The Development of Polysemy and Frequency Use in English Second Language Speakers

Scott Crossley  
Mississippi State University

Tom Salsbury  
Washington State University

Danielle McNamara  
University of Memphis

Spoken language data were collected from six adult second language (L2) English learners over a year-long period in order to explore the development of word polysemy and frequency use. The data were analyzed both quantitatively and qualitatively. In the first analysis, the growth of WordNet polysemy values and CELEX word frequency values were examined. For both indexes, significant growth was demonstrated from the 2nd to the 16th week of observation, after which values remained stable. Growth in word polysemy values also correlated with changes in word frequency, supporting the notion that frequency and polysemy effects in word use are related. A second analysis used the WordNet dictionary to explore qualitative changes in word sense use concerning six frequent lexical items in the learner corpus (think, know, place, work, play, and name). A qualitative analysis compared normalized frequencies for each word sense in the first trimester of the study to the later trimesters. Differences in the number of word senses used across trimesters were found for all six words. Analyses 1 and 2, taken together,

The research reported here was supported by the Institute of Education Sciences, U.S. Department of Education, through Grant IES R3056020018-02 to the University of Memphis. The opinions expressed are those of the authors and do not represent views of the Institute or the U.S. Department of Education. The authors would also like to thank Dr. Philip McCarthy of the University of Memphis for his statistical and methodological assistance. Additionally, the authors are indebted to the anonymous reviewers who provided critical assessments of the early and late versions of this article.

Correspondence concerning this article should be addressed to Scott Crossley, Department of English, Mississippi State University, P.O. Box E., Mississippi State, MS 39762-5505. Internet: scrossley@mail.psyic.memphis.edu
support the notion that L2 learners begin to use words that have the potential for more senses during the first 4 months; learners then begin to extend the core meanings of these polysemous words. These findings provide further insights into the development of lexical proficiency in L2 learners and the growth of lexical networks.

**Keywords** polysemy; word frequency; lexical networks; corpus linguistics; lexical proficiency; computational linguistics

**Introduction**

This article will analyze the development of polysemous word use and word senses as well as word frequency use in the word production of second language (L2) learners. Using a year-long longitudinal study and both quantitative and qualitative analyses to examine the vocabulary production of six L2 learners, this study demonstrates that L2 learners initially begin to produce more polysemous and frequent words but with few sense extensions. Later, as L2 learners’ lexical networks begin to develop, the learners begin to produce peripheral word senses.

We seek to illustrate that L2 lexical proficiency can be studied not only by testing L2 lexical performance but also from an analysis of L2 learners’ word production and its relation to word senses, conceptual levels, and lexical association models (Crossley, Salsbury, McCarthy, & McNamara, 2008; Crossley, Salsbury, & McNamara, 2009; Haastrup & Henriksen, 2000; Huckin & Coady, 1999). Until recently, approaches that analyze L2 lexical sense relations, conceptual development, and lexical networks have been rare (Meara, 2002), with most studies examining broad measures of lexical growth such as lexical accuracy, lexical frequency, and lexical diversity (Polio, 2001). Such studies do not explore the development of word senses and lexical networks (Schmitt, 1998). However, the examination of word sense development and lexical networks is important because words are more than just a simple, linear connection between form and meaning.

From a practical standpoint, the lexical proficiency of L2 learners is a crucial area of study. For one, the inaccurate production of lexical items is a key factor in global errors that inhibit communication (R. Ellis, 1995; R. Ellis, Tanaka, & Yamakazi, 1994; de la Fuente, 2002). In addition, lexical growth is strongly related to academic achievement (Daller, van Hout, & Treffers-Daller, 2003). From a theoretical standpoint, lexical proficiency studies are important because they provide insight into how learners process lexical items cognitively and thus offer the opportunity to explore how L2 learners process and produce lexical
items in an L2. Such explorations into lexical development are critical because L2 lexical acquisition is enigmatic (Schmitt, 1998) and an overall theory of lexical acquisition is lacking (Nation, 1990).

We decided to examine polysemy relationships (and, by extension, word frequency use) in this study because their development in L2 lexical networks has not been fully examined in the past (e.g., Schmitt, 1998). Sense relations such as polysemy are important for developing lexical networks because of their correlation with richness of word knowledge and depth of vocabulary knowledge (Wesche & Paribakht, 1996). Other lexical sense relations that are related to word knowledge have recently been investigated in longitudinal studies. These include hypernymy (Crossley et al., 2009), semantic coreferentiality (Crossley et al., 2008; Crossley, Salsbury, & McNamara, 2010), and word meaningfulness (Salsbury, Crossley, & McNamara, in press). These studies have generally supported the notion that L2 learners’ sense relation knowledge quickly increases with time studying a language and that the growth is likely attributable to lexical networks. Synchronic studies that have analyzed sense relations have also demonstrated that L2 learners have lower lexical knowledge when compared to first language (L1) speakers (Ordonez, Carlo, Snow, & McLaughlin, 2002; Verhallen & Schoonen, 1993, 1998).

Polysemy
Polysemous words are words that have more than one related sense. For instance, the word *class* has at least six related senses. These include socioeconomic class, a body of students, a course of study, a collection of things sharing similar attributes, a league ranked by quality (usually sports related), and elegance in dress or behavior. Polysemy is best analogized using the perspective of a continuum. When viewed this way, polysemy is located in the middle of the continuum with homonymy at one end and vagueness at the other. A polysemous word has one core meaning with various related senses. This is in contrast to a homonym, which is a word with two or more unrelated meanings (i.e., bank as in a river and bank as in a financial institution), whereas a vague word has one meaning with only one sense (Geeraerts, 1993; Tuggy, 1993). Polysemous words are more common than both homonyms and vague words and are more of a rule than an exception (Gyori, 2002; Murphy, 2004).

Historically, the reason for the ubiquity of polysemous words is because people have preferred to take words and extend their meaning rather than create new words (Gyori, 2002; Murphy, 2004). This preference, known as the *law of least effort*, states that speakers will economize their vocabulary by extending word senses in order to conserve lexical storage space. Thus, over time, word
meanings are extended so that individual words possess multiple meanings. This is especially true for more frequent words, which tend to be the most polysemous (Zipf, 1945). Because frequent words have the most senses, learners encounter highly polysemous words most often. However, highly polysemous words, although unavoidable, also exhibit higher degrees of ambiguity and could thus be more difficult to process (Davies & Widdowson, 1974). Nevertheless, with time, the frequency of polysemous words should allow their processing to become more economical and require less effort (Larsen-Freeman, 2002).

**Lexical Networks and Polysemy**

Because polysemy connects different word senses, it is related to conceptual organization. In this sense, when words have multiple related senses, their meanings overlap and relate to the same conceptual structure (Murphy, 2004). The conceptual levels entailed in polysemous relationships are important for theories of lexical networks because the acquisition of lexical items by language learners is recognized to be much more complex than the simple memorization of a word and its definition. For L2 learners, acquiring a word includes not just the recognition of sound patterns and orthography (Bogaards, 2001; Nation, 2005) but also the understanding of a word at the conceptual level (Murphy, 2004, Nation, 1990) and how these conceptual levels link together (Haastrup & Henriksen, 2000). Theories of lexical networks maintain that words interrelate with other words to form clusters of words that act categorically. These clusters connect to other clusters and other words, until entire lexicons are developed based on interconnections (Ferrer i Cancho & Solé, 2001; Ferrer i Cancho, Solé, & Köhler, 2004; Haastrup & Henriksen, 2000). Connections between words allow newly acquired words to be easily assimilated within these networks because new words are not learned in isolation, but through links to already learned words. As learners progress lexically, they build lexical networks that are strengthened by differentiating sense relations between words and within words (Haastrup & Henriksen, 2000; Verspoor & Lowie, 2003).

Such lexical network approaches are critical to understanding polysemy. Network models that represent polysemous relations are premised on the notion that the multiple senses for a word are not contained in separate lexical entries. Such models suggest that separate entries for related word senses would be uneconomical because they would take up more storage space and would fail to capture the sense connections in the word’s uses (Nunberg, 1979; Pustejovsky, 1995; Verspoor & Lowie, 2003). Under a lexical network approach, words connect not only to a meaning but also to networks of semantically similar words. In consideration of polysemous words, lexical networks allow learners
to recognize meaning relationships between a word’s senses (Verspoor & Lowie, 2003) because the word’s senses are located within a single lexical item. This lexical item is based on the core meaning of the word and allows for semantic extensions of that core meaning to remain within the confines of that single lexical item instead of being dispersed into individual lexical items for each related sense (Langacker, 2002).

Polysemy in L2 Studies
One of the few studies that examined L2 polysemy knowledge was conducted by Schmitt (1998). Schmitt tracked the use of English polysemous words used by a group of three advanced L2 learners over the course of a year. He was specifically interested in the L2 learners’ receptive and primed knowledge of word senses, which he examined through a survey instrument. In the survey, which was administered three times throughout the course of the year, L2 learners were asked to explicitly produce their lexical knowledge of 11 specific words. The L2 learners accomplished this task by providing all of the senses to a specific word they could produce when prompted with that word (as well as provide the meaning for each individual sense). The words were not common words, but they did have at least three senses each.

Overall, Schmitt (1998) found that word sense knowledge increased and was retained more than it was forgotten. However, in all cases, the L2 learners in the study had only partial knowledge of all the possible word senses available for a word. In addition, only two of the three students appeared to steadily progress as the study continued. Importantly though, the L2 learners generally showed gains in word sense knowledge in the first half of the study, but these gains ceased in the second half of the study. Schmitt argued that this meant that word sense acquisition had an initial stage of growth but then reached a plateau. Although learning the sense of a word was a slow process according to Schmitt, once the L2 learner had acquired a new sense, it rarely was forgotten. Schmitt also found that L2 learners were unlikely to have strong word associations for words for which they had not acquired multiple senses.

Using a different approach to polysemy knowledge, Verspoor and Lowie (2003) examined whether giving an L2 learner the core meaning of a polysemous word would assist the L2 learner in guessing at the word’s more peripheral meanings and aid in long-term retention of word senses. The core sense, although not necessarily the most frequent sense of a word, is the most literal or concrete sense that gives rise to less literal or concrete senses. The findings of their study supported the notion that giving core word meanings as compared to noncore word meanings to L2 learners assisted in guessing at peripheral
meanings. Core word meaning clues also provided better retention of meanings in long-term memory. Thus, Verspoor and Lowie argued that semantic networks based on word sense connections were beneficial for the learning of peripheral senses in polysemous words.

**Frequency in L2 Studies**

Whereas polysemy relations in second language acquisition (SLA) have not been a common topic within the scholarly literature, word frequency effects have been. As noted earlier, polysemous words tend to be highly frequent. Frequency is important for both individual experiences (such as task frequency) and linguistic experiences (distributional frequency; Harrington & Dennis, 2002). In consideration of linguistic experiences, frequency is important not only for lexical acquisition but also for the acquisition of syntax, phonology, and morphology. The quick acquisition of linguistic skills is argued to be based on the distribution of frequent linguistic forms and is grounded on the notion that frequent forms are more likely to be comprehended, processed, and produced more often (N. Ellis, 2002). Support for links between lexical acquisition and frequency effects can be found in studies that demonstrate that high-frequency words are recognized more rapidly and that frequent words demonstrate strong effects on lexical production (Kirsner, 1994). A few studies have also found that lower proficiency L2 learners with less processing proficiency use more frequent words than higher level proficiency learners (Bell, 2003; Laufer & Nation, 1995), but these studies have been cross-sectional and examined only written texts. Thus, in L2 studies, the evidence supporting frequency effects as a strong indicator in the development of lexical acquisition in natural language is lacking.

**Method**

In this study, we are interested in looking at the use of words with multiple senses and their growth in use with L2 learners. We are also interested in investigating whether L2 learners begin to use more senses of words as a function of time spent learning English. For this study, we selected a longitudinal approach to data collection and analysis because such an approach better focuses on the developmental nature of lexical networks (Haastrup & Henriksen, 2000). Unlike the Schmitt (1998) study, our approach will look at the spontaneous production of polysemous and frequent words over a 12-month period from six beginning L2 learners. This different approach is necessary because Schmitt’s study prompted L2 learners for explicit knowledge of the same infrequent
words over a year-long period. Such a method is likely to have primed learners to be more receptive to those specific words and may have led to the noticing and acquisition of the words’ senses. In addition, Schmitt’s study examined advanced learners’ knowledge of infrequent words. Such an approach, while valid, would tell us little about how common word senses are acquired at the early stages of L2 learning.

To address these issues, we will report on two analyses. The primary analysis is a quantitative and computational examination of L2 learner data using polysemy values taken from the WordNet lexical dictionary as well as word frequency values taken from the CELEX corpus. This analysis allows us to conduct a large-scale computational analysis of the corpus in a systematic manner that is not possible by hand. The strength of this analysis is its breadth and comprehensiveness. A second, more qualitative analysis is also undertaken to strengthen the findings of the quantitative analysis. The purpose of the second analysis is to provide supporting and illustrative evidence for the quantitative analysis. Thus, the second analysis reports on the growth of word sense production over the course of the longitudinal study on a small selection of polysemous words using human word ratings. Both of these experiments are reported in detail below.

**Participant Selection**

The participants used in this study were a group of L2 English learners enrolled in an intensive English program at a large American university. They were interviewed every 2 weeks (not including program and university breaks) over a 1-year period. Learners’ proficiency levels were tested upon arrival to the program using internal assessments. All participants in the study tested into the lowest proficiency level, Level 1, of a 6-level program. The participants reported that they had all studied English at the secondary level in their countries of origin. Thus, we considered the learners false beginners because of their prior English language instruction. However, none of the learners had lived in the US for longer than 3 weeks prior to the start of the study. Learners’ language growth was also assessed every other month through the institutional TOEFL. The first application of the TOEFL occurred at the end of the 2nd month of observation. The mean score on the exam was 358.33 with a standard deviation of 49.79 (see Table 6 for more details on TOEFL scores). The learners continued their participation in the study as they progressed through the program. The learners had 4 different teachers for instruction in any one level of the program, and the teachers changed every 7 weeks when learners progressed to a new level.
In addition, the learners were not all together in the same classes, but rather dispersed among sections within a level. The focus of this study is on six of the learners in the original cohort of 50 students. The other 44 learners were dropped from the analysis because of large gaps in the elicitation data during the year or because they did not complete the year. Each learner in the study was given a pseudonym; this paper reports on data from Marta (Spanish L1), Takako (Japanese L1), Eun Hui (Korean L1), Faisal (Arabic L1), Kamal (Arabic L1), and Jalil (Arabic L1). The participants ranged in age from 18 to 29 years old. As already mentioned, all 6 learners reported studying English in their native secondary schools. Only Marta reported using English in a professional setting, but because of her limited ability with English, she was sponsored by her company to study English intensively for one year.

Interviewers were recruited from a graduate-level course in second language acquisition taught at the university. Interviewers were changed as the year progressed; as a result, each learner interacted with 4 or more interviewers over the year of observation. Participants (interviewers and L2 learners) were given a variety of elicitation materials, but participants were also free to introduce their own spontaneous topics into the conversation. Thus, the sessions are characterized by naturally occurring discourse. In some cases, when the scheduled elicitation session contained more learners than interviewers, learners were paired with an interviewer (e.g. two learners to one interviewer). This provided discourse data between the L2 English learner and his or her native-speaking interviewer as well as learner-to-learner data. The 30- to 45-minute sessions were tape recorded and later transcribed. This method of longitudinal data collection has been successfully employed in similar studies that examine the development of L2 lexical sense relations (Crossley et al., 2008; Crossley et al., 2009, 2010).

Analysis 1

Our purpose in the first analysis is to explore whether L2 learners’ lexicons demonstrate an increase in the production of words that are more polysemous for native speakers of English as the L2 learners study English over the course of a year (we will consider the production of senses attributed to individual words in a later qualitative analysis). We are also interested in examining if the use of frequent words increases as a function of time spent learning English. Such findings would demonstrate a movement toward the use of more polysemous words and thus more ambiguous word choices, indicating the development of lexical relationships. To accomplish this, we use the WordNet database
Table 1  Descriptive statistics for longitudinal language data

<table>
<thead>
<tr>
<th>Learner</th>
<th>No. of meetings/ transcripts</th>
<th>Average no. of words per utterance</th>
<th>Average no. of utterances</th>
<th>Average no. of words per transcript</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eun Hui</td>
<td>18</td>
<td>21.31</td>
<td>52.17</td>
<td>1,120.67</td>
</tr>
<tr>
<td>Faisal</td>
<td>13</td>
<td>33.42</td>
<td>71.08</td>
<td>1,870.07</td>
</tr>
<tr>
<td>Takako</td>
<td>18</td>
<td>19.40</td>
<td>51.00</td>
<td>1,470.72</td>
</tr>
<tr>
<td>Kamal</td>
<td>15</td>
<td>23.75</td>
<td>50.27</td>
<td>1,216.20</td>
</tr>
<tr>
<td>Jalil</td>
<td>17</td>
<td>38.82</td>
<td>61.76</td>
<td>2,359.77</td>
</tr>
<tr>
<td>Marta</td>
<td>18</td>
<td>33.31</td>
<td>63.61</td>
<td>1,912.00</td>
</tr>
</tbody>
</table>

(Fellbaum, 1998) and CELEX word frequency data (Baayen, Piepenbrock, & Gulikers, 1996) to statistically analyze lexical growth. As a general indicator of linguistic development, we also analyze the L2 learners’ TOEFL scores. Our use of TOEFL scores is premised on the notion that a single, higher order factor related to language proficiency underlies individual first-order language ability factors such as lexical ability (Oller, 1979). Such a position has been supported in the literature (Carroll, 1983; Shin, 2005) and specifically in reference to TOEFL scores (Bachman, Davidson, Ryan, & Choi, 1995). Because we are using a longitudinal approach, which makes it more challenging to obtain large numbers of participants, the statistical power of the analysis emerges from having a greater number of observations per participant, rather than a large numbers of participants.

**Corpus**

The spoken data collected from the six learners were transcribed and form the basis for this analysis. A total of 99 transcripts were collected. Descriptive data for the corpora of each learner are presented in Table 1. In preparation for the analysis of the learner corpus, transcriptions of each elicitation session were cleaned to eliminate interjections, non-English words, and all punctuation except periods and question marks. Each elicitation session was saved as a single text file containing the oral production of only the learner in focus, not the interviewer or other learners participating in the session. The text file was manually and electronically checked for spelling errors.

**WordNet**

One method for measuring polysemy development is through computational, lexical databases meant to emulate lexical networks. Perhaps the best suited database of this type is WordNet (Fellbaum, 1998; Miller, Beckwith, Fellbaum,
Gross, & Miller, 1990), which is a lexical reference system inspired by current psycholinguistic theories of lexical processing. In WordNet, over 170,000 English nouns, verbs, adjectives, and adverbs are organized in lexical networks based on connections between related lexical concepts. Polysemy relations in WordNet are based on synsets (i.e., groups of related lexical items), which are used to represent similar concepts but distinguish between synonyms and word senses (Miller et al., 1990). These synsets allow for the differentiation of senses and provide a basis for examining the number of senses associated with a word. WordNet polysemy values were obtained through the computational tool Coh-Metrix (Graesser, McNamara, Louwerse, & Cai, 2004). In this study, we used Coh-Metrix to determine the mean WordNet polysemy values for all content words in each transcript.

In computational linguistics, WordNet polysemy values have been used for word sense disambiguation (Agirre & Rigaus, 1996), document retrieval systems (Loupy & El-Beze, 2002), and the development of semantic lexicons (Dorr & Jones, 1999). In L2 learning, WordNet polysemy values have been used to compare simplified and authentic reading text for differences in levels of ambiguousness (Crossley, Louwerse, McCarthy, & McNamara, 2007; Crossley & McNamara, 2008). This study will use WordNet values as a method of tracking the production of words with multiple senses used by L2 learners over time.

**CELEX Frequency Values**

To further support the WordNet findings, we also analyzed the frequency of word use of the six learners over the year-long period. Word frequency is related to polysemy because more frequent words have more senses than infrequent words. For this study, we used CELEX word frequency measurements obtained from Coh-Metrix (Graesser et al., 2004). CELEX (Baayen et al., 1996) word frequency measurements consist of frequencies derived from the early 1991 version of the COBUILD corpus, a 17.9-million-word corpus.

In this study, we used Coh-Metrix to calculate the mean logarithm of the word frequency for all of the content words in each transcript. The logarithm values are to the base of 10. (See Figure 1.) This approach is different from past indexes of word frequency that have been used in L2 studies because it considers the majority of the words in the text and does not solely look at frequency bands such as the first 1,000 most common words, the second 1,000 most common words, the 1,000 most common words found in academic writing, and unrecognized words (e.g., Laufer & Nation, 1995).
Statistical Analyses

WordNet Polysemy Data

To test the hypothesis that time spent learning English relates to the increase in the production of words with more senses, a repeated measures ANOVA was conducted using the WordNet polysemy results from Coh-Metrix. The ANOVA was used to analyze whether temporal intervals affected WordNet polysemy values. We predicted that as time spent learning English increased, WordNet polysemy values would initially increase quickly, signaling an increase in the use of words with multiple senses, but then would level out asymptotically, as noted by Schmitt (1998). Because participants did not share all of the same temporal data points, the ANOVA test analyzed development on a trimester basis. This allowed for breaks in the data related to winter and spring recesses to be considered as well as missing data points resulting from participant absences. Because data were available for the 2nd and 4th weeks and the 50th and 52nd weeks for all six learners, they were included. These data points were analyzed with data from the 16th week and the 32nd week as well. This ANOVA was supplemented with pairwise comparisons to identify significant differences within the temporal progression and polynomial contrasts to test for linear trends in the data. To assess links between time spent learning English and polysemy values, a Pearson’s product-moment correlation test was also conducted. Because temporal data points for the correlation did not have to be shared as in the repeated measures ANOVA, all polysemy values from all transcripts were examined (n = 99 transcripts). For this analysis, we did not predict a significant positive correlation because we assumed that the trends in the polysemy values would not increase as a function of time but would rather be asymptotic.
**CELEX Word Frequency Data**

Because we predicted initial growth in polysemy values, we also predicted that learners would initially use more frequent words as time spent learning English increased. We tested this notion through a repeated measures ANOVA using the CELEX frequency for content words results from Coh-Metrix. In a fashion similar to the polysemy analysis, this ANOVA was used to analyze whether temporal intervals affected CELEX frequency values. Like the polysemy data, participants did not share all of the same temporal data points, so the ANOVA analyzed development on a trimester basis but included the 2nd and 4th weeks and the 50th and 52nd weeks. As in the polysemy analysis, this ANOVA was also supplemented with pairwise comparisons to identify significant differences within the temporal progression. To assess links between time spent learning English and frequency values, a Pearson’s product-moment correlation test was also conducted. For this analysis, we did not predict a significant positive correlation because we assumed that the trends in the frequency values would not increase linearly as a function of time but would rather be asymptotic in a fashion similar to the polysemy values. To examine the link between the development of polysemy values and word frequency, a correlation between the CELEX frequency values and the WordNet polysemy values was conducted. For this analysis, we predicted a positive correlation because CELEX word frequency values should increase as polysemy values increase.

**TOEFL Scores**

To test the hypothesis that learners’ linguistic abilities increase with time spent learning English, we conducted a repeated measures ANOVA using the learners’ TOEFL scores. The ANOVA was used to analyze whether temporal intervals affected TOEFL scores, with the prediction that as time spent learning English increased, TOEFL scores would increase. This would provide evidence of general linguistic growth and, more specifically, lexical growth. For the TOEFL scores, however, only four learners completed all six of the TOEFL examinations given over the course of the year. One learner missed the second TOEFL examination and a different learner missed the fifth. Thus, the ANOVA for the TOEFL scores only tested four items.

**Results**

**WordNet Polysemy Values**

The results shown in Tables 2 and 3 indicate that the L2 learners’ WordNet polysemy values showed significant differences among the 2nd, 4th, 16th, 32nd, 50th, and 52nd weeks of learning, $F(5, 25) = 8.10, p < .001, \eta^2 = .62$ (see Table 2 for descriptive statistics). A pairwise comparison demonstrated that the
WordNet polysemy values increase significantly from the 2nd meeting to the 16th meeting. After the 16th meeting, the values remain stable, showing no significant growth (see Table 3 for details). These findings provide evidence that words with more senses are used as time spent learning English increases over the first 4 months, but then they level out. This is supported by the correlation between the L2 learners’ time spent learning English and their WordNet polysemy values, which did not demonstrate a significant correlation ($r = .09, p > .05, n = 99$).

**Celex Word Frequency Values**

The results shown in Tables 4 and 5 indicate that the L2 learners’ CELEX frequency values increased significantly across the 2nd, 4th, 16th, 32nd, 50th, and 52nd weeks of learning, $F(5, 25) = 10.35, p < .001, \eta^2 = .78$ (see Table 4 for descriptive statistics). Pairwise comparisons indicate that CELEX frequency values increase significantly from the 2nd meeting to the 16th meeting. In a fashion similar to the polysemy analysis, the values remain stable after the 16th meeting, showing no significant growth (see Table 5 for details). Unlike the polysemy values, though, there was a positive, although low, correlation between the L2 learners’ time spent learning English and their CELEX frequency values ($r = .37, p < .001, n = 99$). Finally, the correlation between the L2 learners’ CELEX frequency values and their WordNet polysemy values showed a significant positive correlation ($r = .59, p < .001, n = 99$), as predicted. These findings provide evidence that as learners spend time studying the English language, they begin to use more frequent words; however, as with the polysemy values, the use of more frequent words begins to level out around the fourth month. Additionally, the results provide evidence that the growth of words used with multiple senses in L2 learners correlates with changes in word frequency, supporting the notion that frequency and polysemy effects in word use are related.
### Table 3  Pairwise comparison of temporal differences in polysemy values

<table>
<thead>
<tr>
<th>Week</th>
<th>4</th>
<th>16</th>
<th>32</th>
<th>50</th>
<th>52</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Diff = −0.28 (0.18)</td>
<td>Diff = −0.76 (0.16) *</td>
<td>Diff = −0.67 (0.13) *</td>
<td>Diff = −0.57 (0.12) *</td>
<td>Diff = −0.65 (0.20) *</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Diff = −0.49 (0.18) *</td>
<td>Diff = −0.39 (0.16)</td>
<td>Diff = −0.50 (0.15)</td>
<td>Diff = −0.37 (0.16)</td>
</tr>
<tr>
<td>16</td>
<td></td>
<td></td>
<td>Diff = 0.10 (0.12)</td>
<td>Diff = 0.19 (0.10)</td>
<td>Diff = 0.12 (0.11)</td>
</tr>
<tr>
<td>32</td>
<td></td>
<td></td>
<td></td>
<td>Diff = 0.09 (0.09)</td>
<td>Diff = 0.02 (0.09)</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Diff denotes the average difference between polysemy values (standard error).  
*p < .05.
Table 4 Mean and standard deviations for CELEX content word frequency values

<table>
<thead>
<tr>
<th>Week</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2.55</td>
<td>0.13</td>
</tr>
<tr>
<td>4</td>
<td>2.57</td>
<td>0.07</td>
</tr>
<tr>
<td>16</td>
<td>2.73</td>
<td>0.10</td>
</tr>
<tr>
<td>32</td>
<td>2.75</td>
<td>0.04</td>
</tr>
<tr>
<td>50</td>
<td>2.73</td>
<td>0.10</td>
</tr>
<tr>
<td>52</td>
<td>2.74</td>
<td>0.07</td>
</tr>
</tbody>
</table>

TOEFL Scores
The ANOVA results show that the L2 learners’ TOEFL scores increased as a function of time, defined as the 6th, 22nd, 42nd, and 52nd weeks of learning, $F(3, 15) = 22.78, p < .001$ (see Table 6 for details). A test of within-subjects contrasts demonstrated that the TOEFL scores from the last examination on the 52nd week were significantly different from the first examination on the 6th week, $F(5, 15) = 33.98, p < .01$. Additionally, significant differences in TOEFL scores were found between the 6th week and the 32nd week, $F(3, 15) = 17.23, p < .01$, and the 6th week and the 42nd week, $F(3, 15) = 35.80, p < .01$. There was also a significant linear trend, $F(1, 25) = 40.07, p < .001$. These findings provide evidence that TOEFL scores increase with time spent learning English and suggest that significant linguistic development (to include lexical development) occurred.

Discussion Analysis 1
The results of Analysis 1 demonstrate that L2 learners begin to use words that have more senses available to native speakers within the first 4 months of studying English in a natural environment. This is not to say that learners produce more senses per individual polysemous word but only that they began to produce more words that have more senses. L2 learners also begin to use more frequent words over time. The use of more frequent words and the use of words that have more senses are correlated. Importantly, though, the growth in both highly polysemous words and frequent words seems to plateau at about the fourth month of learning. We also have confidence that the learners examined in this study did demonstrate linguistic and lexical growth over the course of the year, as evidenced by their increasing TOEFL scores.

The finding that L2 learners produce words that are more polysemous provides support for the notion that L2 learners have the opportunity to use the senses associated with the more polysemous words. This finding is also
Table 5 Pairwise comparison of temporal differences in CELEX frequency values

<table>
<thead>
<tr>
<th>Week</th>
<th>4</th>
<th>16</th>
<th>32</th>
<th>50</th>
<th>52</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Diff = -0.03 (0.05)</td>
<td>Diff = -0.18 (0.05)*</td>
<td>Diff = -0.20 (0.04)*</td>
<td>Diff = -0.18 (0.06)*</td>
<td>Diff = -0.19 (0.05)*</td>
</tr>
<tr>
<td>4</td>
<td>Diff = -0.15 (0.30)*</td>
<td>Diff = -0.18 (0.03)*</td>
<td>Diff = -0.15 (0.04)*</td>
<td>Diff = -0.16 (0.03)*</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Diff = -0.27 (0.03)</td>
<td>Diff = 0.00 (0.05)</td>
<td>Diff = 0.02 (0.03)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td></td>
<td>Diff = 0.03 (0.04)</td>
<td>Diff = 0.01 (0.01)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. Diff denotes the average difference between CELEX frequency values (standard error). *p < .05.
supported through the word frequency findings. These results seem to show that within the first 4 months of studying a language, L2 learners begin to demonstrate productive knowledge of the morphophonology of words that are polysemous in English, but not necessarily the semantics of these words. The results also demonstrate that L2 learners begin to produce words that have more senses for native speakers. The production of polysemous words likely demonstrates that L2 learners at an early stage of language acquisition have the opportunities to recognize and interact with ambiguous language.

From an acquisitional perspective, it is interesting to note that the findings of this analysis appear to support Schmitt’s (1998) contention that L2 learners show quick gains in word sense knowledge but that these gains taper off within 4 months. The findings reported in our first analysis, when combined with those of Schmitt, seem to support the notion that L2 learners have an initial stage of growth when learning word senses and, by extension, frequent words but that this initial stage plateaus. Although the use of polysemous words shows significant growth in the first trimester compared to the second and third trimesters, learners may not actually acquire or produce new senses of those words until later. This interpretation parallels the finding by Bogaards (2001) that new word senses are learned individually. We take up the issue of how new word senses are learned in the second analysis in this study. If we can demonstrate that learners not only produce more words that have the potential for multiple senses but also demonstrate growth in the use of multiple senses, we can make stronger arguments for the growth of lexical networks and the acquisition of lexical depth of knowledge features.

### Analysis 2

#### Methods

Although the findings taken from the WordNet polysemy values support the notion that learners begin to use words with more senses, they do not allow us to argue that learners actually use different senses of these words. For this, we need

---

**Table 6**  Mean and standard deviations for TOEFL scores

<table>
<thead>
<tr>
<th>Week</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>358.33</td>
<td>49.79</td>
</tr>
<tr>
<td>22</td>
<td>418.83</td>
<td>33.04</td>
</tr>
<tr>
<td>42</td>
<td>450.66</td>
<td>30.12</td>
</tr>
<tr>
<td>52</td>
<td>458.83</td>
<td>29.25</td>
</tr>
</tbody>
</table>
to analyze individual words spontaneously produced by the L2 learners. Thus, our second analysis examines a small selection of highly polysemous words that were commonly produced in the L2 learner data found in Analysis 1. The purpose of the second analysis is to provide qualitative support to our initial quantitative analysis and illustrate concrete changes in L2 lexical development. Our contention is that learners begin with a core sense of a lexical item and then extend that knowledge to other related senses.

**Word Selection**
To select the words used in this analysis, a word frequency count was conducted for each transcript from the first analysis. The transcripts were divided into two categories: the first trimester and the later trimesters. We chose to divide the data between the first trimester and the following trimesters based on the results of Analysis 1, which demonstrated that polysemy and word frequency values leveled off after the first trimester. Words (including their morphological variants) were selected if they were produced by all L2 learners in both categories and if they had a normalized frequency of over .002 as well as 10 or more senses according to WordNet. Words that had common homonyms were not selected (e.g., *like*); however, strictly polysemous words that could also be used as fillers were allowed (e.g., *know*). Extremely common verbs (e.g., *be, have,* and *go*) were avoided because of their perceived ambiguity, their common use as auxiliary verbs, their idiomatic uses, their common use as phrasal verbs, and their tendency toward suppletion. These criteria left us with six words to analyze: *know, name, place, play, think,* and *work.*

**Word Evaluation**
We used the WordSmith (Scott, 1996) concordancer to provide a random sampling of the words in context. The linguistic context of words is crucial to understanding polysemous words, especially for their co-occurrence and part-of-speech patterns (Kishner & Gibbs, 1996). Because polysemous words derive their meanings from entire sentences (Gibbs & Matlock, 1997), we examined words at the sentence level but also included the sentence before and after the target word. We limited the analysis to 60 examples of each morphological variant of each word (e.g., *think, thinks, thought, thoughts, thinking,* etc.). Because some words were more frequent than others, certain words had greater incidences and were thus evaluated more often (see Table 7 for more information). The word senses used for the evaluation were taken from the WordNet dictionary.

Two expert raters with Ph.D.s in the field of SLA rated each word occurrence individually and assigned it a sense from the WordNet dictionary. The ratings
were then compared, and each rater was given the opportunity to change their ratings. If agreement was not met, the word incidence was not included in the analysis. This happened most often as a result of contextual scarcity. The final evaluations for each word were then qualitatively analyzed.

**Analysis Techniques**

We first conducted tests of interrater reliability between the raters’ judgments. This was accomplished using Pearson product-moment correlation. We then analyzed the word sense production of each individual learner to ensure that increases in total word senses across the group of L2 learners were not the result of one participant using a greater number of senses. This allowed us to ensure that the L2 participants as a whole were demonstrating increased use of word senses as a function of time spent learning English.

Knowing that some words had greater frequency than other words, we next normalized all of the raw word incidences for frequency based on their occurrence per 100 words of a text. Because many of the frequencies were expected to be less than 5, we could not conduct $\chi^2$ tests for statistical power. Thus, the second analysis was qualitative in nature. However, comparison figures were constructed to visually demonstrate the change in word sense use. The findings for each of the six words are presented in the following section.

**Results**

**Individual Word Sense Growth**

An analysis of individual word sense growth demonstrated that, in most instances, at least three learners produced more word senses in the later trimesters than in the first trimester. The exception to this was the word *name*, with which only two L2 learners demonstrated increased word sense production. For the
words *know* and *think*, all learners showed increasing word sense production. For the words *play* and *work*, five of the six learners exhibited increased word sense production. For the word *play*, three of the six learners demonstrated increased word sense production. Descriptive statistics for this analysis are presented in Table 8.

**Group Word Sense Analysis**

*Know.* Interrater reliability for the two expert raters for the senses used for the word *know* was \( (N = 2) \) \( r = .99, p = < .001 \). Qualitative analyses demonstrated that in the first trimester the L2 learners used four senses of the word *know* and, in the later trimesters, they produced seven senses. Frequency data, word data, and comparisons between the groups are presented in Figure 2.

*Name.* Interrater reliability for the two expert raters for the senses used for the word *name* was \( (N = 2) \) \( r = .99, p = < .001 \). Qualitative analyses demonstrated that the L2 learners used one sense of the word *name* in the first trimester and three senses in the later trimesters. Frequency data, word data, and comparisons between the groups are presented in Figure 3.

*Place.* Interrater reliability for the two expert raters for the senses used for the word *place* was \( (N = 2) \) \( r = .99, p = < .001 \). Qualitative analyses showed that L2 learners in the first trimester used one sense of the word *place* and in the later trimesters produced five senses of the word. Frequency data, word data, and comparisons between the groups are presented in Figure 4.

*Play.* Interrater reliability for the two expert raters for the senses used for the word *play* was \( (N = 2) \) \( r = .98, p = < .001 \). The qualitative analyses demonstrate that L2 learners used two senses of the word *play* in the first trimester and eight senses in the later trimesters. Frequency data, word data, and comparisons between the groups are presented in Figure 5.

*Think.* Interrater reliability for the two expert raters for the senses used for the word *think* was \( (N = 2) \) \( r = .97, p = < .001 \). The qualitative analyses comparing the senses used for the word *think* demonstrated that L2 learners in the first trimester used the 3 senses of the word, whereas the L2 learners produced 13 senses of the word in the later trimesters. Frequency data, word data, and comparisons between the groups are given in Figure 6.

*Work.* Interrater reliability for the two expert raters for the senses used for the word *work* was \( (N = 2) \) \( r = .92, p = < .001 \). The qualitative analyses show that L2 learners used four senses for the word *work* in the first trimester and
### Table 8  Word sense use by learner

<table>
<thead>
<tr>
<th>Learner</th>
<th>Time period</th>
<th>Know: Word senses used</th>
<th>Name: Word senses used</th>
<th>Place: Word senses used</th>
<th>Play: Word senses used</th>
<th>Think: Word senses used</th>
<th>Work: Word senses used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eun Hui</td>
<td>First trimester</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Later trimester</td>
<td>7</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Faisal</td>
<td>First trimester</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Later trimester</td>
<td>8</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Takako</td>
<td>First trimester</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Later trimester</td>
<td>8</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Kamal</td>
<td>First trimester</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Later trimester</td>
<td>8</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Jalil</td>
<td>First trimester</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Later trimester</td>
<td>8</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Marta</td>
<td>First trimester</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Later trimester</td>
<td>8</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>9</td>
<td>3</td>
</tr>
</tbody>
</table>
Figure 2  Frequency for senses used for the word *know*.

Figure 3  Frequency for senses used for the word *name*.
Figure 4 Frequency for senses used for the word *place*.

Figure 5 Frequency for senses used for the word *play*.
seven senses in the later trimesters. Frequency data, word data, and comparisons between the groups are presented in Figure 7.

Discussion
The results of this analysis support the argument that L2 learners use more word senses in the later trimesters than in the first trimester. This finding supports our initial analysis and the notion that L2 learners begin to develop sense relations within words as time spent studying English increases. This finding has important implications for the development of lexical proficiency in L2 learners and lexical networks. We argue that such an increase in word sense relations is the result of learners beginning to make associations between the multiple senses available within individual lexical items. Thus, L2 learners at an early stage are able to recognize and employ semantic extensions of core word meanings. These extensions seem to appear rapidly after the fourth month of learning. After this point, word extensions seem to increase and learners seem to have both a better understanding of word sense relations and the ability to produce more senses for each individual lexical item.

This finding seems to contradict Schmitt’s (1998) study in which he argued that L2 learners demonstrate quick acquisition of word senses in the first 6 months but then gradually reached a plateau. The results from our first analysis concur with Schmitt’s findings. However, as our second analysis demonstrates,
growth in word sense use in the first 4 months of study appears limited, although, as noted in our first analysis, learners start to produce words that have the potential for multiple meanings. After the fourth month, the production of word senses for the selected six words appears to increase for most learners with most words. This finding, conflated with the results from Analysis 1, indicates that L2 learners first produce words that have the capacity for multiple word senses and thus ambiguity; however, only after the learners have acquired the core senses of the word do they begin to acquire and produce the other word senses available to that lexical entry. Our argument follows Verspoor and Lowie’s (2003) findings that learning the core sense of a polysemous lexical item increases the use of peripheral senses. In the present study, word sense expansion does not appear to develop until after the fourth month. This is likely the result of developing lexical networks that allow links to be made between word senses, but likely only after the core sense of a word is acquired.

Evidence for a core sense of a lexical item, as perceived by the learners, is found in the high frequency and early emergence of the most concrete senses of words in the corpus. As illustrated in Figures 2 through 7, each of the six lexical items that we chose for the analysis is used to convey relatively few senses in the first trimester of the study. The following examples illustrate how learners produce and use core sense relation in the first trimester of learning:
1. Know.
   *(Know a specific piece of information)*: Policeman say no problem. I know where your mother is (Marta, first trimester, week 6).
   *(Be familiar or acquainted with a person or object)*: Do you know Chiung man (Takako, first trimester, week 8)?

2. Name.
   *(A language unit by which a person or thing is known)*: Children sing, but I don’t know music name (Eun Hui, first trimester, week 6).

3. Place.
   *(General vicinity)*: Stay in one place and talk. Sometime go shopping (Kamal, first trimester, week 2).

4. Play.
   *(Play a sport)*: Sometime play soccer (Kamal, first trimester, week 2).
   *(Engage in playful activity)*: All time only play, only study, only party, and love of my mother and my father (Marta, first trimester, week 6).

5. Think.
   *(Consider or judge)*: What do you think food American (Faisal, first trimester, week 6)?
   *(Expect or suppose)*: I think he from Chicago (Faisal, first trimester, week 2).

   *(Verb, be employed)*: When I work first years is difficult for me (Marta, first trimester, week 8).
   *(Noun, employment)*: Maybe in future when finish here I have work (Faisal, first trimester, week 8).

From the core sense, learners extend to other senses of the lexical item in the later trimesters of the study. We use the lexical item *think* to illustrate the process. Learners begin the study using *think* to mean *consider or judge* and *expect or suppose* as illustrated earlier in (5). The following examples occur in the second and third trimester of the study and illustrate how learners extend *think* to include other senses.

1. *(Cogitate)*: I have to think a little bit, because I don’t, I forgot Japanese order (Takako, second trimester, week 32).
2. *(Remember)*: I think I talked to you about my physics teacher in high school (Jalil, second trimester, week 30).
3. *(Imagine or visualize)*: I thinking about that. I am very famous gymnastic and I imagine that I am (Marta, third trimester, week 50).
4. *(To intend)*: I am thinking to send you to Miami because we have company for two months (Marta, third trimester, week 52).

5. *(Decide by pondering)*: So I take maybe one month to think. I’m think I’m going be Christian (Faisal, third trimester, week 34).

6. *(Ponder but not decide)*: I just think about one problem (Faisal, third trimester, week 36).

7. *(Dispose mind in a certain way)*: If I read book English now so I know how can they think. How can they write (Faisal, third trimester, week 34)?

Another illustration of how word sense extends from core to periphery meanings is seen with the lexical item *work*. In the first trimester, *work*, both as a verb and a noun, is dominated by the sense *to be employed* or *employment*. Peripheral word senses were observed in the later trimesters, illustrated in the following examples:

1. *(Exert oneself)*: Put him in the jail or do something. I mean let him work hard work (Jalil, third trimester, week 50).

2. *(Have an effect)*: It’s going to work in my world. Trust me. It’s going to work. I control everything (Faisal, third trimester, week 48).

For each of the six lexical items that we chose for analysis, a similar process of movement from the core to periphery senses was observed.

**Discussion**

The qualitative analysis of the six lexical items helps explain the findings from our quantitative analysis. We contend that although learners’ production of polysemous words tapers off after an initial period of growth, the actual sense relations that L2 learners use in their discourse increase in type (more varied senses of a lexical item). In other words, the frequency of polysemous words such as *think* and *know* seem to stabilize as a function of time learning the language; however, the frequency of the different sense relations produced for these words is greater in the second and third trimesters of the study. This finding relates to depth of knowledge of lexical items and provides an important indicator of the learners’ overall lexical proficiency. This would likely have been hidden by looking only at broad measures of lexical development and it highlights the importance of qualitative experiments that explore depth of knowledge (Bogaards, 2001; Daller et al., 2003). We argue that such qualitative work in L2 lexical growth supports quantitative analysis of computational indexes of lexical development. Our study accomplishes this in a longitudinal
design, responding to frequent calls in the literature for more research on oral data studied longitudinally (Ortega & Iberri-Shea, 2005).

An interesting question that is raised as a result of this study is why L2 learners use less frequent words early and only begin to use more frequent words as time spent studying English increases. Various studies have demonstrated that less proficient learners use more frequent words than more proficient learners (e.g., Laufer & Nation, 1995) and that, at different proficiency levels, L2 learners’ receptive vocabulary is greater than their productive vocabulary with regard to word frequency (Laufer, 1998; Laufer & Paribakht, 1998; Webb, 2008). However, to our knowledge, no study has looked at word frequency use longitudinally or in naturalistic spoken data. In these circumstances, less proficient learners appear to produce less frequent words according to the frequency index that we used. Our frequency index, which is based not on frequency bands but rather on large corpus sampling, might also be responsible for differences in our findings compared to past studies.

In light of the findings reported here and of the relationship between core word senses and concreteness, we argue that L2 learners likely first produce words that are more concrete (i.e., words that refer to an object, material, or person; Crossley et al., 2009; Salsbury et al., in press) and later begin to produce words that are more polysemous. Because polysemy is correlated with frequency, but likely not concreteness, words that are less frequent are acquired first. There is also the manner of salience. Frequency allows for the law of least effort, but because frequent words are more polysemous, they often oppose this law because of the possible ambiguities contained within words with multiple senses. Thus, less frequent words would be less ambiguous and would likely have more salient meanings (and be less semantically complex). With time, as frequency effects inform input and intake, polysemous words would become more salient and thus would be used more often (Larsen-Freeman, 2002). Such a theoretical approach would explain why the L2 learners in this study initially produced words that were less frequent than the words produced in later transcripts.

Taken together, the results from Analyses 1 and 2 provide indicators of L2 lexical proficiency and the growth of L2 lexical networks. Because a single, widely accepted, general measure of lexical proficiency does not yet exist, it is important to explore individual indicators that contribute to an understanding of overall L2 lexical proficiency. Thus, in combination with other indicators such as lexical diversity (McCarthy, 2005), frequency values (Laufer, 1994; Laufer & Nation, 1995; this study), hyponymy (Crossley et al., 2009) semantic overlap (Crossley et al., 2008; Crossley et al., 2010), and psycholinguistic word
information indexes (Salsbury et al., in press) this study provides another piece to a comprehensive picture of L2 lexical proficiency and the nature of lexical networks.

**Conclusion**

This study has demonstrated that L2 learners in their first trimester of studying English in a natural environment begin to produce words that are more polysemous and more frequent. However, learners only begin to extend the core meanings of these lexical entries in the second and third trimesters. These findings provide evidence that learners significantly increase their production of words that have the potential for ambiguity in the first trimester and then begin to increase the senses related to the words. This finding provides evidence for the development of lexical proficiency in L2 learners and the growth of lexical networks.

The findings in the current study are encouraging; nevertheless, we acknowledge there are limitations to our research design. One limitation is the small number of L2 learners examined, which is common in longitudinal work. Future work with polysemy should include data from a greater number of L2 learners (children and adults). Another limitation to the current study is the lexical size of WordNet. Although WordNet contains over 170,000 nouns and verbs, some lexical items that the learners use will undoubtedly be missing from the database. Finally, only a small sample of words were qualitatively analyzed and only for a year-long period. Although we are confident that the trends reported here are extendable to most polysemous words, it is possible that other lexical entries, perhaps infrequent entries like those evaluated by Schmitt (1998), would produce different results.

Despite these limitations, a mixed method that uses a computational approach supported by a qualitative analysis such as used in this study is necessary and beneficial for the study of L2 lexical acquisition. Such a method is valuable because lexical acquisition is a complex phenomenon and the exploration of lexical networks benefits from both computational and quantitative approaches (Meara, 2006) and qualitative approaches (Schmitt, 1998). The computational approach used in Analysis 1 provides overall trends in the data that are not available from observation alone. These trends are better understood through the qualitative approach used in Analysis 2, from which we could observe the actual discourse of the learners and illustrate the emergence of new sense relations. Such research designs allow for the study not only of polysemous sense
relations in natural language data but also for the study of other sense relations and depth of knowledge in L2 lexical development.

Revised version accepted 6 May 2009

References


