	R2	.388	-.114	.305
	R3	-.129	-.093	.451

Note. R1, R2, R3 = Round 1, Round 2, Round 3

There are no significant correlations for irregular past tense frequency in the spontaneous language samples and accuracy on the TEGI PTP. For the regular past tense, the only significant correlation found was between accuracy at Round 2 and token frequency of regular past tense forms at Round 3. The previous analysis employing PPVT raw scores and TEGI PTP accuracy scores (see Section 4.3) resulted in more significant results and provided a clearer picture of the acquisition process. The lack of any significant correlations with the irregular past tense verbs is particularly indicative of the weakness of this analysis as both the dual and Usage-based models would predict that the token frequency of irregulars in the lexicon and accuracy would demonstrate a significant correlation. This lack of significant correlations is most likely due to the measures employed for irregular and regular frequencies in the internalized input. The PPVT is not only a more exhaustive measure of vocabulary size, but is also more robust. All children were presented with the same target items at all three rounds, allowing for cross-comparisons of results across children and rounds. The spontaneous transcripts, on the other hand, contained a considerable amount of variation in the verb types and the frequencies with which they were employed by the children. With such variation present in the spontaneous transcripts, the lack of significant correlations is thus not wholly unexpected.

4.5 Lexicon Size, Accuracy with Past Tense Production, and the Single and Dual-route Models

From the descriptive observations of PPVT raw scores and TEGI PTP proportion correct scores for regular and irregular verb production from Rounds 1-3 and the correlations found between these measures in Section 4.3, the development of regular and irregular past tense acquisition can be examined in light of the predictions made by the dual-route and single-route models.

At Round 1, the children demonstrate no significant difference in accuracy between their regular and irregular verb production. In fact, they have a very low level of accuracy with past tense verb production in general (0.23 and 0.11 proportion correct for regular and irregular verbs respectively). There was also no significant correlation found between lexicon size at Round 1 and either regular or irregular accuracy. Chapter 3 demonstrated that regular and irregular verbs had similar type frequencies in the spontaneous language samples (see Table 4). It appears, then, that the children have not had sufficient input to become accurate with either regular or irregular past tense verbs at Round 1.

At Round 2, however, the children demonstrated 0.65 proportion accuracy with the regular past tense TEGI targets, indicating that they are becoming productive with their regular verb production. Their Round 2 accuracy with irregular verbs, on the other hand, remains at only 0.25 proportion correct. The significant correlations between Round 1 and 2 lexicon size and Round 2 regular verb accuracy support Bybee's predictions of schema emergence as well as the critical mass hypothesis. By Round 2, the children have had sufficient input to start becoming productive with regular verbs, but have not had sufficient input to acquire irregular verbs. It was determined in Chapter 3 that regular verbs had a greater type frequency than irregular verbs in the internalized input. The earlier emergence and accuracy of regular past tense production can thus be attributed to its higher type frequency in the input.

It was not until Round 2 that lexicon size became substantial enough for the regular schema to become productive. By Round 3, however, it appears that a critical lexicon size, or a minimum number of verb types, has been surpassed and that regular past tense formation has become highly productive, with accuracy near ceiling at 0.86. No correlation at Round 3 between lexicon size and regular verb accuracy is expected because the children have already acquired the regular past tense schema and are near ceiling for accuracy.

Irregular verb production only achieved 0.50 proportion accuracy at Round 3, far behind regular verb accuracy. It appears that the children have not had sufficient input, even by Round 3, for irregular verb production to become accurate. Irregular verbs are more sensitive than regular verbs to token frequency. It simply requires more input to amass sufficient tokens of a specific past tense verb form then required to amass types of a pattern, such as the regular past tense, to form a lexical representation strong enough to be stored and easily accessed. Regular verbs require less exposure, *i.e.* input, to be acquired since the lexical representations of regular verbs are strengthened by token and well as type frequency. For this reason, accuracy with regular verbs is predicted to emerge earlier.

This suggests that less input is required to attain productivity with regular past tense verbs than irregular past tense verbs due to their higher type frequency in the input in spite of the fact that irregulars generally occur with higher token frequency that regulars as determined in Chapter 3. A 'critical mass' in the sense of regular verb types appears to have been acquired by Round 2 in the data examined here, when we observed increased accuracy in regular past tense verb production. That is, the children have acquired enough regular verb types to form a regular past tense schema by Round 2. Once this critical mass is surpassed, we see that children produce regulars with accuracy near ceiling and their accuracy is no longer correlated with lexicon size. On the other hand, irregular verb accuracy is correlated with lexicon size at all rounds because the token frequencies of individual irregular past tense verbs are still insufficient for them to be acquired and accurately produced. This supports both dual- and single-route models.

The correlations found between accuracy in regular verb production and lexicon size at previous rounds, however, solely support a single-route, emergentist model of acquisition. A single-route model would predict the result observed here, specifically that lexicon size at one round would predict accuracy at the next because it is from internalized input that the schemas emerge.

Chapter 5 –The Role of Allomorphy in Past Tense Acquisition

English regular past tense verbs provide us with another way in which to test the claims of the dual- and single-route models. As discussed in 1.4, there are three past tense allomorphs in English: [t] (*e.g.* jump/jump**ed**), [d] (*e.g.* clean/clean**ed**), and [ed] (*e.g.* skate/skat**ed**). It was observed in Sections 3.3 and 3.4 that these are not equally distributed in the input. The dual-route model does not predict an effect of allomorphy on past tense acquisition. Instead, it claims that allomorphy is the result of phonological detail applied after the morphological level at which a symbolic past tense morpheme and verb base are combined. In contrast, Bybee's Usage-based model predicts that word forms are represented in the mental lexicon at both a semantic and phonological level of representation. This hypothesis, as discussed in Chapter 1, is elaborated and illustrated below. At the semantic level, all three allomorphs are associated with one another, sharing the semantic notion of [PAST]. At the phonological level, however, only the past tense markers of CLIMB and CLEAN form an association since both of these verb forms take the [d] allomorph. In this way, the past tense forms of CLIMB and CLEAN are more strongly associated with each other than with the past tense forms of SKATE and JUMP, although they are all associated at the semantic level of representation. Acquisition would progress from initially acquiring whole, unanalyzed lexical representations to forming associations based on semantic and phonological similarities with time. With more evidence (*i.e.* types) of a schema, the associative networks among the lexical representations would strengthen. Schemas for each of the allomorphs would form based on their semantic and phonological similarities. Eventually, these allomorph-based schemas would be associated with one another based on their shared semantic feature, [PAST].

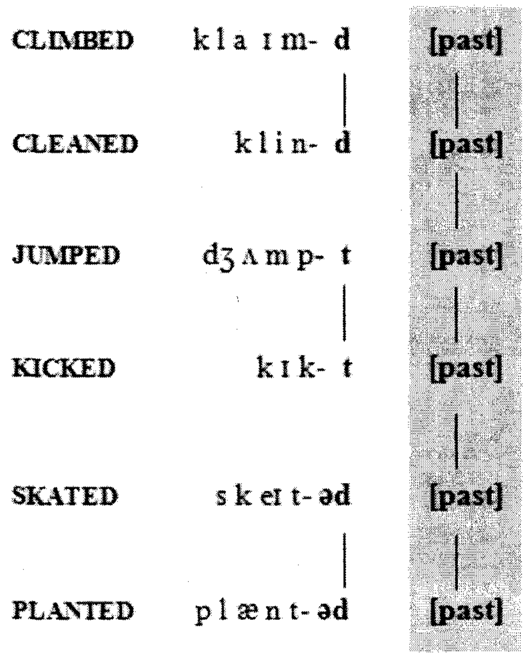

Figure 1. Regular past tense schema and sub-component allomorph-based schemas

5.1 Accuracy as a Function of Allomorph

As discussed in Chapter 3, the three past tense allomorphs vary in the type and token frequencies with which they occur in the input. The single-route model would predict that this would affect the emergent past tense schemas. The allomorph with the greatest type frequency in the speaker's internalized lexicon would have the strongest association network, *i.e.* schema, and it would be predicted that children would first demonstrate accuracy and productivity with this allomorph. An extension of this prediction is that once one past tense schema is acquired, less input will be required to acquire the other two.

If type and token frequency affect acquisition, a differential in accuracy with each of these allomorphs should be observed and should reflect their distributions in the input.

Considering the distribution of allomorphs in the children's internalized lexicons as determined from the spontaneous data in Chapter 3, *i.e.* t, d >> ed, it would be expected that children will first be accurate with the [d] and [t] allomorphs. To determine how the children varied in accuracy in their production of these allomorphs, correct past tense verb forms, as occurring in past tense contexts in the spontaneous data, were calculated and sorted based on allomorph. The results are listed in Table 16 below. [1]

[1] Note that correct past tense forms were calculated using both raw token correct and proportion correct. The analysis is presented here in terms of token frequencies as the percentages in some cases were based on very small numbers. The outcomes of the two approaches produced the same results.

Table 16

Regular Allomorph Correct and Total Token Frequencies in Spontaneous Language Samples

Participant	**Round 1**						**Round 2**						**Round 3**					
	-t		**-d**		**-ed**		**-t**		**-d**		**-ed**		**-t**		**-d**		**-ed**	
	CORR	tkn	CORR	tkn	CORR	tkn	CORR	tkn	CORR	tkn	CORR	tkn	CORR	tkn	CORR	tkn	CORR	tkn
CHRS27	1	3	2	7	1	5	4	6	3	3	3	3	9	10	10	10	5	6
CNDX25	0	4	0	5	0	2	6	7	5	8	2	4	4	5	11	11	4	4
DNLN36	1	2	1	3	-	-	2	5	3	3	2	3	2	4	5	5	-	-
DNNC29	1	10	0	3	-	-	2	3	0	1	0	1	2	2	3	3	2	2
DNNS35	0	5	0	5	0	6	4	4	9	9	3	3	2	2	5	5	6	6
DVDC05	-	-	0	4	-	-	5	6	8	8	-	-	7	8	19	22	6	7
JNNH18	-	-	0	2	-	-	3	3	6	6	2	2	5	8	0	3	2	2
LLKC08	1	8	1	2	-	-	-	-	3	4	-	-	0	1	2	2	-	-
MRSS24	0	2	2	7	-	-	1	5	0	9	0	3	5	5	4	5	2	2
RNL28	1	2	-	-	1	1	1	2	0	1	-	-	1	1	0	0	-	-
SBST17	0	1	-	-	2	2	0	1	0	1	-	-	2	3	17	18	3	4
SHHN32	0	3	1	2	0	1	0	2	5	10	-	-	4	4	4	6	0	3
SMNS22	0	1	0	1	-	-	9	16	9	11	3	7	4	4	3	4	1	1
THRJ33	-	-	0	1	-	-	0	1	1	5	-	-	3	4	2	4	-	-
TNYN20	0	4	0	2	-	-	1	2	6	12	1	1	3	5	2	4	-	-
TRRK11	1	5	-	-	-	-	-	-	-	-	1	2	-	-	1	1	-	-
YSSF12	1	1	1	2	-	-	3	3	-	-	1	1	7	7	3	3	1	1
Total	**7**	**51**	**8**	**46**	**4**	**17**	**41**	**66**	**58**	**91**	**18**	**30**	**60**	**73**	**91**	**106**	**32**	**38**
N	**14**	**14**	**14**	**14**	**6**	**6**	**15**	**15**	**15**	**15**	**11**	**11**	**16**	**16**	**17**	**17**	**11**	**11**
M	**0.50**	**3.64**	**0.57**	**3.29**	**0.67**	**2.83**	**2.73**	**4.40**	**3.87**	**6.07**	**1.64**	**2.73**	**3.75**	**4.56**	**5.35**	**6.24**	**2.91**	**3.45**
SD	**0.52**	**2.68**	**0.76**	**2.02**	**0.82**	**2.14**	**2.55**	**3.72**	**3.29**	**3.79**	**1.12**	**1.74**	**2.41**	**2.61**	**5.62**	**5.91**	**2.07**	**2.11**
Accuracy	**0.14**		**0.17**		**0.24**		**0.62**		**0.64**		**0.60**		**0.82**		**0.86**		**0.84**	

Note. CORR= token correct, tkn =number of past tense contexts requiring specified allomorph.

5.2 Allomorphy and Accuracy

At Round 1, the children's spontaneous language samples demonstrate very low production accuracy for all three allomorphs in past tense contexts. The mean tokens correct were less than one for all allomorphs. The mean number of contexts in which past tense forms were required per transcript were 3.64, 3.29, and 2.83 for [t], [d], and [ed] respectively. The children, therefore, do not attempt past tense structures very frequently in their spontaneous language samples. There is also a great amount of variation in terms of the number of past tense contexts and accuracy in production in these contexts among the children. For examples, DNNC29's transcript has 10 past tense contexts requiring the [t] allomorph, but DVDC08, JNNH18, and THRJ33's transcripts have no past tense [t] contexts. There are two few contributing data points and the mean proportions correct for the allomorphs are too similar to warrant an ANOVA analysis to determine if the differences between them are statistically significant.

At Round 2, mean past tense contexts and production accuracy have increased for all three allomorphs, but particularly for the [t] and [d] past tense allomorphs. The greatest increase observed was in [d] allomorph mean past tense contexts. Standard deviations for accuracy and past tense contexts, however, are still quite large. An ANOVA analysis was not conducted as the proportions correct across the children by allomorph were too similar at 0.62, 0.64, and 0.60 for [t], [d], and [ed], respectively.

At Round 3, mean past tense contexts are observed to have increased for all three allomorphs with the greatest gains in mean past tense contexts observed with [ed]. Mean accuracy, however, has increased similarly for all three allomorphs: [t]= 0.82, [d]= 0.86, and [ed]= 0.84. These proportions are too similar to warrant an ANOVA analysis.

5.3 Dual-route Models, Bybee's Usage-based Model, and the Acquisition of Regular Past Tense Allomorphs

The single-route model makes specific predictions with respect to the acquisition of regular past tense allomorphs, whereas dual-route models relegate allomorphy to the phonological, rather than morphological level of language production. Proponents of dual-route models claim that a symbolic past tense marker is concatenated to a verb stem, the phonetic realization of which is later determined by the phonology. Past tense acquisition should therefore be insensitive to the type and token frequencies of past tense allomorphs.

In contrast, the single-route model proposes that associations made between linguistic representations are both semantic and phonological in nature. Networks of such associations (*i.e.* schemas) are strengthened by type frequency in the input. The past tense allomorphs are thus predicted to demonstrate varying acquisition patterns. Support for this claim, however, was not found in the analysis presented in this chapter. Across all rounds, the past tense allomorphs were produced with similar levels of accuracy across all children. Contrary to predictions, accuracy in allomorph production was not found to mirror the allomorph type frequency distribution in the children's internalized input, as determined in Chapter 3, where: t, d >> ed.

At all rounds, a great amount of variation was observed among the children in terms of accuracy and attempts at producing past tense contexts. Children acquire morphology at different rates and this may partially account for the observed variation. However, the effect of variation in exposure to English must also be considered when studying children who are learning English as a second language. Finally, the nature of the spontaneous language sample must be considered. As an unstructured language measure, some of the variation may potentially be due to sampling method.

Chapter 6 – Discussion and Conclusions

This thesis set out to establish if there is evidence to support Bybee's Usage-based approach to linguistic processing using data collected as part of a larger longitudinal study of children acquiring English as a second language. Data was collected from 17 children from a variety of L1 backgrounds with an average age of exposure to English of 9.5 months at Round 1. Three rounds of testing were then conducted at 12 month intervals at which children were recorded in a spontaneous language session and administered a measure of lexicon size (PPVT) and a past tense elicitation task (TEGI PTP). This population provided us with the opportunity to conduct elicitation tasks with children aged 4;2 – 6;9 (mean 5;5) at Round 1, who had had very little English exposure. Monolinguals with similar levels of exposure are simply too young to perform these tasks and measures. Therefore, studying this population permitted us to observe the effects of input factors on the process of past tense acquisition.

Bybee's model makes specific predictions for the acquisition of morphologically complex forms, such as the past tense, and particularly focuses on the role of *frequency* in the input. Proponents of usage-based models claim that linguistic structures and their organization in the brain emerge from the speakers' *use*, *i.e.* their production and perception, of language. Frequency in linguistic input is discussed in terms of token and type frequency. Token frequency, *i.e.* the number of occurrences of a form or pattern, is claimed to play a central role in establishing and strengthening lexical representations. These lexical representations store detailed phonological and semantic information about a form and establish associations with other lexical representations based on shared or similar phonological and semantic features. It is from these associations that schemas emerge. Bybee proposes that it is type frequency, *i.e.* the number of different forms to which a pattern applies, which strengthens these schemas so that the more types a pattern applies to, the stronger it becomes. Based on these features of Bybee's Usage-based model, three research questions and predictions were formulated with respect to past tense acquisition and are reiterated here from Chapter 1, Section 1.8.

1 a) What are the type and token frequency distributions of regulars, irregulars, and regular allomorphs in English, *i.e.* the children's *external input*?

b) Since Bybee's model predicts that schemas emerge from each speakers' *internalized input*, what are the frequency distributions of regulars, irregulars, and regular allomorphs in the children's lexicons at each round?

2) The Usage-based model predicts that schemas emerge once sufficient types of a pattern are amassed in the lexicon. Is lexicon size a factor in the acquisition, *i.e.* in the accuracy of production, of regular and irregular past tense verbs?

3) Is allomorphy a factor in the accuracy with which children produce the regular past tense? That is, are the three regular past tense allomorphs acquired simultaneously or consecutively?

The results of the analyses conducted to address each of these research questions are outlined below in sections 6.1.1, 6.1.2, and 6.2.3 respectively. Section 3 provides an overview of the results from each testing round, presented in light of Bybee's Usage-based theory, with some discussion of these findings with respect to the dual-route model of linguistic processing. How this study contributes to our understanding of linguistic processing, morphological acquisition and representation, and child language acquisition is discussed in Section 6.2.

6.1 Results

This section will present a brief summary of the analyses undertaken using the longitudinal L2 data to answer each of the above research questions, as well as an overview of the findings. These will be discussed in more detail in Section 3 in light of Bybee's Usage-based model.

6.1.1 Frequency distributions in the external and internal input.

In Chapter 3, the type and token frequencies of regular and irregular past tense verbs were calculated using the British National Corpus Spoken All and Spoken Classroom corpora to represent the children's *external input*. In addition, their frequencies in the children's *internalized inputs* were calculated from their spontaneous language samples, as described in Section 2.2.2.

With respect to regular and irregular past tense verb acquisition, the two BNC subcorpora chosen to reflect the children's *external input* demonstrated the same general pattern as described in previous literature: regulars occur with a greater type frequency and irregulars have a greater token frequency in the input. The type and token frequencies of the three regular past tense allomorphs in the external input demonstrated a two-way distribution in both BNC subcorpora: d >> t, ed. In the children's *internalized input*, the difference between regular and irregular past tense frequencies eventually mirrored those in the external input. At testing Round 1, regulars and irregulars had similar type frequencies, but became increasingly differentiated from each other at Rounds 2 and 3 where regulars demonstrated greater type frequency than irregulars. In terms of token frequency, irregular past tense verbs were roughly twice as frequent as regular verbs at all testing rounds. A statistical analysis of the spontaneous transcripts confirmed a significant two-way frequency distribution: d, t >> ed.

6.1.2 Lexicon size and accuracy in regular and irregular past tense production.

To evaluate the claim that lexicon size is a factor in past tense acquisition, lexicon size, as estimated using the PPVT, and past tense production accuracy, as calculated from the children's TEGI PTP results, were correlated for each testing round. The difference in production accuracy of regulars and irregulars was insignificant at Round 1, but significant at Rounds 2 and 3. Statistical correlations demonstrated that lexicon size at all rounds was predictive of irregular past tense verb accuracy at Round 3. It was also shown that lexicon size at Rounds 1 and 2 was associated with regular past tense production at Round 2, but not at Round 3.

6.1.3 Order of acquisition of regular past tense allomorphs.

Chapter 5 sought to determine if allomorphy was a factor in the children's accuracy of regular past tense production. Mean past tense contexts and accuracy were calculated from the spontaneous language samples at each round for each of the three allomorphs. There were no significant differences in accuracy in the production of the regular past tense allomorphs at any round.

6.2 Overview of Acquisition of Past Tense from Rounds 1-3 with respect to Bybee's Usage-based Model

6.2.1 Round 1.

When children first begin to form lexical representations for words, the Usage-based model claims that they store multimorphemic words whole with little decomposition or internal analysis. Forms occurring frequently in the child's input, *i.e.* with high token frequency, would be instantiated in the mental lexicon as *lexical representations* along with their phonological and semantic detail. At this stage, the children's lexicons are relatively small, with insufficient types of any morphological pattern to form many phonological and semantic associations with other forms, and to thereby extrapolate a schema from this internalized input. Children may thus produce high frequency multimorphemic forms accurately at this early stage by retrieving them whole from their lexicons, but not by accessing a schema or rule. Productivity of morphological patterns is also not predicted to occur.

The children appear to be at this stage of acquisition at testing Round 1. Chapter 4 examined the role of lexicon size and the children's accuracy in the production of regular and irregular past tense verbs. At Round 1, the children had a mean receptive vocabulary score of 46.1, as measured using the PPVT, and demonstrated mean proportion accuracy scores of 0.23 with regular and 0.11 with irregular past tense verbs on the TEGI PTP. Lexicon size was not found to significantly correlate with either regular or irregular past tense accuracy. From this, we can conclude that the children at Round 1 have simply not had sufficient input to become accurate with their past tense production. This conclusion is corroborated with the analysis results from Chapter 5, which examined accuracy in allomorph production in the children's spontaneous language samples. The children demonstrated low accuracy in the production of all three regular allomorphs as evident from their mean proportion correct scores: [t]= 0.14, [d]= 0.17, and [ed]=0.24. If we examine the frequency results from Chapter 3, we can observe that the children's internalized inputs collectively include 39 regular past tense verb types. Their allomorph type frequencies are 16 for [d], 18 for [t], and 5 for [ed]. Such numbers appear to be insufficient for schema emergence and productivity. The children also demonstrate low accuracy with irregular past tense verbs, which would be predicted by Bybee's model. Irregular forms are highly sensitive to token frequency and it would thus take longer to amass sufficient tokens of a form to strengthen its lexical representation so that it would be easily accessed. This claim is also maintained by the dual-route processing models.

6.2.2 Round 2.

With increased English input, the children are exposed to more tokens of past tense forms, thereby strengthening their lexical representations for these forms. At Round 2, the children's mean receptive vocabulary score has increased to 70.8 and we would expect there to have been changes with respect to the structure and organization of their mental lexicons. The Usage-based model predicts that with time and exposure, associations will form among lexical representations based on their phonological and semantic similarities. As a result, the internal structures of morphologically complex forms are revealed. In this way, morphological patterns with high type frequencies will begin to emerge as *schemas*. The role of type frequency in the formation and strengthening of these schemas is pivotal to Bybee's Usage-based model.

At Round 2, it is observed that the children have become quite accurate with regular past tense inflection as compared to irregular past tense inflection: 0.65 proportion correct for regulars, as opposed to 0.25 for irregulars on the TEGI PTP. This can be attributed to the high type frequency of regular past tense forms. Although irregular past tense forms are more frequent in the input in terms of token frequency, the high type frequency of the regulars results in the formation of a schema that the speaker can then draw upon during past tense inflection. Chapter 3 calculated that at Round 2, the children have 65 regular past tense types in their collective internalized input and 40 irregular types. It should be noted, however, that whereas 65 regular past tense represent 65 verb forms which are inflected for the past tense through the concatenation of one of three regular past tense allomorphs to their stems, the 40 irregular 'types' represent 40 verbs forms which undergo inflection through a variety of irregular means including zero-marking, vowel change, suppletion, and others, as discussed in Section 1.4. Thus the type frequency of irregulars is a bit misleading in that it doesn't refer to a single 'irregular' pattern of past tense formation.

Chapter 4 found that lexicon size at all rounds was significantly correlated with accuracy of irregular inflection at Round 3. For regular past tense acquisition, however, lexicon size at Rounds 1 and 2 was found to be significantly correlated with regular accuracy at Round 2 and there was no significant correlation found for lexicon size and regular accuracy at Round 3. It is important to note that not only was lexicon size at Round 2 correlated with regular accuracy at Round 2, but lexicon size at Round 1 was also correlated with Round 2 accuracy. Such a correlation, where lexicon size at a previous round is found to predict future accuracy in production, supports an *emergent* view of schemas.

Bybee's Usage-based model claims that schemas emerge at various levels of morphological representation. Each regular past tense allomorph should thus emerge as its own schema, *i.e.* we would expect a '[d] schema', a '[t] schema', and an '[ed] schema' to first form based on the phonological and semantic similarities of their members, and then to form a larger 'regular past tense schema' based on the shared semantic feature of the three allomorphs, [PAST]. The individual allomorph schemas would emerge as they each amass sufficient types, thus they are not expected to emerge in synchrony. The type frequencies of the allomorphs at Round 2 in the spontaneous transcripts were: [d] 25, [t] 28, and [ed] 12. The children's mean accuracy scores in their spontaneous transcripts at Round 2, however, were: [t]= 0.62, [d]=0.64, [ed]=0.60. The allomorphs are produced with similar levels of accuracy and do not reflect the same distribution as their type frequencies. The predictions for asynchronous emergence of allomorph schemas were not supported by the data.

Forms with low type frequency, *i.e.* the irregular past tense forms which are either formed idiosyncratically or belong to small 'gangs', would be predicted to continue to be steadily acquired over time and their lexical representations would continue to strengthen with token frequency. It is possible that schemas would form among members of the irregular 'gangs', but these have low type frequencies and thus schema strength would be limited. Both the dual-route model and Bybee's Usage-based model would agree with respect to irregular acquisition.

6.2.3 Round 3.

From the time of testing at Round 2 until testing at Round 3, the input the children were exposed to strengthened their lexical representations of all forms, regular and irregular, as well as their allomorph and regular schemas. The children's mean receptive vocabulary score at Round 3 increased to 94.2 and the type frequencies of their regular and allomorph schemas were also observed to increase. The regular past tense had a type frequency of 89 types as calculated from the collective Round 3 spontaneous transcripts, whereas the regular allomorph type frequency distributions from the spontaneous transcripts were: [t]=33, [d]=38, and [ed]=18. Bybee's Usage-based model claims that schemas are strengthened by type frequency and this is reflected in the increased accuracy the children demonstrated with regular verbs. Mean proportion correct regular past tense verb production on the TEGI PTP was observed to be 0.86, nearing ceiling. Lexicon size was no longer found to correlate with regular past tense accuracy, therefore the schema appears to have acquired a sufficient number of types to become highly productive. Examining the regular past tense more closely by considering the regular allomorphs, it was observed that all three allomorphs demonstrated similarly high levels of accuracy in the spontaneous language samples: [t]= 0.82, [d]= 0.86, and [ed]= 0.84.

The lack of significant differences in the accuracy of regular past tense allomorph production across all rounds poses a challenge to Bybee's single-route model. One possibility this presents is that the dual-route model of language processing is correct: a symbolic rule exists which forms the past tense in the morphology using a symbolic rule and the phonology then selects the appropriate allomorph for the final output form. Speakers are predicted by the dual-route model to be equally accurate with all regular past tense allomorphs during acquisition, regardless of their respective types in the lexicon.

However, it is also possible that asynchronous allomorph acquisition was not observed due to the nature of vocabulary acquisition and the fact that lexical associations can be formed on the basis of phonological or semantic similarity. Early vocabulary acquisition is predominantly noun-based, with verbs generally being later acquired. Early language acquisition may be more phonologically based, becoming increasingly focussed on forming semantic associations over time. If this is the case, we may expect to observe allomorph effects with nominal morphology but not with verbal morphology. Sorenson (2005) found significant differences in the acquisition of the English plural allomorphs by the same ESL children who are under study here, but no significant differences with the homophonous verbal third person singular suffix. Therefore, the uniform accuracy of past tense allomorphs could possibly be attributed to the fact that by the time the children begin to produce verbs and multimorphemic verbal forms, they have already formed sufficient semantic associations to overcome the phonological dissimilarity of the allomorphs.

It is also possible that the testing Rounds may have omitted the period of time in which such differentiated accuracy could be observed. At Round 2, the children appear to have acquired a productive regular past tense schema and produce the regular allomorphs with similar levels of accuracy. It is possible that by Round 2, allomorph effects can no longer be observed due to the formation of the productive 'regular past tense schema'. Examining data at a point between Round 1, where no productivity was observed with the allomorphs, and Round 3 may potentially reveal differential accuracy with the allomorphs and evidence of a '[d] schema', a '[t] schema', and even an '[ed] schema'.

As semantic associations are formed among the allomorphs themselves based on the shared semantic feature of [PAST], strengthening one schema would be predicted to also strengthen all the schemas to a certain extent. In this way, once the first allomorph schema emerges, the subsequent allomorph schemas should require less input to emerge. This appears to be some evidence for this, as we can observe from Tables 7 and 16. In Round 1, for example, the [t] allomorph had a type frequency of 18 and mean proportion accuracy of 0.14. In Round 3, [ed] also had a type frequency of 18 and mean proportion accuracy of 0.84. Thus type frequency of the allomorph is not the only factor contributing to production accuracy. In regular past tense production, the emergence of the [t] and [d] schemas may have served to strengthen the [ed] schema as well. Although the [ed] allomorph lags behind the [t] and [d] allomorphs in terms of type frequency, which would be predicted to affect the strength and productivity of its schema, its emergence has been 'boosted' in a sense through its semantic association with the other two allomorphs. This may also account for the relatively uniform rates of production accuracy of the allomorphs at Rounds 2 and 3.

The acquisition of the irregular past tense, on the other hand, appears to be progressing in a steady, linear manner. There were 54 types of irregular past tense forms at Round 3, but the children's mean proportion correct on the TEGI PTP was only 0.50. In general, irregular types were observed to increase steadily from Rounds 1 to 3 with increased input, as predicted by both models due to the fact irregulars are sensitive to token frequency alone. Irregular production accuracy at Round 3 was found to be correlated with lexicon size at Rounds 1, 2, and 3. It appears, then, that at Round 3, the children have finally had sufficient exposure, *i.e.* have amassed sufficient tokens of irregular forms, to begin producing irregulars with a certain amount of accuracy, although mean production accuracy is still about chance. It is also possible that the children have also acquired sufficient types of irregular verbs to start making associations among members, forming schemas for some of the irregular 'gangs.' If testing were to continue beyond Round 3, we would expect the children to become highly accurate in their past tense production and the frequency distributions of regulars, irregulars, and allomorphs in the children's lexicons to reflect their distributions in the external input.

6.3 Further Study

The results from this study have contributed towards a better understanding of child second language acquisition and particularly the input factors that shape morphological acquisition. Support was found from the longitudinal L2 data for Bybee's single-route, Usage-based model of linguistic processing. Although some aspects of the data could be accounted for by a dual-route model, *e.g.* earlier demonstrated accuracy with regulars than irregulars and uniform accuracy in allomorph production, the correlation between lexicon size at Round 1 and regular past tense accuracy in Round 2 supports an emergent view of language and runs contrary to dual-route predictions. Input factors including phonological and semantic features, type and token frequency, and lexicon size were found to affect the strength of lexical representations and the emergence and strength of morphological schemas. Further research is needed to determine if allomorph effects exist.

Current research is increasingly focusing on a single-route approach to acquisition with increasing attention being paid to connectionist and usage-based models of language to account for linguistic phenomena. The predictions made by these models are also highly testable, whether by means of corpus analysis or by using the computer modelling techniques employed by connectionist researchers. This new direction in linguistic processing research is now leading to the view that language learning is much like other cognitive learning and that the factors affecting it are neurologically and usage-based.

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Appendix A – Irregular verbs from the BNC Spoken All Subcorpus

LEMMA	Tokens	Tokens/Million Words
WAS	83784	8,106.86
DID	34845	3,371.57
WERE	28473	2,755.02
SAID	25206	2,438.91
HAD	23344	2,258.74
GOT	10563	1,022.07
WENT	9435	912.92
THOUGHT	7580	733.43
CAME	4862	470.44
TOOK	2881	278.76
TOLD	2151	208.13
SAW	2109	204.06
KNEW	1726	167.01
MADE	1668	161.39
GAVE	1508	145.91
BOUGHT	1262	122.11
FOUND	1074	103.92
FELT	872	84.37
LEFT	854	82.63
HEARD	818	79.15
KEPT	628	60.76
WROTE	610	59.02
MEANT	560	54.19
SAT	550	53.22
BROUGHT	522	50.51
SENT	480	46.44
BECAME	457	44.22
SPOKE	435	42.09
LOST	429	41.51
FELL	427	41.32
RAN	403	38.99
RANG	401	38.8
FORGOT	398	38.51
WON	300	29.03
BROKE	298	28.83
READ	293	28.35
MET	292	28.25
STOOD	278	26.9
BEGAN	258	24.96
SPENT	256	24.77
SOLD	220	21.29
DROVE	158	15.29
CAUGHT	155	15
THREW	152	14.71

ATE	140	13.55
CHOSE	132	12.77
BUILT	128	12.39
WORE	127	12.29
LEARNT	121	11.71
GREW	120	11.61
WOKE	117	11.32
STUCK	110	10.64
DREW	105	10.16
HELD	105	10.16
UNDERSTOOD	105	10.16
LAY	104	10.06
FLEW	93	9
SLEPT	93	9
BLEW	76	7.35
LED	74	7.16
SHOT	69	6.68
SANG	66	6.39
TAUGHT	59	5.71
DEALT	57	5.52
BIT	53	5.13
STRUCK	50	4.84
AROSE	49	4.74
LENT	44	4.26
LAID	42	4.06
ROSE	41	3.97
DRANK	39	3.77
BURNT	36	3.48
DUG	36	3.48
FOUGHT	33	3.19
HID	33	3.19
HUNG	33	3.19
SWORE	31	3
SHOOK	29	2.81
DREAMT	27	2.61
RODE	27	2.61
SOUGHT	26	2.52
UNDERTOOK	22	2.13
BURST	21	2.03
DRUNK	20	1.94
BENT	19	1.84
SMELT	19	1.84
SLID	18	1.74
SPREAD	18	1.74
STOLE	17	1.64
FED	17	1.64
RUN	16	1.55
WOUND	16	1.55
CREPT	14	1.35

SPELT	14	1.35
TORE	14	1.35
UNDERWENT	14	1.35
SWEPT	13	1.26
SPOILT	12	1.16
FROZE	12	1.16
SWAM	12	1.16
SANK	11	1.06
WITHDREW	11	1.06
LEAPT	10	0.97
SWUNG	10	0.97
MISUNDERSTOOD	9	0.87
OVERCAME	9	0.87
SHONE	9	0.87
LEANT	8	0.77
SPILT	8	0.77
BOUND	8	0.77
OVERTOOK	8	0.77
BRED	7	0.68
FLUNG	7	0.68
FORGAVE	7	0.68
SPUN	7	0.68
UNDID	7	0.68
SPAT	6	0.58
TROD	6	0.58
KNELT	5	0.48
WEPT	5	0.48
LIT	5	0.48
MISTOOK	5	0.48
STOOK	5	0.48
AWOKE	4	0.39
FLED	4	0.39
SHED	4	0.39
GROWN	4	0.39
OVERSLEPT	3	0.29
REBUILT	3	0.29
SLUNG	3	0.29
SPED	3	0.29
SPRANG	3	0.29
SPRUNG	3	0.29
STANK	3	0.29
STUNK	3	0.29
SUNG	3	0.29
WOVE	3	0.29
MISREAD	2	0.19
UN-SLEPT	2	0.19
FORBADE	2	0.19
FORESAW	2	0.19
OVERDID	2	0.19

RE-WROTE	2	0.19
REWOUND	2	0.19
SNOOK	2	0.19
STUNG	2	0.19
UNDERLAY	2	0.19
UNWOUND	2	0.19
WORN	2	0.19
WRIT	2	0.19
QUIT	2	0.19
BLED	1	0.1
EARNT	1	0.1
MIS-SPELT	1	0.1
UNSTUCK	1	0.1
CHUNG	1	0.1
RE-THOUGHT	1	0.1
REDID	1	0.1
SNUCK	1	0.1
STRODE	1	0.1
STROVE	1	0.1
SLIT	1	0.1
BEFELL	1	0.1
DOVE	1	0.1
OVERRAN	1	0.1
SHRANK	1	0.1
WITHHELD	1	0.1

Appendix B – Irregular Verbs from the BNC Spoken Classroom Subcorpus

LEMMA	**Tokens**	**Tokens/ Million Words**
HAD	544	1265.20
SAID	351	816.34
GOT	260	604.69
THOUGHT	166	386.07
WENT	151	351.19
CAME	101	234.90
GAVE	75	174.43
TOOK	58	134.89
SAW	52	120.94
MADE	46	106.98
KNEW	40	93.03
WROTE	36	83.73
FOUND	31	72.10
TOLD	20	46.51
FELT	18	41.86
BOUGHT	17	39.54
MEANT	16	37.21
READ	16	37.21
DREW	15	34.89
RAN	15	34.89
FORGOT	14	32.56
LEFT	14	32.56
BECAME	12	27.91
KEPT	12	27.91
SPENT	12	27.91
SAT	11	25.58
BROUGHT	9	20.93
SPOKE	9	20.93
WON	8	18.61
ATE	7	16.28
MET	7	16.28
STOOD	7	16.28
CHOSE	6	13.95
FLEW	6	13.95
LEARNT	6	13.95
LOST	6	13.95
UNDERSTOOD	6	13.95
BEGAN	5	11.63
FELL	5	11.63
GREW	5	11.63
HELD	5	11.63
SANG	5	11.63
SENT	5	11.63
SOLD	5	11.63

THREW	5	11.63
BURNT	4	9.30
CAUGHT	4	9.30
TAUGHT	4	9.30
WOKE	4	9.30
DRANK	3	6.98
STUCK	3	6.98
SWAM	3	6.98
BUILT	2	4.65
DREAMT	2	4.65
FOUGHT	2	4.65
HID	2	4.65
MISHEARD	2	4.65
SHOT	2	4.65
SLEPT	2	4.65
WORE	2	4.65
AWOKE	1	2.33
BENT	1	2.33
BIT	1	2.33
BLEW	1	2.33
BROKE	1	2.33
DROVE	1	2.33
LAY	1	2.33
LED	1	2.33
OVERTOOK	1	2.33
RE-WROTE	1	2.33
REDID	1	2.33
SHONE	1	2.33
SHOOK	1	2.33
SNUCK	1	2.33
STOLE	1	2.33
WOUND	1	2.33
WRIT	1	2.33

Appendix C – Past Tense Verbs in Round 1 Spontaneous Samples

Irregular Past Tense Verbs from Round 1 Spontaneous Language Samples:

LEMMA	Tokens	Tokens Correct	Proportion Correct
LOSE	13	13	1.00
SAY	19	12	0.63
GO	55	10	0.18
GET	16	9	0.56
SEE	31	8	0.26
FORGET	5	5	1.00
EAT	22	4	0.18
BUY	4	3	0.75
WIN	4	3	0.75
FIND	2	2	1.00
GIVE	11	2	0.18
MAKE	10	2	0.20
BITE	2	1	0.50
COME	16	1	0.06
FALL	3	1	0.33
FLY	4	1	0.25
HEAR	1	1	1.00
RUN	3	1	0.33
TAKE	4	1	0.25
TELL	1	1	1.00
BRING	1	0	-
BUILD	1	0	-
CATCH	10	0	-
DRAW	6	0	-
DRINK	1	0	-
DRIVE	1	0	-
FIGHT	3	0	-
KNOW	3	0	-
READ	1	0	-
RIDE	1	0	-
SIT	1	0	-
SLEEP	1	0	-
TEACH	1	0	-
THROW	4	0	-
WEAR	1	0	-
WRITE	2	0	-

Regular Past Tense Verbs from Round 1 Spontaneous Language Samples:

LEMMA	Allomorph	Tokens	Tokens Correct	Proportion Correct
CHASE	t	1	1	1.00
KICK	t	2	1	0.50
WRECK	t	2	1	0.50
FIX	t	4	1	0.25
HELP	t	5	1	0.20
JUMP	t	5	1	0.20
WATCH	t	9	1	0.11
BRUSH	t	1	0	0.00
BUMP	t	1	0	0.00
COOK	t	2	0	0.00
DANCE	t	1	0	0.00
DRESS	t	2	0	0.00
DROP	t	1	0	0.00
KISS	t	2	0	0.00
LIKE	t	2	0	0.00
LOOK	t	4	0	0.00
WALK	t	4	0	0.00
WASH	t	3	0	0.00
HAPPEN	d	1	1	1.00
SCORE	d	1	1	1.00
DIE	d	4	3	0.75
TURN	d	2	1	0.50
OPEN	d	5	1	0.20
PLAY	d	20	1	0.05
KILL	d	1	0	0.00
CALL	d	1	0	0.00
CRY	d	1	0	0.00
COLOR	d	2	0	0.00
LISTEN	d	1	0	0.00
MOVE	d	1	0	0.00
PHONE	d	1	0	0.00
PULL	d	1	0	0.00
STAY	d	2	0	0.00
TRY	d	2	0	0.00
NEED	ed	1	1	1.00
PRETEND	ed	1	1	1.00
START	ed	4	1	0.25
WANT	ed	10	1	0.10
SKATE	ed	1	0	0.00

Appendix D – Past Tense Verbs in Round 2 Spontaneous Language Samples

Irregular Past Tense Verbs from Round 2 Spontaneous Language Samples:

LEMMA	Tokens	Tokens Correct	Proportion Correct
BECOME	2	2	1.00
BEND	1	1	1.00
BUILD	1	1	1.00
FORGET	18	18	1.00
HEAR	1	1	1.00
LOSE	5	5	1.00
MEET	1	1	1.00
SAY	67	67	1.00
TELL	9	9	1.00
THROW	4	4	1.00
WEAR	1	1	1.00
SEE	26	24	0.92
MAKE	7	6	0.86
COME	11	9	0.82
TAKE	11	9	0.82
RUN	4	3	0.75
GET	53	38	0.72
GO	91	65	0.71
WAKE(UP)	3	2	0.67
BUY	11	7	0.64
BREAK	9	5	0.56
BRING	2	1	0.50
KNOW	2	1	0.50
TEACH	2	1	0.50
WIN	6	3	0.50
GIVE	8	3	0.38
EAT	15	5	0.33
FALL	12	4	0.33
STEAL	3	1	0.33
READ	5	1	0.20
BEGIN	1	0	0.00
BITE	1	0	0.00
FIGHT	1	0	0.00
FIND	1	0	0.00
FLY	1	0	0.00
FREEZE	2	0	0.00
HOLD	2	0	0.00
RIDE	4	0	0.00
SIT	2	0	0.00
SLEEP	4	0	0.00

Regular Past Tense Verbs from Round 2 Spontaneous Language Samples:

LEMMA	Allomorph	Tokens	Tokens Correct	Proportion Correct
BUMP	t	1	1	1.00
DROP	t	1	1	1.00
FINISH	t	2	2	1.00
JUMP	t	3	3	1.00
LAUGH	t	1	1	1.00
LIKE	t	1	1	1.00
MISS	t	2	2	1.00
MIX	t	2	2	1.00
PICK (UP)	t	1	1	1.00
PROMISE	t	1	1	1.00
SCRATCH	t	1	1	1.00
SKIP	t	1	1	1.00
TALK	t	4	4	1.00
TRICK	t	2	2	1.00
LOOK	t	3	2	0.67
PUSH	t	3	2	0.67
WATCH	t	15	8	0.53
KICK	t	4	2	0.50
PRACTICE	t	4	2	0.50
DRESS	t	3	1	0.33
ASK	t	1	0	0.00
BRUSH	t	2	0	0.00
HOP	t	1	0	0.00
KISS	t	1	0	0.00
PEEK	t	1	0	0.00
PRESS	t	1	0	0.00
SQUASH	t	2	0	0.00
WALK	t	1	0	0.00
CLIMB	d	2	2	1.00
COPY	d	1	1	1.00
DIE	d	5	5	1.00
DODGE	d	1	1	1.00
DREAM	d	1	1	1.00
FILL	d	1	1	1.00
FOLLOW	d	1	1	1.00
HAPPEN	d	4	4	1.00
LIE	d	3	3	1.00
MARRY	d	1	1	1.00
PAY	d	1	1	1.00
PEE	d	1	1	1.00
TRY	d	1	1	1.00

MOVE	d	3	2	0.67
USE	d	3	2	0.67
PLAY	d	38	24	0.63
KILL	d	7	4	0.57
STAY	d	4	2	0.50
CHANGE	d	6	1	0.17
BATTLE	d	2	0	0.00
LEARN	d	1	0	0.00
NAME	d	1	0	0.00
SHARPEN	d	1	0	0.00
SPILL	d	1	0	0.00
TURN	d	1	0	0.00
DECIDE	ed	1	1	1.00
EXPLODE	ed	2	2	1.00
FART	ed	1	1	1.00
FLOAT	ed	1	1	1.00
INVITE	ed	1	1	1.00
NEED	ed	2	2	1.00
START	ed	8	6	0.75
WANT	ed	6	4	0.67
LAND	ed	2	0	0.00
PRETEND	ed	2	0	0.00
SKATE	ed	1	0	0.00
WAIT	ed	3	0	0.00

Appendix E – Past Tense Verbs in Round 3 Spontaneous Language Samples

Irregular Past Tense Verbs from Round 3 Spontaneous Language Samples:

LEMMA	Tokens	Tokens Correct	Proportion Correct
BREAK	3	3	1.00
BRING	3	3	1.00
CATCH	3	3	1.00
DRAW	1	1	1.00
EAT	11	11	1.00
FORGET	16	16	1.00
HEAR	2	2	1.00
KEEP	5	5	1.00
KNOW	4	4	1.00
LEAVE	1	1	1.00
MEET	6	6	1.00
PASS	1	1	1.00
READ	4	4	1.00
RIDE	1	1	1.00
RUN	5	5	1.00
SAY	51	51	1.00
SING	1	1	1.00
SLEEP	1	1	1.00
SPEND	1	1	1.00
TEACH	3	3	1.00
THINK	3	3	1.00
WEAR	1	1	1.00
WIN	5	5	1.00
WRITE	1	1	1.00
GO	58	57	0.98
MAKE	32	31	0.97
COME	23	22	0.96
SEE	27	25	0.93
GET	75	67	0.89
LOSE	5	4	0.80
FIND	9	7	0.78
TELL	13	10	0.77
TAKE	8	6	0.75
FALL	9	6	0.67
SIT	3	2	0.67
GIVE	25	16	0.64
DRINK	2	1	0.50

SHOOT	2	1	0.50
SLIDE	2	1	0.50
THROW	2	1	0.50
BUY	16	6	0.38
BITE	1	0	0.00
BLEED	1	0	0.00
BUILD	2	0	0.00
DIG	1	0	0.00
HANG	1	0	0.00
HIDE	1	0	0.00
HOLD	1	0	0.00
SEND	1	0	0.00
SPIN	2	0	0.00
STAND+UP	1	0	0.00
STEAL	3	0	0.00
SWING	1	0	0.00
USE	1	0	0.00

Regular Past Tense Verbs from Round 3 Spontaneous Language Samples:

LEMMA	Allomorph	Tokens	Tokens Correct	Proportion Correct
ASK	t	2	2	1.00
BODYCHECK	t	1	1	1.00
BUMP	t	1	1	1.00
CHASE	t	1	1	1.00
CRUSH	t	1	1	1.00
DANCE	t	1	1	1.00
DRIP	t	1	1	1.00
DROP	t	3	3	1.00
FINISH	t	2	2	1.00
KICK	t	1	1	1.00
KNOCK	t	1	1	1.00
LICK	t	2	2	1.00
MISS	t	5	5	1.00
POP	t	1	1	1.00
PUNCH	t	1	1	1.00
RIP	t	1	1	1.00
SKIP	t	3	3	1.00
SMASH	t	1	1	1.00
SNEAK	t	3	3	1.00
TOUCH	t	5	5	1.00
WIPE	t	1	1	1.00
WORK	t	1	1	1.00
JUMP	t	6	5	0.83
PASS	t	5	4	0.80
WATCH	t	7	4	0.57
BLOCK	t	2	1	0.50
CRASH	t	2	1	0.50
HELP	t	2	1	0.50
KISS	t	2	1	0.50
LOOK	t	4	2	0.50
PUSH	t	2	1	0.50
CURSE	t	1	0	0.00
GUESS	t	1	0	0.00
BELIEVE	d	1	1	1.00
BLAME	d	1	1	1.00
BOW	d	1	1	1.00
BUG	d	1	1	1.00
CLIMB	d	1	1	1.00
DAB	d	1	1	1.00
EXPLORE	d	1	1	1.00
FAIL	d	1	1	1.00
GRAB	d	8	8	1.00
HAPPEN	d	1	1	1.00
KILL	d	2	2	1.00
LEARN	d	2	2	1.00

LIVE	d	3	3	1.00
MOVE	d	2	2	1.00
OPEN	d	2	2	1.00
RAIN	d	1	1	1.00
REMEMBER	d	2	2	1.00
SAVE	d	3	3	1.00
SCARE	d	2	2	1.00
SCORE	d	2	2	1.00
SNOW	d	2	2	1.00
SPILL	d	1	1	1.00
SPONGE	d	2	2	1.00
STAY	d	2	2	1.00
TAG	d	3	3	1.00
TRAIN	d	1	1	1.00
TRY	d	7	7	1.00
TURN	d	2	2	1.00
USE	d	6	6	1.00
DIE	d	9	8	0.89
SHOW	d	4	3	0.75
PLAY	d	15	11	0.73
CALL	d	2	1	0.50
MARRY	d	2	1	0.50
CHANGE	d	6	2	0.33
DROWN	d	1	0	0.00
SLAM	d	1	0	0.00
WRESTLE	d	1	0	0.00
ADD	ed	1	1	1.00
BOOST	ed	1	1	1.00
CELEBRATE	ed	1	1	1.00
END(UP)	ed	2	2	1.00
FART	ed	2	2	1.00
GRANT	ed	1	1	1.00
HATE	ed	1	1	1.00
INVITE	ed	2	2	1.00
LAND	ed	3	3	1.00
NEED	ed	2	2	1.00
PAINT	ed	1	1	1.00
POINT	ed	1	1	1.00
SKATE	ed	1	1	1.00
TRADE	ed	2	2	1.00
WANT	ed	7	6	0.86
START	ed	6	5	0.83
COLLECT	ed	2	0	0.00
DECORATE	ed	2	0	0.00

Appendix F – TEGI PTP Target Verb Frequencies in the BNC Subcorpora

Target Verb	**Allomorph**	**Spoken All**		**Spoken Classroom**	
		Tokens	**Tokens/ Million**	**Tokens**	**Tokens/ Million**
picked	t	307	29.71	6	13.95
jumped	t	122	11.80	2	4.65
kicked	t	49	4.74	1	2.33
brushed	t	6	0.58	1	2.33
climbed	d	41	3.97	2	4.65
cleaned	d	35	3.39	2	4.65
tied	d	30	2.90	2	4.65
lifted	ed	41	3.97	0	0.00
painted	ed	30	2.90	1	2.33
made		1668	161.39	46	106.98
gave		1508	145.91	75	174.43
wrote		610	59.02	36	83.73
caught		155	15.00	4	9.30
ate		140	13.55	7	16.28
blew		76	7.35	1	2.33
dug		36	3.48	0	0.00
rode		27	2.61	0	0.00