Measuring L2 Lexical Growth Using Hypernymic Relationships

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This study investigated second language (L2) lexical development in the spontaneous speech of six adult, L2 English learners in a 1-year longitudinal study. One important aspect of lexical development is lexical organization and depth of knowledge. Hypernymic relations, the hierarchical relationships among related words that vary in relation to their semantic specificity (e.g., Golden Retriever vs. dog vs. animal), are an important indicator of both lexical organization and depth of knowledge. Thus, this study used hypernymy values from the WordNet database and a lexical diversity measure to analyze lexical development. Statistical analyses in this study indicated that both hypernymic relations and lexical diversity in L2 learners increase over time. Additionally, lexical diversity and hypernymic values correlated significantly, suggesting that as learners’ lexicons grow, learners have access to a wider range of hypernymy levels. These findings are discussed in relation to developing abstractness in language, extending hypernymic knowledge, and the growth of lexical networks.

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Introduction

Lexical proficiency in second language (L2) learners is far detached from simplistic performance assessments such as number of words used or comprehended or the ability to match dictionary definitions with strings of letters. It is now more fully recognized that an L2 learner’s lexical proficiency includes knowledge of syntactic properties, conceptual levels, sense relations, and complex lexical association models (Haastrup & Henriksen, 2000; Huckin & Coady, 1999). The lexical proficiency of L2 learners is of special interest because misinterpretations of lexical items are key elements in global errors that inhibit communication (de la Fuente, 2002; Ellis, 1995; Ellis, Tanaka, & Yamakazi, 1994). Lexical proficiency is also crucial because the understanding of lexical acquisition in relation to its deeper, cognitive functions can lead to increased awareness of how learners process and produce an L2. Additionally, studies into the development of L2 lexical proficiency, until recently, have been an often neglected area of study in L2 acquisition (Meara, 2002). Those studies that have looked at lexical development have examined broad measures of growth, such as lexical accuracy, lexical frequency, and lexical diversity (Polio, 2001). Studies that consider lexical growth in L2 learners are important because lexical growth strongly correlates with academic achievement (Daller, van Hout, & Trefiers-Daller, 2003).

This study explores one aspect of lexical proficiency: sense relations. Of interest is the development of sense relations in L2 lexical acquisition and how these sense relations relate to the richness of word knowledge and the depth of vocabulary knowledge exhibited by L2 learners (Wesche & Paribakht, 1996). There are multiple variables that can be studied when analyzing depth of L2 lexical knowledge. These include measures of polysemy, hypernymy (superordinate and subordinate terms), synonymy, semantic overlap, and other variables related to the conceptual meaning of words such as concreteness and imageability. Although studies of L2 depth of lexical knowledge have been rare, those studies conducted have generally demonstrated that L2 learners generally do not have as much depth of lexical knowledge as do first language (L1) speakers of those languages (Ordonez, Carlo, Snow, & McLaughlin, 2002; Verhallen & Schoonen, 1993, 1998).

This study will concentrate on the growth of hypernymic relations in L2 learners’ lexicon. Hypernymic relations are semantic links between
conceptually related words such as animal and dog. In this example, animal is semantically linked to dog but functions as a superordinate term, as it is more abstract than the concrete, subordinate term dog. Although there have been a few studies that have analyzed the hypernymic knowledge of bilingual speakers (Defour & Kroll, 1995; Ordonez et al., 2002; Sharifian, 2002) and L2 learners (Ijaz, 1986; Levenston & Blum, 1977), to our knowledge no study has investigated the idea that as L2 learners acquire language; they also extend and further develop lexical hypernymic relations. The possibility of investigating hypernymic relations in relationship to the growth of lexical networks was raised by Haastrup and Henriksen (2000), but they did not directly investigate hypernymy and instead measured synonymy, lexical gradation, and antonymy. They argued that these were more crucial aspects of adjectives, which was the linguistic category that was the focus of their study. This study, however, will analyze verb and noun use and is thus well suited for investigating hypernymic relationships. An analysis such as this could provide crucial information about L2 lexical growth in three ways. First, it could provide evidence for the development of lexical proficiency based on the use of extended sense relations. Second, it could provide supporting evidence for the development of lexical networks in L2 language systems. Finally, it could provide evidence of abstraction in L2 language use.

Hypernymy Defined

As stated earlier, this study will examine the growth of lexical hypernymic relations in L2 learners. It will not analyze the growth of L2 hypernymic concepts because the data examined in this study come from adult L2 learners, who, ostensibly, have fully developed conceptual knowledge of the world. Lexical hypernymy is considered a fundamental semantic relationship that is founded on the connection between general and specific lexical items (Chaffin & Glass, 1990; Haastrup & Henriksen, 2000). Hypernymic relations are hierarchical associations between hypernyms (superordinate words) and hyponyms (subordinate words). A hypernym is defined as a word that is more general than a related word (animal compared to dog) and a hyponym is more specific than a related word (dog as compared to animal). Another example of hypernymy is the association between car and vehicle. In this case, car is the hyponym of the hypernym vehicle because car has a narrower and more specific denotative scope than vehicle, which would also include trucks, go-carts, golf carts, and hearses.
An important aspect of hypernymy is the notion of basic level categories. The theory of basic level categorization avers that an object at a specific level of categorization has a superior status and is the concept that is used most often to discuss an object (Brown, 1958). An important element that identifies whether an object is a basic-level category is cue validity. Cue validity is premised on the collection of features that distinguish an object from other objects. The strongest cues are those that automatically place an object in a category (e.g., gills for fish). Cue validity is important to basic categories because basic categories are the level at which the largest number of attributes are contained. All other members of a category (subordinates and superordinates) belong to that category based on the number of features they share with the basic category. Thus, car is a basic category, as it contains the most features that allow it to be distinguished from other objects at a similar level (e.g., motorcycles, trucks, and golf carts). Its subordinate, sedan, has lower cue validity because most of its cues are shared across the category and few features distinguish it from a car. In comparison, the superordinate category vehicle contains fewer shared attributes of the basic category car (Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976). In summary, a basic category word is preferred for concept labeling because subordinates are less distinctive but more informative, whereas superordinates are more distinctive but not more informative. In contrast, basic-level categories are associated with a large amount of information and they are different from other categories at the same level.

There is much research that supports the notion of a natural preference to use basic-level categories in speech and most research shows an overwhelming propensity to describe the world using basic-level concepts (Murphy, 2004). In studying the language habits of Tzeltal speakers, Berlin, Breedlove, and Raven (1974) found that basic-level categorizations were named most readily, were culturally more important, were more easily remembered, and were perceived holistically. Downing (1980) reported that both native speakers of English and Japanese had a tendency to categorize objects at the basic level compared to using more concrete or abstract terms. Specifically, in the narratives collected by Downing, she noted that native speakers of English used basic-level names 935 of the time and native speakers of Japanese used basic-level names 83% of the time. Downing found that when superordinate or subordinate terms were used, they were used for items that had poor basic-level coding, meaning the item lacked prototypical features that fit the basic-level category (e.g., paddleball or rooster). When subjects are asked to list properties for categories other than basic-level categories, they are more likely to assign abstract properties to superordinate terms and concrete properties to subordinate terms. Thus, the
higher on the hypernymic hierarchy a word is located, the more likely the word will be abstract. The lower the word is located on the hierarchy, the more likely the word will be concrete (Lakoff, 1987; Rosch, 1973; Tversky & Hemenway, 1984).

The competent use of hypernymic relations and abstraction is associated with a speaker’s aptitude to manage academic and formal registers (Snow, 1990; Snow, Cancino, Gonzalez, & Shriberg, 1989; Snow, Cancino, De Temple, & Schley, 1991). According to Ordonez et al. (2002), the more informal speech is, the more hypernyms are used (i.e., “I took the animal there”), and the more formal speech is, the more hyponyms are used (i.e., “I drove the Golden Retriever to the doctor’s office”). Interest in academic and formal registers as they relate to levels of abstraction has a long history in both linguistics and cognitive science. For instance, Vygotsky (1962) argued that even minimal academic writing skills require a high level of abstraction.

**The Development and Knowledge of Hypernymy Relations**

As noted by Ordonez et al. (2002), research on the acquisition of hypernymic relations has demonstrated that hypernymic relations are more likely acquired as the learners advance cognitively (Anglin, 1993; Snow, 1988; Vygotsky, 1962), as they increase their levels of education (LeVine, 1980; Snow, 1990), as they acquire more specific lexical knowledge (Wolter, 2001), and in an L1 rather than an L2 (Meara, 1982; Söderman, 1993). Most studies that have considered hypernymic development have focused on L1 acquisition. A few have examined bilingual conceptual development, not lexical development (e.g., Defour & Kroll, 1995; Sharifian, 2002). It appears that no studies have analyzed the development of hypernymic lexical relations in L2 learning, although some studies have examined L2 learners’ use of hypernymy and the possible influence of L1 conceptual categories on their use of L2 words.

Because it appears that no studies have looked at the development of hypernymic lexical knowledge in L2 learners and few studies have analyzed L2 learners’ static, hypernymic, and lexical knowledge, a brief overview of hypernymic studies in L1 learners will serve as an introduction to the idea. By providing an overview of L1 hypernymic studies, we can establish a basic theoretical framework to serve as the foundation for this study and to guide our eventual interpretations of the results. Seminal studies in the acquisition of hypernymic conceptual knowledge in an L1 were conducted by Welch and Long (1940) and Piaget (1972). These studies demonstrated that at a very young age (2–6 years old), children can distinguish between hypernyms and hyponyms in
their L1. Additional studies that considered the acquisition of hypernymic relations in the L1 have demonstrated that children’s perception of categories differs from that of adults and that children develop hierarchical patterns over time (Anglin, 1977; Rosch, 1973; Rosch et al., 1976). More interestingly, children display patterns of hypernymic, lexical, and conceptual development. Multiple studies have affirmed that children first name and sort basic-level categories; they then proceed toward superordinate categories (Berlin et al., 1974; Brown, 1958; Mervis & Crisafi, 1982; Murphy, 2004) and later toward subordinate categories (Berlin et al.). This is likely because basic-level categories demonstrate the most distinct level of action, contain names that are shortest and most frequent, are the most natural level of categorization (Brown; Lakoff, 1987), and are the names most often found in the speech addressed to children (Anglin).

When considering hypernymic categorizations and L2 learners, research has supported the notion that L2 learners do not have the same access to hypernymic relations as L1 speakers. Levenston and Blum (1977), for instance, found that L2 learners use more words of general than of specific meanings. This dependency on general terms leads L2 learners to make inappropriate overgeneralizations and not adhere to expected uses of registers and collocations. In a study concerning the use of the prepositions on and over, Ijaz (1986) found that L2 learners associated the prepositions most often with contexts that were typical to their basic-level categorizations. Thus, L2 learners matched the basic categorizations used by L1 speakers, but they failed to attribute similar relationships to noncentral categories. This led to both the overuse and underuse of central and noncentral conceptual categories. Specifically, on was used by L2 learners in contexts in which more specific terms were required (upon and onto). Overall, studies that consider the access L2 learners have to hypernymic lexical categories demonstrate that L2 learners depend mostly on basic-level, lexical categories.

One concern that is specific to L2 lexical acquisition is the role of cross-linguistic influence and its function in semantic development. This is best represented in Ijaz’s (1986) study in which she found that L2 learners tended to transfer semantic relationships from their L1 system to their L2 system. This transfer could influence the selection of contextually appropriate semantic choices. Although Ijaz’s study was not directly related to hypernymic knowledge, it is possible that cross-linguistic influence may exert certain effects on learners’ understanding of how words are hierarchically related. However, Ijaz did not address this possibility directly, and we contend that because hypernymic relationships are relatively consistent across languages, there is no reason to
assume that L2 learners would process hypernymic structures differently between their L1 and L2.

**Lexical Networks and Hypernymy**

The acquisition of lexical items is now realized to be much more complex than the simple memorization of a word and its definition. Even at the surface level, word knowledge is more than simple definitions and includes the recognition of sound patterns, orthography (Bogaards, 2001; Nation, 2005), and pronunciation accuracy. In addition to these surface-level components, word knowledge also includes syntactic specifications and links to conceptual content. It is generally argued that the meaningful acquisition of lexical items involves the use of inferencing strategies over memorization strategies and making connections between related words as opposed to memorizing definitions (Haastrup & Henriksen, 2000; Huckin & Coady, 1999). The premise for such an approach is founded on the notion of lexical networks, which is the idea 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). One assumed strength of these interconnections is that although words can have thousands of related connections or nodes, the distance between each node (the connections between words) is usually quite small (N. Ellis, in press). The relatively short distance between nodes provides the primary means for the quick growth of lexical networks. 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).

Network building is also related to theories of emergentism, which is the notion that language is a complex, adaptive system based on human interaction. Importantly, language from an emergentist perspective is dynamic and self-organizing (Ellis & Larsen-Freeman, 2006). Thus, lexical emergence is thought to be based on the interaction of simple components (words) that generate complex networks. According to Meara (2006), the emergent properties of a lexicon are similar to the properties of other types of complex structures that exhibit behaviors that are not explicitly built into them. These structures develop spontaneously through interactions between simpler components. Specifically, this it taken to mean that L2 lexical networks emerge
from simple initial conditions that generate more complex networks from basic lexical components.

An important approach to understanding lexical networks is complexity. Most lexical relations are ordered by complexity in order to categorize and identify elements of different relations (Herrmann & Chaffin, 1986; Klix & van der Meer, 1980). In most network theories, hypernymy is considered a primitive or simple sense relation. However, this does not mean that hypernymy is not important. On the contrary, some theorists even suggest that hypernymy is the single most important organizational system for lexical relations (Miller & Teibel, 1991). This is because hypernymic relations allow for hierarchical categorizations that define how hyponyms inherit properties from their related hypernyms and allow set inclusion among category members. Hypernymy is a foundational lexical relationship that is consistent with network models in that it allows for the economical representation of lexical properties (Chaffin & Glass, 1990; Murphy, 2004). Such properties allow for learners to generalize about terms and allow for cognitive economy because every object is part of a conceptual category, not its own conceptual category (Murphy). A sense relation such as hypernymy that is based on an economy of representations allows for the faster processing of language and ideas. This is compared to other sense relations like synonymy, for which two concepts are treated as equals, or polysemy, for which information is continuous (Chaffin & Glass). Relations such as synonymy and polysemy are argued to be more difficult to process.

**Computationally Measuring Hypernymy**

One method for measuring hypernymic 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 computational, lexical reference system inspired by current psycholinguistic theories of lexical processing. In WordNet, English nouns, verbs, adjectives, and adverbs are organized into lexical networks based on connections between related lexical concepts. In WordNet, noun and verb hypernymy is measured through conceptual taxonomic hierarchies. For example, chair (a type of seat) has seven hypernym levels below it: seat $\rightarrow$ furniture $\rightarrow$ furnishings $\rightarrow$ instrument $\rightarrow$ artifact $\rightarrow$ object $\rightarrow$ entity. Thus, counterintuitively, a word located lower on the WordNet scale has a higher hypernymy level and is thus more abstract. A word located higher on the WordNet scale is more concrete.
WordNet hypernymy values have been used in various studies. Most of these studies involve disambiguating word sense and semantic relations for natural language processing tasks (Fragos & Maistros, 2005; Resnik, 1992), investigating semantic similarity (Leacock & Chodorow, 1998), and measuring conceptual density (Agirre & Rigau, 1996). In L2 studies, WordNet hypernymy values have been used to compare simplified and authentic reading text for differences in levels of abstraction (Crossley, Louwerse, McCarthy, & McNamara, 2007; Crossley & McNamara, in press). This study will use WordNet values as a method to track the range of hypernymic levels used by L2 learners over time and to show how the range of meanings used by L2 learners develops. By proxy, this development can be used to examine the growth of L2 lexical networks.

Method

Our purpose in this study is to explore whether L2 learners develop hypernymic lexical relationships as their lexicon grows and, if so, how such growth relates to the development of lexical networks. To accomplish this, we use the WordNet database to assess the spoken utterances of L2 learners using longitudinal data. We examine whether WordNet indexes of hypernymic relations increase or decrease as learners acquire an L2. We make the prediction that as L2 learners develop lexical knowledge, there will be a corresponding increase in lexical hypernymy levels in a manner similar to the growth of hypernymic relations in an L1. Findings such as these would suggest that as L2 learners’ lexicons grow, the L2 learners begin to make simple, hierarchical hypernymic lexical connections. This result would provide support for the development of abstract language ability as well as for the development of lexical networks in L2 learners.

Because of the slow, developmental nature of lexical networks (Haastrup & Henriksen, 2000), we selected a longitudinal approach to data collection and analysis. A longitudinal approach is better suited for analyzing the building of lexical networks because it allows for the investigation of language learners over a long period of time. In contrast, a cross-sectional study examines separate groups of participants, each at different developmental states or levels. This type of approach does not allow for the examination of gradual increases in lexical proficiency. Thus, the longitudinal approach is better suited to capture gradual lexical developments, such as lexical networks. However, it is more challenging to obtain large numbers of participants in longitudinal studies. As such, the statistical power of longitudinal studies emerges from having a
greater number of observations per participant rather than large numbers of participants.

**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. The elicitation sessions were scheduled such that they coincided with the students’ regular speaking class. Learners’ proficiency levels were tested upon arrival to the program, and all participants in the study tested into the lowest proficiency level, Level 1, of a six-level program. The learners continued their participation in the study as they progressed through the program.

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 of observation or because they did not complete the year. Each learner in the study was given a pseudonym; this article 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 and had all successfully completed high school in their country of origin. None of the learners had lived in the United States for more than 3 weeks prior to the start of the study. All learners had studied 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 1 year.

Interviewers were recruited from a graduate-level course in second language acquisition (SLA) taught at the university. Participants (interviewers and L2 learners) were given a variety of elicitation materials, including emotion cards (Rintell, 1989), picture description tasks, questions, and topics for discussion as prompts to promote spontaneous speech. The participants were also free to introduce their own spontaneous topics into the conversation. Language data were collected in naturalistic settings; that is, although interviewers came to the sessions prepared with various topics from which the learners could choose, the sessions were characterized by naturally occurring discourse. In some cases, when the scheduled elicitation session contained more learners than interviewers, learners were paired with an interviewer, providing discourse data between the L2 English learner and his or her native-speaking interviewer as well as learner-to-learner data. Elicitation sessions generally lasted between 30 and 45 min. The sessions were tape-recorded and later transcribed. Because
the focus of the current article is on sense relations, we sought longitudinal data from multiple learners engaged in discourse on various topics. In comparison to studies using data from a limited number of oral or written topics, the method used in the current study elicited a greater quantity and variety of vocabulary. It also captured learners in a naturalistic environment and is arguably a better representation of the learners’ oral proficiency. This method of longitudinal data collection has also been successfully employed in research on the SLA of tense-aspect relations (Bardovi-Harlig, 2000).

Corpus
The spoken data collected from the six learners was transcribed and forms 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 modified in the following ways: Interjections such as *ah*, *uhm*, and *yea* were deleted, as were any words that were clearly non-English words, such as a word in the learner’s native language or an invented word. All punctuation except the period and question mark was eliminated from the transcriptions. 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.

Coh-Metrix
The computational tool Coh-Metrix (Graesser, McNamara, Louwerse, & Cai, 2004) was used to assess the lexical development of the learners in this study (general lexical growth and hypernymy). Coh-Metrix measures cohesion and
text difficulty at various levels of language, discourse, and conceptual analysis. The system integrates lexicons, pattern classifiers, part-of-speech taggers, syntactic parsers, shallow semantic interpreters, and other components that have been developed in the field of computational linguistics (Jurafsky & Martin, 2000).

Coh-Metrix also provides WordNet measures for hypernymy. In Coh-Metrix, texts are first processed through the Brill Tagger (Brill, 1995), which assigns part of speech tags to all words. Coh-Metrix then measures the hypernymy values for both nouns and verbs using WordNet. WordNet hypernymy values are provided on a normalized scale, with 1 being the highest hypernym score and all related hyponym values decreasing after that. As noted earlier, this means that a lower score reflects an overall use of more abstract words, whereas a higher score reflects an overall use of more concrete words. Thus, entity, as a possible hypernym for the noun chair, would be assigned the number 1. All other possible hyponyms of entity as it relates to the concept of a chair (e.g., object, furniture, seat, chair, camp chair, and folding chair) would receive higher values. Similar values are assigned for verbs (e.g., hightail, run, and travel). This is a product of a categorical structure that requires the most abstract concept to be the most stable concept, as it will be shared by all lexical items. This means that all lexical items will share a default value of 1 (an abstract relation), but not all lexical items will share larger values (concrete relations). In this study, we use these WordNet values to evaluate the growth of hypernymic relations in L2 learners.

In addition to WordNet values, Coh-Metrix also reports word meaning values from the MRC Psycholinguistic Database (Coltheart, 1981). To provide support for the hypothesis that L2 hypernymic relations increase with time and lexical growth, we will also examine MRC concreteness values. This is because we hypothesize that as hypernymic relations in L2 learners’ oral discourse increase (with lower WordNet hypernymy values), their lexicons will become more abstract. To test this hypothesis, we will compare WordNet hypernymy values to MRC concreteness values, with the expectation that MRC concreteness values will decrease with WordNet hypernymy values. MRC concreteness values are based on the work of Paivio, Yuille, and Madigan (1968), Toglia and Battig (1978), and Gilhooly and Logie (1980), who asked participants to score nouns based on concreteness on a numerical scale (from 1 to 7). A word that refers to an object, material, or person generally receives a higher concreteness score than an abstract word (Toglia & Battig).

To examine L2 lexical growth, we will use the Measure of Textual and Lexical Diversity (MTLD: McCarthy, 2005) that is also reported by
Coh-Metrix. MTLD is a lexical diversity (LD) measure. MTLD overcomes potential confounds of text length by separating a text into segments that have a TTR value of .71. The total segments in the text are then divided by the total number of words in the text (the forward value). The whole process is then repeated starting at the end of the text rather than the beginning (the reverse value). The forward and reverse values are then summed and divided by 2 for the MTLD value of the text. MTLD was selected to link the WordNet hyponym data to lexical growth because LD measures are commonly used to analyze lexical growth (Jarvis, 2002; Malvern & Richards, 2002; Polio, 2001). MTLD is also similar to other measures of LD such as D (Malvern, Richards, Chipere, & Duran, 2004) or TTR (Miller, 1981; Templin, 1957), but, unlike other LD measures, MTLD does not vary as a function of text length for text segments whose length is in the 100–2,000-word range. MTLD also allows for comparisons between text segments of largely different lengths (up to 2,000 words) and produces reliable results over a wide range of genres while strongly correlating with other LD measures (McCarthy). Thus, MTLD is able to assess differences of lexical diversity between different texts (both spoken and written), even when those texts may be considerably different in terms of text length. We use MTLD in this study to assess if L2 learners exhibit signs of lexical growth over the course of a year.

Results

To test the hypothesis that time spent learning English relates to the development of hypernymic relations, a repeated-measures analysis of variance (ANOVA) was conducted using the WordNet results from Coh-Metrix. The ANOVA was used to track the linear trend of the WordNet values over the increasing temporal intervals and to test the assumption that as time spent learning English increased, WordNet hypernymic values would decrease, signaling an increase in hypernymic relations. Because participants did not share all 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. Because not all participants shared all temporal points, the repeated-measures ANOVA analyzed an unequal sample of the
temporal points available. Thus, a separate growth modeling analysis (a linear curve estimation) to control for random effects was conducted. This allowed for both shared temporal data points (N = 36) and all temporal data points (N = 99) from the L2 learners to be analyzed and examined if the linear trend reported in the ANOVA was supported individually and collectively.

To support the ANOVA and linear curve estimation findings, two Pearson’s product-moment correlation tests were also conducted. The first was the correlation test between time spent learning English and the WordNet hypernymy values using all available data points (N = 99). For this analysis, we predicted negative correlations because WordNet hypernymy values would actually decrease as time increased, signaling a wider range of hypernymic knowledge. A second correlation was conducted between WordNet hypernymy values and MRC concreteness values for all data points (N = 99). For this analysis, we predicted a positive correlation because MRC concreteness values should decrease with an increase in abstract words, which would correlate to a decrease in WordNet hypernymy values as hypernymic knowledge develops.

Table 2 shows that the L2 learners’ WordNet hypernymy values decreased as a function of time, defined as the 2nd, 4th, 16th, 32nd, 50th, and 52nd weeks of learning, $F(5, 25) = 13.57, p < .001, \eta^2 = .73$. Pairwise comparisons of the WordNet hypernymy values from the 2nd week demonstrated significant differences from other temporal data points beginning in the 16th week and continuing until the 52nd week (see Table 3 for details). There was also a significant linear trend, $F(1, 25) = 19.31, p < .01, \eta^2 = .78$. The linear curve estimate conducted to support the ANOVA findings demonstrated a significant linear trend for all participants, $R^2 = .87, F(1, 4) = 25.62, p < .01$. Individual linear curve estimates demonstrated significant linear trends in five of the six participants in the study (see Table 4). These findings indicate that as time spent learning English increased, hypernymy levels increased. These findings also provide evidence that hypernymic relations develop with time spent learning English.

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Hypernymic Relationships

Table 3

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<th>Week</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Diff = 0.10 (0.05)</td>
<td>Diff = 0.21 (0.07)</td>
<td>Diff = 0.34 (0.06)</td>
<td>Diff = 0.24 (0.07)</td>
<td>Diff = 0.13 (0.04)</td>
<td>Diff = 0.08 (0.04)</td>
<td></td>
</tr>
<tr>
<td>Diff = 0.38 (0.09)</td>
<td>Diff = 0.32 (0.06)</td>
<td>Diff = 0.21 (0.06)</td>
<td>Diff = 0.17 (0.06)</td>
<td>Diff = 0.10 (0.04)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. Diff denotes the average difference between cosines (standard error).

* p < .05.
Table 4 WordNet hypernymy linear curve estimations for individual participants

<table>
<thead>
<tr>
<th>L2 learner</th>
<th>N</th>
<th>$R^2$</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eun Hui</td>
<td>18</td>
<td>0.67</td>
<td>32.69</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Faisal</td>
<td>13</td>
<td>0.79</td>
<td>40.77</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Takako</td>
<td>18</td>
<td>0.76</td>
<td>51.75</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Kamal</td>
<td>15</td>
<td>0.04</td>
<td>0.53</td>
<td>&gt;.05</td>
</tr>
<tr>
<td>Jalil</td>
<td>17</td>
<td>0.74</td>
<td>42.19</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Marta</td>
<td>18</td>
<td>0.75</td>
<td>48.28</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

learning English. In addition, a correlation between the L2 learners’ time spent studying English and their WordNet hypernymy values also demonstrated significant negative correlations ($r = -0.65, p < .001, N = 99$). As expected, a correlation between the L2 learners’ WordNet hypernymy values and their MRC concreteness values showed a significant positive correlation ($r = 0.62, p < .001, N = 99$). These findings help to demonstrate that as L2 learners’ time studying English increases, hypernymic relations develop and their lexicon becomes more abstract.

To test the assumption that learners’ lexical diversity grows as time spent learning English increases, a repeated-measures ANOVA was conducted using the MTLD results from Coh-Metrix. In a fashion similar to the hypernymy analysis, this ANOVA was used to track the linear trend of the MTLD values over the increasing temporal intervals. Like the hypernymy data, participants did not share all the same temporal data points, so the ANOVA analyzed development on a trimester basis, but it included the 2nd and 4th weeks and the 50th and 52nd weeks. As in the hypernymy analysis, this ANOVA was also supplemented with pairwise comparisons to identify significant differences within the temporal progression and polynomial contrasts to test for linear trends in the data. A separate growth modeling analysis (a linear curve estimation) was also conducted to support whether the linear curve reported in the ANOVA was supported individually and collectively. To support the ANOVA and linear curve estimation, the Pearson’s product-moment correlation test between time spent learning English and MTLD values using all available data points ($N = 99$) was also calculated. For this analysis, we predicted a positive correlation because lexical diversity should increase as a function of time. To examine the link between the development of lexical diversity and hypernymic relations, a correlation between the MTLD values and the WordNet hypernymy values for all data points ($N = 99$) was conducted. In this analysis, we predicted a negative
correlation because MTLD values were expected to increase as a function of time, whereas WordNet hypernymy values were expected to decrease.

Table 5 shows that the L2 learners’ MTLD values increase as a function of time, defined as the 2nd, 4th, 16th, 32nd, 50th, and 52nd weeks of learning, $F(5, 25) = 7.41, p < .001, \eta^2 = .60$. Pairwise comparisons of the MTLD values demonstrated significant differences between the 2nd week and the 52nd week (see Table 6 for more details). There was also a significant linear trend, $F(1, 25) = 22.83, p < .01, \eta^2 = .64$. The linear curve estimate conducted to support the ANOVA findings demonstrated a significant linear trend for all participants, $R^2 = .92, F(1, 4) = 45.55, p < .01$. Individual linear curve estimates demonstrated significant linear trends in five of the six participants in the study (see Table 7). These findings indicated that as time spent learning English increased, MTLD values increased. As predicted, the correlation between the L2 learners’ time spent learning English and their MTLD values demonstrated a significant positive correlation ($r = 0.45, p < .001, N = 99$). In addition, the correlation between the L2 learners’ MTLD values and their WordNet hypernymy values showed a significant negative correlation ($r = -0.40, p < .001, N = 99$) as predicted. These findings provide evidence that as learners spend time studying the English language, their lexical diversity increases. Additionally, it provides evidence that the development of hypernymic relations in L2 learners is related to growth in lexical diversity.

**Discussion**

This analysis has demonstrated that as time studying an L2 increases, there is a corresponding increase in the range of hypernymy levels available to L2 learners. It has also demonstrated that hypernymy growth is related to L2 lexical growth. These findings have important implications for the development of abstract and formal language use in L2 learners as well as the growth of L2
Table 6 Pairwise comparison of temporal differences in MTLD 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 = 3.06 (2.78)</td>
<td>Diff = 0.07 (2.85)</td>
<td>Diff = -6.44 (3.07)</td>
<td>Diff = -6.99 (2.48)*</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Diff = -2.82 (1.43)</td>
<td>Diff = -2.99 (0.72)*</td>
<td>Diff = -9.50 (1.10)*</td>
<td>Diff = -10.05 (1.40)*</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Diff = -0.17 (1.48)</td>
<td>Diff = -6.68 (2.11)*</td>
<td>Diff = -7.23 (2.34)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Diff = -6.51 (1.71)*</td>
<td>Diff = -7.05 (1.81)*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>Diff = -5.5 (1.80)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note. Diff denotes the average difference between cosines (standard error).
*p < .05.
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**Table 7** MTLD linear curve estimations for individual participants

<table>
<thead>
<tr>
<th>L2 learner</th>
<th>N</th>
<th>$R^2$</th>
<th>$F$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eun Hui</td>
<td>18</td>
<td>0.24</td>
<td>4.99</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Faisal</td>
<td>13</td>
<td>0.32</td>
<td>5.05</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Takako</td>
<td>18</td>
<td>0.41</td>
<td>10.88</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Kamal</td>
<td>15</td>
<td>0.5</td>
<td>12.10</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Jalil</td>
<td>17</td>
<td>0.05</td>
<td>0.87</td>
<td>&gt;.05</td>
</tr>
<tr>
<td>Marta</td>
<td>18</td>
<td>0.67</td>
<td>32.53</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Lexical networks and L2 lexical proficiency. The data presented here provide evidence that L2 learners make rapid and significant changes in their use of hypernymic terms over the course of 1 year. Spoken L2 vocabulary exhibits significantly higher levels of hypernymy at 16 weeks, 32 weeks, 50 weeks, and 52 weeks than during lexical production in the second week. Significant differences between all weeks up until the 50th week were also found. These findings not only show that learners begin to use more abstract language as their lexicon develops, but they also point toward the growth of simple, hierarchical lexical connections. This finding suggests the development of L2 lexical networks.

These findings should not be viewed holistically as a strict linear progression from the concrete to the abstract, but, more importantly, as the development of a range of available lexical choices. Thus, these data should not be solely viewed as allowing a learner to move from the term *dog* to *entity*, but, if the adopted framework is accurate, also for predicting that the learner would have access to the lexical levels that fall between *dog* and *entity*, such as *mammal*, *animal*, *organism*, and *object*. Exemplified in this way, the lexical acquisition of L2 learners is not a simple migration from concrete to abstract, but it a collection of steps that ultimately provides L2 learners with not only the ability to use abstract language but, more importantly, also a greater range of available lexical items. The mean hypernymy values support such a movement (see Table 2); however, the results are speculative and it will be the task for future studies to identify the degree to which learners have access to intermediate hypernymic levels. Interestingly, though, as time spent learning English increases, the standard deviations between learners decreases. This demonstrates that learners’ hypernymic values converge as their vocabularies develop and become more abstract, likely signaling the lack of choice available at the top end of the hierarchy (the most abstract hypernyms). It could also signify that learners are not taking advantage of the range of lexical choices available to them.
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From a practical standpoint, the WordNet as well as the MRC concreteness findings do support the idea that L2 learners begin to use more abstract language and this is also important. Abstract language use is not only fundamental to most forms of communication, but it is also important for specific language genres such as professional and academic genres. Abstract language use also demonstrates that L2 learners likely become more adept at using formalized speech (Ordonez et al., 2002). Additionally, advancing levels of hypernymic relations are related to the development of specific lexical knowledge (Wolter, 2001). This growth in abstract language should allow the L2 learner to speak about ideas that are displaced from the “here and now” and should allow L2 learners to discuss broad concepts and decontextualized ideals. Abstraction likely gives the L2 learner the opportunity to discuss ideas in general terms, instead of discussing specific objects.

Examples selected from the data supporting a movement toward more abstract language use are provided below. These examples are not representative; they are meant to be illustrative. The first examples are taken from Faisal’s data. In (1), taken from the second week, Faisal is discussing arranged marriages. In (2), taken from the 50th week, Faisal is discussing his English ability. In (1), there are multiple examples of specific language use (restaurant, eat, sit, salt, cup, clothes, mother, and sister) and few examples of general terms (home and woman). In (2), the lexical choices are much more generalized (feel, man, language, understand, opinion, someone, and something).

(1) Some day I go to a restaurant, I eat here, I sit here eat. He’s want salt. I have salt. He say, cup, clothes. Come my home. He’s come my home, and my mother, no my mother. Do you know my mother’s sister? No my mother’s sister. She’s woman. what name?

(2) I feel like a new man, because I can speak new language. I’m someone different. I can another language. I can understand another opinion, not, Arabian like, American opinion, so American something, you know. You learn something you feel something different, you know, that’s me.

Excerpts selected from Jalil’s data also demonstrate that there is a movement from the concrete to the abstract. In (3), taken from the third week, Jalil is talking about statues of famous people. His utterances contain multiple examples of more concrete lexical items such as newspaper, month, tourist, stone, John Kennedy, and picture and only a few abstract terms. Example (4) taken from the 50th week demonstrates the use of more hypernymic language use. In this example Jalil is discussing his future. He uses multiple examples of more abstract lexical choices such as fantasy, future, something, and universe.
(3) I read in one newspaper last, uh, one month. The visitor of tourist see one, the stone, one stone like, like the, uh, John Kennedy. The same look like. He get the, uh, picture.

(4) But I have a lot of fantasy in the future, like working in NASA company, ah, like discovering something new, nobody know about it, universe, or something in astronomy. So, this is one of my most fantasy that I looking to.

Examples (3) and (4) were extracted from Eun Hui’s data. In (5), taken from the third week, Eun Hui is discussing loneliness. In doing so, she depends on very concrete lexical items such as Thursday, evening, raining, parents, room, and night. Later, in the 50th week, Eun Hui contrasts American and Korean classrooms. During this discussion, Eun Hui uses more abstract terms such as style, remember, things, attention, and person.

(5) Thursday evening, raining. Me very very lonely. I think my country, my parents, my family, very very sad. And my room, my room, night, only, only alone, lonely.

(6) But this style is, maybe, that’s wrong, because we have to remember many, many things, during our class. Just we have to pay attention to the teacher. If, if the teacher asked, ask a student, just, ah, indicated one person, the person have to answer. But depend on person.

The statistical findings also suggest the growth of lexical networks in L2 learners. Although hypernymy is a simple sense relation, it is important because it allows for hierarchical categorization. Evidence that shows the growth of hierarchical ordering systems might also demonstrate that learners are able to differentiate lexical sense relations as they progress and thus are likely in the process of constructing lexical networks (Haastrup & Henriksen, 2000). Hypernymic relations, as a part of lexical network building, are important because they allow for lexical properties to be represented economically in hierarchical fashion. This approach to lexical ordering should allow for related words to be stored in categorical clusters. This would permit words to be processed and recalled more quickly and could affect the comprehensibility of the L2 learners’ output. Connections between related words also provide learners with an efficient system from which to associate newly encountered words with already acquired words. These links should help L2 learners more quickly acquire lexical proficiency (R. Ellis, 1994; Haastrup & Henriksen) because they would allow learners to draw inferences about lexical hierarchies as well as use taxonomical reasoning to make generalizations about words.
not stored in memory (Murphy, 2004). Such rapid growth can be observed in the data presented in this study, especially when considering the finding that significant hypernymic growth was realized within the first 4 months of learning English in a native environment as well as significant increases across all temporal intervals in the first 8 months. Findings such as these lend credence to notions of lexical networks as well as theories of language emergence.

Another interesting finding of this study is that adult L2 learners appear to follow lexical learning patterns similar to those followed by L1 learners. These patterns can be detected in the changes found in the mean WordNet hypernymy values for all the learners (see Table 2). These mean values demonstrate that L2 learners move from more concrete terms to more abstract terms in a manner similar to L1 learners (Berlin et al., 1974; Brown, 1958; Mervis & Crisafi, 1982; Murphy, 2004). Because each word in WordNet will produce different hypernymy values, it is difficult to judge whether or not the initial words used by the L2 learners in this study are generally basic category words, but this is likely the case considering past studies which show a propensity for L2 learners to depend on basic category terms (Ijaz, 1986; Levenston & Blum, 1977). Although speculative, the movement toward more subordinate terms found in the 52nd week may correspond to the last stage of word learning found in L1 learners: the movement back toward more specific referents (Berlin et al., 1974).

Conclusions

This study has demonstrated that lexical hypernymic relations increase as L2 learners spend time studying a language and as their lexicon develops. This finding has important implications for the growth of lexical knowledge and a greater range of lexical meanings. Specifically, it demonstrates that L2 learners develop the ability to use more abstract language as time increases. The findings also indicate the growth of L2 lexical networks and increased L2 lexical proficiency.

Although the findings of the study are convincing, there are some limitations. First and foremost, the number of L2 learners examined was small. Although this is often unavoidable in longitudinal work, future studies should attempt to gather language data from larger groups of L2 learners. Another possible limitation is the lexical size of WordNet. Although WordNet is quite large with over 170,000 lexical items (nouns and verbs only), it is not totally inclusive and some lexical items as well as hypernymic levels might have been omitted. In addition, this study was unable to control for the effects of the
learners’ L1. This mostly resulted from the methods used in this study, which depended on a large-scale analysis that concentrated not on specific word production but on the development of the lexical system as a whole. However, as a past study has shown, there is a likely link between the concepts developed in an L1 and their influence on conceptual and lexical development in an L2 (Ijaz, 1986). Future studies should consider to what degree an L1 influences the development of sense relations and lexical networks. Additionally, this study was not able to make a strong connection between lexical proficiency and hypernymic development because the study depended on a measure of LD. LD, although an important component of lexical proficiency, is not completely representative of lexical proficiency. Thus, future studies should examine links among lexical proficiency, hypernymy, and lexical diversity. This, however, is beyond the scope of the current study.

Despite these limitations, a computational approach such as that found in this study is both necessary and beneficial, as lexical acquisition is a complex phenomenon and the exploration of lexical networks benefits from computational approaches (Meara, 2006). Additionally, the approach found in this article blends real-world data and computational tools, enabling the investigation of lexical development in a way that utilizes natural language processing and relies on both psycholinguistic and corpus linguistic methods. Because the results are encouraging, we contend that future studies in L2 lexical development would benefit from considering hypernymic relations as well as other sense relations and deeper knowledge levels. In addition, more studies are needed that consider natural language data and computational tools. Such approaches allow for the investigation of lexical network formation and provide valuable insights into how L2 learners develop deep lexical knowledge.

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Queries

Q1  Author: Please update N. Ellis, in press, throughout text and in the References.

Q2  Author: Please update Crossley & McNamara, in press, throughout text and in the References.

Q3  Author: Should TTR be spelled out at first use?


Q5  Author: Please provide the page range for the chapter.

Q6  Author: Page range needed.

Q7  Author: Please provide the page range for the chapter.

Q8  Author: Please check the page range. 919–934 or 919–1034?

Q9  Author: Please provide the location of the publisher.


Q11 Author: Please provide the editors.

Q12 Author: Please provide the month and location of the Workshop.