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Acquiring English complex compound nouns: An L2 study of Korean learners

Lee, JeongEun

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Acquiring English complex compound nouns: An L2 study of Korean learners

by

JeongEun Lee

A THESIS

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Abstract

My thesis is designed to see how adult second language learners (L2) process compounds containing plurals in non-head constituent (e.g., *rats eater). These compounds have been well-studied in first language (L1) acquisition but not in L2 acquisition. They are interesting for several reasons: there is an interesting constraint such that the plural-marked noun can be irregular but not regular (*mice eater vs. *rats eater); they are infrequent; Korean lacks plurals inside compounds like the English ones. They thus lend themselves to the study of three claims: 1) the ability of learners to process novel information is limited by how L1 grammatical knowledge is represented and processed; 2) L2 learners are nonetheless able to represent new linguistic distinctions; 3) the frequency of constructions in the input also constrains L2 learning. A goal is therefore to determine what Koreans learn of this construction and which acquisition mechanisms explain what they know.
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List of Abbreviations

Adj = Adjective
ACC = Accusative case
AP = Adjectival phrase
CL = Classifier
Cli = Clitics
CP = Complimentizer phrase
DECL = Declarative
DET = Determiner
GEN = Genitive case
INDET = Indefinite
Infl: Inflectional
L1 = First language
L2 = Second language
NP = Noun phrase
N = Noun
NOM = Nominative case
PL = Plural
PP = Prepositional phrase
PW = Phonological Words
V = Verb
VP = Verb phrase
Chapter 1: Introduction

1.1 The research problem

My thesis examines how second language learners (L2ers) and native English speakers (English NSs) process number in noun-noun compounds and the factors that affect adult L2ers’ ability to learn this linguistic phenomenon. Noun-noun compounds have been extensively studied as an example of Poverty of the Stimulus Hypothesis (POV) in first language (L1) acquisition (Chomsky 1980; Gordon 1985; Pinker & Prince 1994), meaning that native speakers present knowledge that could not have been acquired from an analysis of the linguistic and non-linguistic stimuli that L1 child learners are normally exposed to. Specifically, speakers of American English reject regular plurals in the left constituent of compound nouns: to She put up a *towels rack1, adults and children prefer She put up a towel rack. Interestingly, irregular plurals can occur in this position: She bought a teeth guard. If, by hypothesis, normal conversation will not support inferences as to the correct structure, several questions arise with respect to second language acquisition: Do L2 learners show evidence of cognizing the same constraints? If the answer is “No”, does the problem lie with the low frequency of the construction? Can learning be improved by “enriching” the stimuli that learners are exposed to? Or, does knowledge of the L1 affect processing of noun-noun compounds in the L2 and get in the way of learning the constraints? My research focuses on the processing of plurals inside compounds by both English NSs and Korean L2 learners (KL2ers). I will investigate how L2ers’ L1 grammatical knowledge is represented and processed in L2 learning and see whether the frequency of constructions in the input constrains L2 learning.

1 * means that the form is ill-formed.
A ‘compound word’ is composed of two or more words combined to form another word (e.g., green + house → greenhouse). Due to its simplicity, productivity, and high frequency, compounding is a mechanism to coin words and is acquired early in L1 acquisition (Gordon 1985; Clark et al. 1986; Hiraga 2010). Noun compounds are a common form of compounding: 99% of coined words in Korean are nouns and 40.8% of those words are compound nouns (Jang 2007). Noun-noun compounds are nouns that are composed of two nouns (e.g., dog + house and vacuum + cleaner). In English, the head of compounds is on the right. Head are words that determine the morphological, syntactic and semantic properties of the compound. Thus, a doghouse is semantically a kind of house, while the noun on the left of a noun-noun compound (the non-head noun) denotes KIND's (Berent et al. 2005). Only heads can mark inflectional properties (Benczes 2006). Thus, the form of the plural the compound noun doghouse takes, namely –es, is based on the requirements of house (doghouses). In short, in doghouse, house is the head and dog is the non-head.

English compounding infrequently marks plural in compound non-heads (e.g., *rats eater and mice eater). Gordon (1985) shows that English speaking children produce irregular plural non-heads but rarely produce regular non-heads. Gordon argues that if children learn language only from input, the dislike of regular plural non-heads and the preference for irregular plural non-heads is difficult to explain. From the frequency facts and the preferences shown by young children, Gordon builds a POV argument. Before going into details about plural non-heads and learning mechanisms, the following sections illustrate English and Korean compounding and how number is marked in both languages.

---

2 Conceptual constituents, “a unitary piece of mental representation”, will be displayed in capital letters throughout this thesis (Jackendoff 1983: 42).
1.2 English compounding

As noted, English compounds follow the Right-hand Head Rule (Williams 1981) which stipulates that the right-most elements in compounds are always heads\(^3\). The majority of English compounds follow one of two patterns: *synthetic compounding* (also called *deverbal compounding*) and *root compounding* (Lieber 1992). Root compounds are compounds consisting of simplex units or *roots* (e.g., [N+N]-file cabinet, [N+A]-sky blue, [A+A]-icy cold, [A+N]-blue bird, [N+V]-babysit, and [V+N]-pick pocket). Synthetic compounds are constructions in which the head is derived from a verb (and is therefore itself a complex unit called a *stem*) while the first component is interpreted as an argument of this stem: truck driver, gift-giving and home-grown. Synthetic compounds have several restrictions. If the verb requires more than one internal arguments, synthetic compounds cannot be formed (e.g. *book-placer*, Lieber 1992). As these simple examples illustrate, while English phrasal order in English sentences is S(ubject) V(erb) O(bject): *George washed the dishes/*Georges the dishes washed. English compounds do not present the same order: *George is our best *washer dishes/*washer dish/dishwasher. Moreover, no functional elements (such as case markers like ‘of’ or determiners) can appear in a compound, making a clear contrast between the compound (*George is our best dishwasher*) and a phrasal complement (*George is our best washer of dishes*). See Lieber (1992) for details.

The examples so far have all involved compounds consisting of two words but English compounds can be composed of more than two words. That means non-heads can be phrases (AP, NP, VP, PP and CP) or words (Lieber 1992; Benczes 2006) as in the items in (1).

\(^3\) There are exceptional cases found such as *dry-clean-only* in English but I will not discuss left-headed compounds in my thesis (for details see Bauer & Renouf 2001).
(1) a. the [[Charles-and-Di] Syndrome]]
   b. an [[ate-too-much] headache]]
   c. his [[God-is-dead] theology]]

Source: Lieber, 1992

This type of compound raises the question of how we can distinguish between noun compounds and noun phrases. There has been much debate on the criteria for defining compounds. Specifically, in noun-noun compounds, the major criterion to distinguish those two is stress. If the stress falls on the first constituent it is a compound while phrases, originating in the syntax, must have end-stress (Lieber 1992; Bauer 1998; Giegerich 2004) as in (2).

(2) a. fore-stress compounds: 'blackbird (species), 'toy factory (factory where produces toys)
   b. end-stress phrases: black 'bird (its colour is black), toy 'factory (factory that is a toy)

   Source: Lieber, 1992; Giegerich, 2004

Linguists claim that stress is a strong indicator in defining compounds, however, there are counter-examples from corpus-based studies which show that stress is not able to fully explain all the facts (Giegerich 2004; Plag 2006; Plag et al. 2007).

In contrast to phrases, where adverbials can appear, English compounding system does not allow the insertion of a modifier within the compound (e.g., *truck-careful-driver). It is also generally known that non-heads with plurals are not permissible. There are, however, a number of counter-examples allowing plural non-heads such as admissions office and Parks Canada. As only heads can determine syntactic properties of compounds, the role of non-heads should be investigated in detail.
1.3 English number marking

English is classified as a mass-count language. English nouns are divided into two sub-categories: mass nouns such as *water* and count nouns such as *flowers*. Mass and count nouns behave in different ways. Generally, only count nouns mark grammatical number as in (3a), (3b) and (3e). Mass nouns generally denote substances and they cannot be marked with plurals or cannot be modified by numerals as in (3c) and (3d).

(3) a. There are *trees* in the park
   b. There are only *two flowers* in the park.
   c. *Waters* are all over the floor.
   d. *I saw two sands* in the beach.
   e. You should brush your *teeth* at least three times a day.

As illustrated in (4) below, some determiners and quantifiers with similar meanings are differentiated according to the type of noun (mass or count) they co-occur with. Accordingly, they also present good tests for noun sub-type.

(4) a. the/a/this/that/one/every/each/no/ *tree*
   b. these/those/two/several/some/many/no/all *trees*
   c. *much/*little *tree(s)*
   d. ?the/*a/this/that/*one/*every/no *wood*
   e. *these/*those/*two/*several/*some/*many *woods*
   f. some/no/all/much/little *wood*  

Source: Wiltschko, 2012
In addition, only mass nouns and pluralized count nouns can be bare arguments (i.e. uninflected forms) in sentences as in (5a) and (5b) but bare count nouns cannot be as in (5c).

(5) a. I saw snow.
   b. I saw snowflakes.
   c. *I saw snowflake.  

   Source: Wiltschko, 2012

In some circumstances, mass nouns can be counted when they have the general meaning of “a serving of” or “a kind of N” or when a reference is qualified in some way or “an instance of N” (Serwatka & Healy 1998) as shown in (6).

(6) a. Can I get two coffees/beer/waters?
   b. This is a grass.
   c. This is an excellent wine.
   d. a difficulty  

   Source: Quirk et al., 1972: 1015

As Corbett (2000) shows, number systems are not simple. There are various types of grammatical number other than singular and plural in the world’s languages. For example, Bayso\(^4\) distinguishes singular, plural and general which allows the contrast in (7).

---

\(^4\) A Cushitic language found on Gidicho Island in Lake Abaya (Southern Ethiopia) and on the western shore of the lake (Corbett 2000).
This artificial version of English based on Bayso in (7a) shows how general number expresses one or more dogs by the contrast between a bare form and the affixed forms. General number is unspecified for number and Speakers express specific number “when it matters” and not automatically (Corbett 2000:14). General number can be combined with the singular giving a general/singular versus plural system in some languages like Japanese. A Japanese word like inu ‘dog’ is unspecified for number thereby it can indicate one or more dogs. To specify its number, Japanese uses numerals with classifiers (e.g. ip-piki ‘one-CLASSIFIER’) or a plural form tati ‘-s’ as in inu-tati ‘dogs’ (Corbett 2000).

In this regard, non-heads of English noun compounds present a descriptive dilemma. We saw above that English obeys the Right-hand rule so grammatical number is marked on head nouns. Thus, if there is more than one watchmaker, you must say watchmakers but not *watches maker. As noted it is generally assumed that non-heads are bare forms which do not refer to single INDIVIDUALs but rather to KINDs (Berent et al. 2005). It follows that non-heads are unspecified for number. Leaving the notion of ‘unspecified for number’ of bare non-heads for now, existing noun compound words with plural non-heads (e.g., publications catalog) raise questions about interpretation: Do Korean learners of English process non-head bare forms as KINDs or singular or simple general number? If bare non-heads denote kinds, then they are not referential and can be used even in cases where no entity could exist, e.g., extinct species or fictional characters. If instead, bare non-heads are construed as simple general number, they ought to be referential in context and refer to one or more entities. If non-heads can be pluralized,
will Korean learners of English cognize the difference between regular and irregular plurals and limit plural-marking to the latter?

1.4 Korean compounding

Compounding in Korean is very productive. Like English, Korean has two major types of compounding: root compounding and synthetic compounding. In noun compounds, heads are the right-most elements as well as shown in (8).

(8) a. nat.cam  b. namul.pap
    day.sleep  vegetables.rice
    ‘nap’  ‘rice with vegetables’

Some Korean synthetic compounds need suffixes as in (9).

(9) a. koki.pok.um  b. koki.cap.i  c. cip.cis.ki
    meat.broil.suffix  fish.catch.suffix  house.build.suffix
    ‘broiled meat’  ‘fishing’  ‘house building’

Korean word order is S(ubject) O(bject) V(erb) as we can find in (10).

5 There are headless compounds which are semantically opaque and the head is not on the right side so that one cannot infer the whole meaning from the meaning of its constituents but I will not discuss them in my thesis.
Korean synthetic compounds usually follow Korean phrasal order (SOV), which accounts for about 85 percent of the structure of novel compound words (Kim 2007). Phrases can be non-heads in Korean compounds as in (11).

(11)  
i  tal.uy  wusu  sawen  sang  
this  month.GEN  excellent  employee  award  
‘employee-of-the-month award’

As in English, the criteria for determining the status of noun compounds versus noun phrases are controversial in Korean. Korean has no word stress\(^6\) to differentiate the two types of constituents. In the Korean writing system, compounding does not allow spaces within a compound. See (12).

(12) a. cakun.hyeng  b. cakun hyeng  
second eldest.brother  short  man  
‘one’s second eldest brother’  ‘short man’

Inseparability in writing is considered one of key criteria in Korean compounding. Therefore,

---

\(^6\) Some researchers have argued that Korean does have word stress that can differentiate noun compounds from noun phrases, but this claim is very controversial and we set it aside here (Kim 2000:36).
(12a) is a compound and (12b) is a noun phrase even though the only difference between the two is a space. Inseparability also shows that constituents are closely organized so that the order of constituents cannot change.

(13) a. non.pat - *pat.non
   paddy.field - *field.paddy
   ‘farmland’

b. an.matang - matang an
   inner.yard - yard inside
   ‘courtyard’ ‘the inside of yard’

Source: Kim, 2000:37

(13a) is an example where a change in order inside the compound leads to unacceptability and (13b) is an example where a change in order brings meaning differences in noun compounds. This criterion is nevertheless not one that can apply to all Korean compounds.

Recall that compounding systems preclude the insertion of another word within a compound word (English *truck-careful-driver vs. Korean *twaycikunwuli, ‘pigsty’ and cakun means ‘small’). Nevertheless, a small number of Korean noun compounds allow a functional element inside compounds such as nam.uy.tal ‘the month following the estimated month of childbirth’ or tak.uy.eli ‘hencoop’ (Kim 2000:80). Uy in both compounds is a Korean genitive case. Interestingly, however, the Korean optional plural marker tul ‘-s’ cannot be inserted into compounds (e.g., moksakongpwu vs. *moksatulkonpwu ‘a study for becoming a pastor’).

---

7 Not all compounds that have semantically similar constituents show this type of restriction (Choi 1993:62).
1.5 Korean number marking

Korean is a classifier language. Classifier languages typically do not have definite and indefinite determiners. They also typically do not have a formal contrast between singular and plural nouns. Consequently, bare nouns can refer to individuals and substances, to one individual or to more than one. In these languages, when speakers want to enumerate objects, they use a distinct grammatical category, a noun classifier, which is often differentiated in very rich ways to express sub-classes of nouns based on semantic properties of the referent.

Korean bare forms have general number (i.e. indicating one or more elements) following Corbett’s (2000) terminology. Salam in (14a) is interpreted as a person or people and to specify the grammatical number, Korean uses a classifier phrase, [N + Quantifier + Classifier], as in (14b). The use of a classifier is required with numerals (Lee & Lee 2009), as shown in (15).

(14) a. kongwen.e salam.i iss.ta
   park.in person.NOM exist.DECL
   ‘There is/are a person or people in the park.’

   b. kongwen.e salam han.myeng.i iss.ta
   park.in person one.CL.NOM exist.DECL
   ‘There is a person in the park.’

(15) a. Mary.ka chayk twu kwen.ul ilknun.ta
   Mary.NOM book two CL.ACC read.DECL
   ‘Mary reads two books.’

---

8 Exceptionally, some nouns (usually nouns denoting human beings) can be used directly with numerals (e.g., se.salam ‘three.person’).
As for mass nouns such as mwul ‘water’, Korean marks the distinction between count and mass nouns by the appropriate choice of functional category: classifier versus ‘massifier’ (Cheng & Sybesma 1998). Korean massifiers are usually containers such as byeng ‘bottle’ with liquids like wine or water.

Although Korean does not have a singular-plural contrast, an optional plural marker tul ‘-s’ does exist. Generally, Korean mass nouns therefore cannot be pluralized (e.g., *mwul-tul ‘waters’) while bare nouns and pluralized count nouns mean usually the same thing as the two examples in (16) show.

(16) a. yeki    salam.i    mahn.ta
    here    people.PL.NOM   many.DECL
    ‘There are many people here.’

b. yeki    salam.tul.i  mahn.ta
    here    people.PL.NOM   many.DECL
    ‘There are many people here.’

There is, however, an interesting change underway in the Korean number system. This optional plural marker is increasingly behaving like an obligatory plural marker in some cases (MacDonald 2014). As (17) shows, Korean bare nouns that refer to humans, such as namcaai
‘boy’, denote only a single individual.

In this regard, we can say that the Korean number system is becoming a general/singular versus plural system just like Japanese or Turkish (e.g., Turkish ev ‘a house or houses’ vs. evler ‘(must be) houses’) as Corbett (2000) describes. Nevertheless, unlike English, Korean noun compounds do not allow plural non-heads (*puphum pocung ‘parts warranty’ vs. puphumtu$^\text{b}$ pocung ‘parts warranty’).

1.6 Goals of the thesis

My thesis has three main goals:

1. I will examine plural non-heads in English noun-noun compounds (e.g., admissions policy) by comparing nativist accounts and sub-symbolic connectionist accounts. If plural non-heads are idiosyncrasies, they should be memorized whenever we encounter them. If there are any constraints on plural non-heads, however, we need to clarify what factors account for their existence and how native English speakers process and interpret them. This will be a starting point to analyzing how L2ers learn and process these infrequent constructions.

---

9 The reason of why some nouns can be interpreted as a single individual has been under much debate. One of proposals is that its usage is dependent on context (Kim 2007, 2008). I will discuss this type of case in Chapter3.

10 Some researchers are working on ‘mixed’ approaches that combine neural network models with nodes that stand for symbolic entities, like constituents. Since the precise differences between these approaches and those that invoke computation of constituents through unification is a matter of the details of implementation, I will ignore these mixed approaches here.
Another interesting point turns on the research methodology that Gordon (1985) used to show that English speaking 3-5 year olds produce *mice eater* but not *rats eater* in an elicited production task with pictures. Ramscar & Dye (2011) demonstrate that Gordon’s work (1985) induced a priming effect. When they changed the order of questions, the preference for irregular plural non-heads was no longer statistically significant when compared to regular plural non-heads. Their study suggests that the putative constraint barring plural non-heads in English compounds is not absolute. If it turns out to be true that there is no such constraint, Gordon’s (1985) POV argument falls apart\(^\text{11}\). My experimental study will show how these contradictory findings can be reconciled.

2. In English noun compounds, non-heads are considered to be bare nouns which denote kinds (Berent et al. 2005) while some researchers view them as singulars (Haskell et al. 2003; Ramscar & Dye 2011). Nouns denoting kinds are assumed to be unspecified for number. However, as we saw in sections 1.3 and 1.5, bare forms in classifier languages can mark general number (no number specification) or a singular/general contrast. Thus, bare forms might turn out to be ambiguous for second language learners of English. In particular, it is not going to be the case that the referential context will always clearly lead to an inference to a kind-meaning as opposed to a referential meaning. Accordingly, the status of bare forms in non-heads should be scrutinized to compare Korean bare forms with English counterparts. The literature on second language acquisition certainly leads us to expect L1 transfer effects when L2ers process English bare/plural non-heads.

3. By carrying out two original empirical studies, I will see how native English speakers process

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\(^{11}\) This does not mean, of course, that there are no POV arguments supporting a case for Universal Grammar.
and interpret bare and plural non-heads in both noun compounds and phrasal compounds. This analysis will be a first step to explain whether L2ers learn these infrequent constructions and what the role of L1 processing procedures and grammatical knowledge is. In addition, the analysis will also give us a chance to see how frequency works in L1 processing and L2 learning.

1.7 Organization of the thesis

My thesis is organized as follows. Chapter 2 reviews the literature on English plural non-heads in first language acquisition studies and compares two distinctive standpoints. On the one hand, several analyses argue that plural non-heads allow irregulars but not regular plurals (Gordon 1985; Pinker & Prince 1994; Alegre & Gordon 1996; Cunnings 2003). Regulars and irregular plurals are considered as psycholinguistically and linguistically distinct categories. This claim leads to Gordon’s conclusion that the dislike of regular plural non-heads in compounding is an innate constraint (e.g., *rats eater vs. mice eater). On the other hand, connectionist analyses argue that there is no innate constraint to explain the preference for irregular non-heads (Haskell et al. 2003; Ramscar & Dye 2011). Preferable meaning combinations or phonological constraints based on frequency can account for the data.

Chapter 3 presents previous adult L2 studies involving the processing of plural non-heads. To account for how L2ers process low-frequency non-head constructions, Chapter 3 examines two L2 theories: Emergentism (Ellis1998; Gregg 2003; MacWhinney 2008) and the Autonomous Induction Theory (Carroll 2001). Chapter 4 presents my first experiment on the processing and interpreting of bare/plural non-heads. Chapter 5 presents my second experiment on the processing of phrasal compounds to see whether the presence of regular plural non-heads affects interpretation. Since most L2 research reviewed in Chapter 3 replicates Gordon’s (1985) or Alegre & Gordon’s (1996) studies, I used a different methodology to explore Korean L2ers’ L1
grammatical knowledge and processing procedures. In Chapters 4 and 5, we will see that native English speakers showed a complex pattern of processing and interpreting both bare non-heads and plural non-heads in compounding and Korean L2ers were able to represent new linguistic distinctions even though they did not reach native-like performance. The final chapter, Chapter 6 will provide conclusions to my thesis and implications for future research.
Chapter 2: Number in English compounding and first language acquisition studies

2.1 Inconsistent findings in L1 studies

It has been known that English noun-noun compounds allow irregular plural non-heads while not permitting regular plural non-heads (Gordon 1985; Berent & Pinker 2007). The best known example is the contrast between a rat eater, *rats eater and ?mice eater\textsuperscript{12}. In other words, English speakers prefer rat eater but when it comes to plural non-heads in noun compounds, they prefer irregular non-heads, mice eater, and avoid regular plural non-heads, rats eater (Gordon 1985). This finding has led some researchers to claim that the dislike of regular plural non-heads but not irregular plural non-heads in compounding is an innate constraint (Gordon 1985; Pinker & Prince 1994; Alegre & Gordon 1996). However, this finding has come under challenge from connectionists who showed that plural non-heads are dispreferred regardless of their inflection (Buck-Gengler et al. 2001; Haskell et al 2003; Ramscar & Dye 2011). In this regard, studying English plural non-heads is intriguing for two reasons. First, from the L1 acquisition point of view, this specific phenomenon makes us compare linguistic nativism to non-nativist approaches to acquisition, such as the “self-organizing” approaches embraced in much work in connectionism\textsuperscript{13}. Second, studying plural non-heads will give us a way to examine compounding and number systems in both English and Korean. As we saw in Chapter 1, Korean has an optional plural marker -tul while its bare form marks general number. At the same time Korean compounding only allows bare non-heads, contrary to English. Once we have an accurate description of how English plural non-heads work, the difference between the two languages will

\textsuperscript{12} ? indicates that the form is marginally accepted.

\textsuperscript{13} Connectionism is a way of implementing linguistic cognition in a model of neural processing. It could make use of symbolic or non-symbolic computations. In practice, however, connectionists tend to reject nativism (“eliminative” connectionism). See Marcus (1998, 2001) for discussion.
allow us to explore how L2 learning works, either in terms of L1 transfer or in terms of the encoding of novel form-function mappings. Chapter 2 explores experimental studies and theories to account for the preference for irregular non-heads and the dislike of regular non-heads in the two different perspectives. In addition, I will also introduce two studies (Alegre & Gordon 1999, Senghas et al. 2007) that have attempted to explain how native English speakers constrain the presence of plural non-heads. They showed that the meaning of the head noun plays a role in allowing regular plural non-heads but still there remains the question of the meaning of plural non-heads.

2.2 Previous studies from a nativist perspective

In this section, I will review four nativist studies which claim that the dislike of regular plural non-heads and the preference for irregular plural non-heads are universal and innate (Kiparsky 1982; Gordon 1985; Pinker & Prince 1994; Alegre & Gordon 1996). The analyses offer some explanations with the linguistic phenomenon however the facts are contentious and will eventually require further investigation.

2.2.1 Kiparsky (1982)

Kiparsky (1982) proposed a linguistic universal, the Level Ordering Hypothesis, which stipulates that there are successive internally-ordered levels in the creation of morphologically complex words, including compounds (generally from two to five, Lardiere 1995). The Level Ordering Hypothesis was designed to account for the interaction of morphological operations with phonological processes. The Level Ordering Hypothesis presupposes a view of the mental lexicon in which only unpredictable information is stored in lexical entries (Chomsky 1965; Di Sciullo & Williams 1987). Gordon (1985) adopted the Level Ordering Hypothesis with three
levels to explain English speaking children’s behaviour in producing plural non-heads.

As Figure 2.1 shows (Ramscar & Dye 2011), there are three levels required to form compounds. At Level 1, only idiosyncratic forms such as irregular inflection and pluralia tantum nouns (e.g., scissors) are derived. These are stored as such in the mental lexicon and enter word formation processes or syntactic derivations directly. Regular derivational morphology (e.g., infest\(\text{v}\) + ation\(\text{s}\) → infestation) but not regular inflectional morphology takes place at Level 1. Therefore, regular plurals such as rat+s cannot be formed in this level. Since compounding is a regular derivational process, Level 2\(^{15}\) is the level at which compounds are formed. Finally, Level 3 is reserved for regular inflectional morphology, thus at this level regular plurals attach to their bases. Given that the order of levels is fixed, regular plurals can never attach within compounds as they have been formed already at Level 2. Thus, the Level Ordering Hypothesis captures elegantly the unacceptability of *rats eater while still permitting mice eater. It follows from the analysis that forms like *rats eater can, in fact, never be formed. Gordon(1985) has drawn on the Level Ordering Hypothesis to explain his experimental results. His study, a seminal work investigating plural non-heads in first language acquisition research will be discussed in some detail.

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\(^{14}\) Derivation is one of several word-building processes. It concatenates roots or stems and affixes to create new lexical items (Katamba 1994). For example, the words happiness and unhappy are derived from happy—a suffix—ness, e.g.\([\text{happy }]_{\text{adj}} \text{-ness}\)\(\text{s}\) and a prefix un-\(\text{-[ happy }]_{\text{adj}}\)\(\text{adj}\) create new lexical items from the adjective happy.

\(^{15}\) Gordon (1985) included another type of derivational morphology in Level 2. According to him, Level1 includes primary affixes —non-compositional & non-productive ones—such as -ity, -ion, -ous, etc. Level 2 involves the secondary affixes which are productive and semantically predictable such as -ness, -er, -ist, un-etc. These two affixes are also classified as Class 1 and Class 2 or +boundary and #boundary affixes in other versions of ordering hypotheses, for details, see Allen, 1978 among others. However, this distinction is not relevant in Gordon’s work (1985) since he used only -er(i.e. eater) in his experiment.
2.2.2 *Gordon (1985)*

The Level Ordering Hypothesis with the aforementioned three levels makes the prediction that English-speaking children will produce irregular plural non-heads and pluralia tantum non-heads but not regular plural non-heads in compounds. Since the constraints on ordering are innate, children will obey them in the absence of positive evidence. In fact, English-speaking children are exposed to ‘singular non-head + head’ compounds such as *cat lover* but not to plural non-heads. According to frequency data, some highly frequent nouns such as *mouse, man, tooth, foot* and *goose* (token frequency: 153) are found as non-heads in compounds but their plural counterparts rarely occur (token frequency: 3) as non-heads (Kučera & Francis 1967). In this respect, regular plural non-heads and even irregular plural non-heads can be considered as low-frequency in English. Thus, Gordon assumed that if children produce irregular plural non-heads but do not regular plural non-heads, we can attribute this to an innate constraint like the Level Ordering Hypothesis.

Gordon recruited 33 three-to-five-year-old English-speaking children. Here is a brief illustration of the methods used. First, a ‘Cookie Monster’ puppet was introduced to children by the experimenter. Children responded to an elicited production task with pictures which were designed to elicit singulars, plurals and compounds. Gordon included singulars to make sure that
children know the right form of singulars as well as their plurals (i.e. regular, irregular and pluralia tantum nouns). He selected semantically and perceptually similar counterparts as Table 2.1 shows.

Table 2.1 Testing items of Gordon’s experiment (1985)

<table>
<thead>
<tr>
<th>Singular - regular</th>
<th>Plural - regular</th>
<th>Singular-irregular</th>
<th>Singular-plural</th>
<th>Counterparts of pluralia tantum</th>
<th>Pluralia tantum</th>
</tr>
</thead>
<tbody>
<tr>
<td>mouse, man, tooth, foot and goose</td>
<td>mice, men, teeth, feet and geese</td>
<td>rat, baby, bead, hand and duck</td>
<td>rats, babies, beads, hands, and ducks</td>
<td>toy, shirt, shoe, and knife</td>
<td>clothes, pants, glasses and scissors</td>
</tr>
</tbody>
</table>

With these testing items, the experimenter used the following prompt in (18) to elicit an X-eater from children where the X was the stimulus.

(18) Do you know who this is? … It’s the Cookie Monster. Do you know what he likes to eat? (Expected answer: Cookies) Yes, and do you know what else he likes to eat? He likes to eat all sorts of things… (Pictures with the target testing items presented) What do you call someone who eats X? (Expected answer: An X-eater).

Results showed that children produced irregular plural non-heads 90% of time but regular plurals only 2% as the examples in (19) indicate.

(19) How would you call someone who eats mice? 90% mice eater produced (i.e. 10% mouse eater)  
How would you call someone who eats rats? 98% rat eater produced (i.e. 2% rats eater)
For pluralia tantum non-heads, the prediction was correct to a large extent although only *clothes* and *pants* were used as non-heads but not *glasses* and *scissors*. Gordon had several explanations for this dichotomy. First *glasses eater* and *scissors eater* can be semantically odd to children because people do not normally eat such objects, and second, those two words are used as singular forms by some adults. According to Gordon, the results, in general, suggest that children seem to conform to the Level Ordering Hypothesis.

2.2.3 Alegre & Gordon (1996)

Gordon’s findings (1985) are further supported by another study (Alegre & Gordon 1996) which tested complex phrasal compounds such as *new books shelf*. This [Adj+Ns+N] compound seems to be a counter-example to the Level Ordering Hypothesis just like [Ns+N] compounds (e.g., *publications list*), however they demonstrate that this construction does not undermine the innate constraint. Rather it is formed within the framework by recursion\(^\text{16}\) as phrasal elements can be non-heads in English (e.g., *a seat-of-the-pants executive* or *the how-can-it-be- innate-if-it-needs-experience absurdity*). Once *new books* is formed like phrases in syntax\(^\text{17}\) it then feeds back into morphology to create a compound *new books shelf*. This also explains why *books shelf* is not acceptable because it is not formed by recursion. Thus, Alegre & Gordon assume that the presence of regular plurals inside this phrasal compounds leads to only one interpretation in which the Adj has scope only over the noun immediately to its right, e.g., ‘[[red rats] eater]’.

Trees in Figure 2.2 illustrate the recursive interpretation (i.e. an eater eats red rats) on the assumption (widely accepted in generative linguistics) that the scope of modifiers is constrained

\(^{16}\) Recursion refers to a structural process in which a syntactic unit contains another instance of itself; for example, English possessive -s is structurally recursive in N[ NP[John’s]poss [ NP[father’s]poss book]].

\(^{17}\) Alegre & Gordon pointed out that regular inflection is considered as non-syntactic by some researchers however they assume that regular inflection is attached in a syntactic derivation.
by c-command and locality\textsuperscript{18}. Note, however, \textit{red rat eater} can have two interpretations: 1) there is a rat eater whose colour is red (= the non-recursive interpretation). 2) there is an eater that eats red rats (= the recursive interpretation).

![Figure 2.2 Internal structures of complex compounds showing adjectival scope](image)

Alegre & Gordon assumed that the recursive interpretation requires more processing power than the non-recursive interpretation due to the additional recursion process, so they speculated that people would prefer the non-recursive interpretation when there is no other factor such as plurals inside complex words. However, \textit{red rats eater} blocks a non-recursive interpretation and should force a recursive interpretation.

To test this hypothesis, Alegre & Gordon conducted a comprehension task with 36 three- to-five-year-old children. The experiment involved pictures of various animals (e.g., a cow, fish, or monster) eating various organisms (e.g., flowers, crabs, rats, or spiders) with two linguistic conditions, expressions in the singular or in the plural. In each picture, either animals or organisms had the target colour. For example, to test a \textit{red rats eater}, the picture depicted either \textit{rats} that were red or the \textit{eater} who was red. In the singular condition, an experimenter asked ‘Can you point to the picture that shows \textit{red rat eater}?’ and in the plural condition, he asked ‘Can you point to the picture that shows \textit{red rats eater}?’.\textsuperscript{18}

\textsuperscript{18} \textit{C-command} is a structural relation between nodes in a tree as follows: \(\alpha\) c-commands \(\beta\) iff the first branching node immediately dominating \(\alpha\) also dominates \(\beta\) (Reinhart 1983: 41). Two nodes are in a strictly local relationship if they are sisters, in which case they mutually c-command each other.
Results indicated that children in the plural condition chose two to three times more pictures associated with the recursive interpretation (rats that were red) than in the singular condition. Roughly, children selected the recursive interpretation 70% of the time in the plural condition, and 27% of the time in the singular condition. This could suggest that children apply their grammatical knowledge of regular plural non-heads and choose the recursive interpretation.

One thing to note is that the recursive interpretation was selected less often in the plural condition (3-year-olds 83% vs. 5-year-olds 63%) while it was selected more often in the singular condition (3-year-olds 25% vs. 5-year-olds 38%) although no statistically significant effect was found.

Unfortunately, irregulars were not tested in this experiment.

### 2.2.4 Pinker & Prince (1994)

The Level Ordering Hypothesis is not the only means to account for the facts regarding the greater acceptability of *mice eater* to *rats eater*. There is another model which posits that regular and irregular plurals are processed in a completely different way. Pinker & Prince (1994) proposed a Dual Route model to explain the difference between regulars and irregulars. Their focus was past tense (i.e. -ed vs. irregular past tense) rather than plurals however their model can be applied to the regular-irregular plural distinction as well. According to the Dual Route model, regulars are computed in real time by linguistic rules while irregulars are stored in the mental lexicon and are activated directly from memory (Pinker 1999). As such, only the irregulars are affected by properties known to affect memory such as the frequency of the form and similarity of one form to another. Memorized words can affect the learning of other items when they are similar in form or meaning. Later, Berent & Pinker (2007) explained this distinction in terms of morphological difference. According to their analysis, irregulars which can be classified as roots and bare uninflected forms (i.e. stems) can be non-heads while inflected words including regular
This dual route to the creation and use of regulars and irregulars is supported by three main findings. First, only irregular past tense but not regular is affected by the frequency and similarity of forms in priming studies. Second, only irregulars can be involved in word-formation process such as compounding. Third, in studies of aphasia, patients have been found who were impaired in the processing of irregulars while the processing of regular forms remained unimpaired. There is however, counterevidence to such claims. As for frequency, regular plurals can be affected by whole-word frequency too when the frequency of the inflected form is over 6 out of one million words (Alegre & Gordon 1999a). Indeed, the relationship between frequency and storage, as well as frequency and productivity is complex and does not support a simple correlation between regularity/rule and irregularity and storage (Baayen 1993; Baayen & Neijt 1997). On the second point, as we know, regular plurals are acceptable even in English compounding and they appear to be free in other languages such as German, Dutch and Spanish (Lardiere & Schwartz 1997; Banga et al. 2013).

2.2.5 Summary

There have been two observations in first language acquisition studies relevant for my research. First, only bare non-heads and irregulars are permissible as non-heads, which has been considered as motivation for universal nativist constraints. Indeed, the argumentation for, e.g., Kiparsky’s Level Ordering Hypothesis (1982), turns on POV claims. Gordon (1985) claimed that the regular-irregular plural dissociation is universal and innate. In addition, Pinker & Prince (1994) demonstrated that regulars and irregulars have different properties and may be computed in a very different way. Second, Alegre & Gordon (1996) demonstrated that English phrasal compounds have a recursive interpretation 70% of the time since regular plural non-heads are not
acceptable in English compounding. The accuracy of the two proposals, however, turns on the correctness of two claims: (1) that English speakers never produce regular plural non-heads in novel compounds, (2) and that other languages also do not allow regular plural-non heads. However, counter-examples such as injuries report have been found and are a big hurdle for the account. For that reason, Alegre & Gordon (1999b) and Senghas et al (2007) have attempted to discover the possible constraints on regular plural non-heads in noun compounds. Their claims will be explored in section 2.5. There are, however, still three issues with this nativist account. First, other languages such as German, Dutch and Spanish allow regular plural non-heads freely so the constraint itself cannot be universal (Lardiere 1995; Lardiere & Schwartz 1997; Banga et al. 2013). Second, L2 replication studies have shown that it is not easy for L2ers to obey this specific constraint, a surprising result if it is universal (Lardiere 1995; Murphy 2000; Cunnings 2003; Nicoladis 2003; Pilar & Mayo 2006). Finally, a distinct account is possible according to which bare non-heads are unspecified for number and denote properties rather than individuals. Thus, in kitchen table, the non-head expresses KITCHENNESS (Di Sciullo & Williams 1987). That is why bare non-heads are preferred (Berent & Pinker 2007). Considering the fact that both bare non-heads and plural non-heads indeed are bare forms without determiners, we must examine plural non-heads in terms of their meaning as well. How do psychological analyses resolve this issue?

2.3 Previous studies from a connectionist perspective

I will examine two studies in this section. The first study provided a different account to explain why English speakers dislike plural non-heads. The main claim is that there is no innate constraint on compounds (Haskell et al. 2003) and the preference for irregulars over regulars is not absolute as required by the Level Ordering Hypothesis. The second study demonstrated that
the experiments conducted by Gordon (1985) and Alegre & Gordon (1996) are plagued by a task effect. When this problem is corrected, English-speakers dislike both regular and irregular plural non-heads in English compounds (Ramscar & Dye 2011).

2.3.1 Haskell et al. (2003)

Haskell et al. used three different methodologies (i.e. corpus data analysis, grammaticality judgment tasks with voicing-changing nouns (e.g. *wolf-wolves*) and pluralia tantum nouns, and computational modeling) to show that regular plurals are highly dispreferred while irregular plural and pluralia tantum nouns are somewhat less preferred when compared to singulatrs. If the Level Ordering Hypothesis is correct, irregulars should be acceptable as singulatrs, however, as we have seen, this is not the case. Therefore Haskell et al. rejected the Level Ordering Hypothesis and provided an alternative model to explain why such gradual acceptability occurs in English compounding. Their model is based on a connectionist network account which posits that we can learn language from input without any sort of innate language learning mechanisms (Rumelhart & McClelland 1986). According to this account, language learning involves a single mechanism (association) which learns the distribution of words in the input. Once an association is formed, its associative weight will increase based on the frequency with which the network processes a form. The well-formedness of a novel input is contingent on how well it fits the constraints embedded in the network. Based on this account, Haskell et al. claimed that “linguistic elements such as morphemes are defined in terms of correlations between different types of information (e.g. sound, meaning and contexts)”. In this regard, they assumed that two factors, semantics and phonology, account for different acceptability levels of regular, irregular and singular as Table 2.2 shows. Basically, this model provides probabilistic constraints to model how plural non-heads relate semantically and phonologically to singular nouns. If non-heads mean ‘more than one
referent’ or if codas end in sibilant sounds, violations are stacked up resulting in gradual impermissibility. Apparent counter-examples like fox hunter, which is permissible even though the non-head ends in a sibilant sound, can be accommodated because the network embodies gradient constraints rather than absolute constraints (in contrast to the Level Ordering Hypothesis).

Table 2.2 Predictions of non-head acceptability by semantic and phonological factors

<table>
<thead>
<tr>
<th>Example</th>
<th>Semantically plural?</th>
<th>Phonologically plural?</th>
<th>Acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>rat, mouse</td>
<td>No</td>
<td>No</td>
<td>Acceptable</td>
</tr>
<tr>
<td>mice</td>
<td>*Yes</td>
<td>No</td>
<td>Marginal</td>
</tr>
<tr>
<td>rats</td>
<td>*Yes</td>
<td>*Yes</td>
<td>Dispreferred</td>
</tr>
</tbody>
</table>

Even though they did not attempt to resolve the issue of existing plural non-heads in their study, Haskell et al. provided several grounds to explain the existence of such cases. First, they suggest that plural non-heads might be used when they convey extra information or have special meaning such as polysemy – security vs. securities. Thus, a security firm might install alarms, while a securities firm might sell investments. Second, sensitivity to frequency is the key characteristic of connectionist models, plural non-heads which have higher frequency over their singular forms may be more acceptable compared to plural forms with low plural frequency. Third, as another frequency effect, possessive and regular plural (e.g. dogs vs. dog’s) have the same sound ending and occur in the same position in words, so the characteristics of possessive might affect acceptability of plural non-heads. Since possessive is largely attached to animate nouns (especially those referring to human beings), the acceptability of plural non-heads can be increased if plural non-heads are animate.
2.3.2 Ramscar & Dye (2011)

Ramscar & Dye demonstrated that English speakers dislike plural non-heads regardless of inflection type and prefer singular non-heads. They carried out seven experiments with children and adults. Among those seven experiments, three of them showed that Gordon’s (1985) work induced a priming effect and Alegre & Gordon’s (1996) experiments involved a semantic factor rather than the regular plural constraint.

The first experiment replicated the Gordon’s experiment while changing the order of procedures. Participants produced compounds first while seeing a picture and then named the testing items (i.e. non-heads) in plural forms. Without mentioning the target word mice or rats, Ramscar & Dye let participants produce compounds based on a picture either with a single object or with multiple objects. The results revealed that 45 Edinburgh university students produce mice eater only 18% of time (Gordon’s experiment: 90%) and rats eater 5% of the time (Gordon’s experiment: 2%) respectively. It is interesting to note that participants produced singular forms consistently even with a picture of multiple objects. The same results were also found in the second experiment with 3- to 8-year-olds. Children also produced more rat/mouse forms instead of their regular and irregular plural counterparts when the order of procedures was changed. From these findings, Ramscar and Dye concluded that there was a problem with the procedures in the original studies, those results were unreliable, and the conclusions regarding the Level Ordering Hypothesis unwarranted.

The third experiment involved a phrasal compound interpretation task with 66 Stanford university students. The researchers showed that a recursive reading of phrasal compounds was not forced due to the dislike of regular plural non-heads, as Alegre & Gordon (1996) had claimed. As Table 2.3 shows, the recursive reading (NP+N) of phrasal compounds depends on a semantic factor, namely, the interpretation of phrasal compound words depends on whether an adjective is
matched with the second word or the last word. Contrast *brave soldiers list* (meaning solders are brave) versus *long soldiers list* (meaning the list is long). Thus, knowledge of semantic features (*brave* requires an animate noun) and collocational knowledge (people are *tall* and not *long*) will push listeners to compute *brave* with scope over *soldiers*, rejecting an alternative computation where it takes scope over *list*, while the alternative computation will be favoured in the case of *long* and *list*. Accordingly, in the original study, the choice of adjectives was skewed. Moreover, pragmatics (i.e. plausibility of meaning) is known to matter when people judge sentences (Schütze 1996). Therefore, we need both an implicit form of testing, such as a priming task, and better, non-skewed, items such as *torn receipt envelope* (Berent & Pinker 2007) to see whether the presence of regular plurals does play a role in recursive interpretations.

Table 2.3 Results of a phrasal compound study (Ramscar & Dye 2011)

<table>
<thead>
<tr>
<th>Adjectives</th>
<th>Regular plurals</th>
<th>Recursive reading rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brave vs. Long</td>
<td>Soldiers list</td>
<td>100% / 14%</td>
</tr>
<tr>
<td>Pink vs. Precise</td>
<td>Flamingos scale</td>
<td>67% / 14%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Adjectives</th>
<th>Irregular plurals</th>
<th>Recursive reading rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stinky vs. Metal</td>
<td>Feet crusher</td>
<td>83% / 14%</td>
</tr>
<tr>
<td>Fat vs. Modernized</td>
<td>Geese farm</td>
<td>75% / 7%</td>
</tr>
</tbody>
</table>

As an alternative account of the dislike of plural non-heads, Ramscar & Dye suggest that two factors, frequency (i.e. distribution patterns of regulars and irregulars) and the dislike of sibilant sound at the right edge of the non-head, restrict plural non-heads irrespective of inflection type. In a task involving judgments of the naturalness of novel English compounds, they showed that when the frequency of non-heads increased, they sounded more natural to native English speakers. When the non-heads ended in sibilant sounds, they sounded less natural. Ramscar & Dye however did not attempt to explain existing counter-examples such as *services coordinator*. 
2.3.3 Summary

Experimental studies have shown that there is no qualitative difference between regular plurals and irregular plurals when they occur in non-heads in compounds (Buck-Gengler et al. 2001; Haskell et al. 2003; Senghas et al. 2007; Ramscar & Dye 2011) contrary to the work of Gordon, inspired by the Level Ordering Hypothesis. Ramscar & Dye (2011) showed that experiments linked to nativist accounts (Gordon 1985; Alegre & Gordon 1996) involved task effects and the results are therefore unreliable. In addition, they proposed a dislike of sibilants at the right-edge of non-heads in compounds. However, this dislike of sibilant sounds, the Phonology Constraint, was not found in a Berent & Pinker’s (2007) experimental study. Berent & Pinker’s grammaticality judgment task results showed that singular non-heads that sound like regular plurals were not dispreferred. Thus, for example, singular non-heads like hose collector were not less acceptable than meaning-matched non-heads (e.g. pipe collector) or than phonological controls (e.g. hoe installer). This result was also found when they tested non-words regardless of whether stimuli were presented auditorily or in written form. A non-word grammaticality judgment task showed that the regular-irregular distinction is the key to naturalness ratings.

Symbolic nativist accounts also differ from connectionist models in the properties they attribute to non-heads. In nativist accounts, the left-most element in compounds is a bare noun which denotes KINDs rather than INDIVIDUALs (Di Sciullo & Williams 1987 cited in Berent et al. 2005; Pinker & Prince 1994) while it is treated as singular in the connectionist models (Haskell et al. 2003). As for plural non-heads, on the one hand, connectionists take it for granted that plurals denote multiple individuals. Accordingly, researchers did not test why some existing compounds allow regular or irregular plural non-heads. On the other hand, some nativist accounts are incompatible with gradient data and have tried to explain counter-examples (Alegre &
Gordon 1999b; Senghas et al. 2007) without questioning the meaning of plural non-heads. Do plural non-heads mean multiple individuals? Before investigating this question, we must first sort out the issue of the status of existing compounds with plural non-heads.

2.4 Regular plural non-heads in English compounding

When we examine the results from previous studies, it seems that counter-examples involving regular plural non-heads should be very rare. Nativists claimed that only irregular plural non-heads are allowed, while connectionists claimed that both regular and irregular plural non-heads are highly dispreferred. As noted earlier, however, there are many instances of regular plural non-heads in English as in (20).

(20) billing rights summary, chemical weapons attack, counterexamples list, compounds research, decades-long, dissertations shelf, eating disorders specialist, excess profits duty, the experiment instructions manipulation, functional categories session, gimmicks war, grants management, information practices act, injuries report, Johnson Games T-shirt, landmarks commission, letters policy, MIT awards ceremony, MIT Innovative Structures program, MLA Chicago events directory, NBA assists record, nuclear weapons capability, parts guarantee, profits estimate, publications catalog, sex crimes scandal, skills gap, small claims court, supplies buyer, top videos list

Source: Senghas et al., 2007

The known compounds with regular plural non-heads in the literature are as follows: 388 tokens from Ms. Magazine, Guitar Player, and MIT’s Tech Talk, 957 tokens from Reuters, and 244 tokens from The……
tokens from the parsed version of the Brown corpus (Haskell et al. 2003; Senghas et al. 2007).

Obviously, these words are neither rare nor highly specialized. Moreover, we do not know what the role of plural non-heads is and why they are allowed sometimes regardless of the regularity of inflection. This undermines both nativist and connectionist accounts. To remove this obstacle, linguistic accounts have attempted to figure out why there are attested regular plural non-heads. Connectionist accounts must explain why both irregular and regular plural non-heads are found and the contexts in which each occurs.

2.5 Possible constraints on regular plural non-heads

Senghas et al. (2007) tested five different conditions on regular plural non-heads in phrasal compounds to see when both compounds and phrasal compounds allow plural non-heads. The five conditions are: the regular-irregular dichotomy, collective vs. distributive interpretation of non-heads, the root-synthetic compound distinction\(^{20}\) (regular plural non-heads should be more acceptable in synthetic compounds), the historical origin of irregular plurals (Germanic: mouse/mice, vs. Latin-Greek: alumnus/alumni) and the regular plural non-heads in phrasal compounds. As for compounds, the naturalness rating showed that the regular-irregular dichotomy was the key factor in obtaining higher naturalness ratings of compounds. Irregular plural non-heads (e.g. geese feeder) were more acceptable than regular plural non-heads (e.g. ducks feeder). Another interesting finding in their experiment was the interpretation of non-heads. They assumed that a collective meaning (i.e. when a noun is interpreted as a GROUP not as an INDIVIDUAL) might increase the acceptability of plural non-heads as opposed to the distributive meaning (i.e. interpreted as a set of individuals acted upon individually). The

\(^{20}\) Recall that root compounds are compounds consisting of simplex units or roots (e.g., [N+N]-file cabinet and [V+N]-pick pocket). Synthetic compounds are constructions in which the second constituent is derived from a verb while the first component is interpreted as an internal argument of this stem as in truck driver.
interpretation of non-heads indeed showed a significant effect to non-heads with regular plural non-heads being more acceptable even though the naturalness ratings of the collective interpretation of regular plural non-heads were not as high as the naturalness ratings of irregular plural non-heads. Even though Senghas et al. could not find an effect of type of compounds (synthetic compounds vs. root compounds), Lardiere (1995) claimed that only root compounds allow regular plural non-heads. This constraint on the distribution of regular plurals in non-heads led her to suggest that permissibility of regular plural non-heads depends on structural characteristics of compounds rather than semantic idiosyncrasy. The naturalness of phrasal compounds with regular plural non-heads (e.g. torn receipts envelope) increased when the target word was interpreted in a recursive reading (i.e. an envelope contains torn receipts) while bare non-heads (e.g. torn receipt envelope) were interpreted non-recursively (i.e. an envelope containing receipts is torn). This suggests that the existence of regular plural non-heads led participants to prefer one interpretation over the other. In a nutshell, they concluded that regular plurals and irregular plurals are qualitatively different and the other factors did not affect the naturalness of compounds.

Alegre & Gordon (1999b) analyzed existing counter-examples and then proposed two semantic factors that could explain why regular plural non-heads are sometimes permissible. First, they claimed that head nouns can be divided into two sub-classes based on whether they result in a heterogeneous or non-heterogeneous reading of the head nouns. Heterogeneous head nouns denote the ‘different types of instances’. For example, faces lab means the lab studies different types of faces. The second factor is the abstractness of non-heads. When non-heads describe plants or animals, compounds sound odd even when their non-heads involve heterogeneous nouns, as in *animals research and ?flowers catalogue however abstract non-head nouns such as compounds, qualifications and injuries sound natural. In their naturalness testing, they let
participants decide whether the listed words are abstract or concrete.

Using a 7-point scale naturalness test where “1” was unnatural and “7” meant completely natural, both heterogeneity and abstractness showed main effects and their interaction was the key factor related to increases in the naturalness ratings of regular plural non-heads. Heterogeneous nouns got a mean naturalness rating of 4.61 and non-heterogeneous nouns got a rating of 3.79. Abstract non-heads received 4.69 as mean rating while concrete non-heads received 3.72. Notice, however, that in this type of traditional point-scale grammaticality judgment task, the uniformity of a unit in the scale is not clear and we do not know whether participants judge the given stimuli in the same intervals or not (Bard et al. 1996). Even though the results were statistically significant, we are not sure what the ratings mean beyond the preference Concrete < Abstract; non-Heterogeneous < Heterogeneous nouns. In addition, Banga et al. (2013) demonstrated that native English speakers use regular plurals (8%) and irregular plurals (14%) even when non-heads denote multiple instance of the same kind (i.e. non-heterogeneous) in a picture naming task.

In short, the two studies presented in this section made three claims. First, the regular-irregular distinction is real. Second, heterogeneous heads allow regular plurals inside compounds. Third, if non-heads denote abstract concepts, they are more readily acceptable. However, the two studies do not explain all counter-examples and we still do not know why sometimes plural non-heads are used instead of bare non-heads. Such findings raise a fundamental question: What is the meaning of the plural markers?

2.6 The meaning of the English plural

The standard analysis of plural morphology is that it denotes multiple individuals or a sum of individuals (groups) from a set of singularities (Link 1983; Portner 2005; Dayal 2011) as given in
A, B, C are “atoms” (“singularities” or single entities) while the rest are plural individuals or groups. In languages with a Dual-Plural contrast, plurals would have to be constrained to denote only A+B+C, with Dual inflection picking out the intermediate level (A+A, A+B, A+C, B+B, B+C, C+C). In languages without plural-marking, such as Chinese, *ma* is a bare noun which can describe both atoms and “pluralities” (Portner 2005). However, the meaning of plural morphemes is not simple since it could mean both singular groups as well as a plural group (Dayal 2011). As exemplified in (21), one could raise one’s hand even when one has only one child. In these examples, *children* seem to mean one or more children contrary to two more children as the traditional analysis of plural meaning suggests.

(21) a. If you have children, please raise your hand.

    b. Everyone who has children, please raise your hand.

    c. Do you have children?  

Source: Dayal, 2011

English bare plurals also denote KINDs (Carlson 1977a). Like bare non-heads they can have three different meanings: KIND, GENERIC and EXISTENTIAL respectively as examples in (22) show.
(22) a. Dinosaurs are extinct.
    b. Dogs bark.
    c. Dogs are barking.  

(22a) and (22b) are general statements which describes properties. Accordingly, they do not refer and can be true even when no referents are available. Indeed, (22a) denies the existence of dinosaurs and predicates non-existence of the KIND. (22b), in contrast, says something about individual members of the KIND, e.g., “If x is a member of the KIND DOG, then it has the ability to bark”. (22c) describes the current states of some particular dogs, so it is only true if it is referential. Grammatical properties such as tense and aspect differentially cue semantic concepts like PROPERTY vs. STATE (compare (22b) vs.(22c)). As well, the semantics of Adjective Phrases matter (compare, e.g. Frogs are awake vs. Frogs are clever, Carlson 1977a: 35\textsuperscript{21}) while bare plural itself means KINDs (Carlson 1977a,b; Portner 2005). These properties cue the distinction between GENERIC/KINDs meaning versus EXISTENTIAL meaning (Carlson 1977a,b) not bare plurals. As Carlson (1977a,b) observed, if bare plurals denote KINDs, we may ask why bare non-heads are preferred and why plural non-heads sometimes are used instead of bare non-heads. We would expect that plural-marking would also show up on non-heads denoting multiple individuals. If plural non-heads denote multiple individuals (not KINDs), we also need to see whether native English speakers indeed choose to mark plural on non-heads when multiple individuals are referred to.

\textsuperscript{21} Such contrasts are now regularly referred to as Individual vs. Stage-predicates. See Carlson (1977), Kratzer (1995). On the emergence of these semantic differences, see Coley (1995).
2.7 Summary

On the one hand, nativist accounts have shown that the regular-irregular distinction is valid in compounding and claimed that only irregular plural non-heads can participate in compounding (Gordon 1985; Pinker & Prince 1994; Senghas et al. 2007). Gordon (1985) argued that this constraint is universal. On the other hand, connectionist accounts claimed that there is no qualitative difference between regular and irregular plural non-heads, but rather, they all together are not preferred in compounding as a result of associative learning (Haskell et al. 2003; Ramscar & Dye 2011). The existing counter-examples (e.g., services coordinator) and the preference for regular plural non-heads even in experimental studies, however, raise a fundamental question: Why do native English speakers use regular plural non-heads and what are the differences between bare non-heads and plural non-heads? To answer this question, Alegre & Gordon (1999b) and Senghas et al. (2007) conducted a grammaticality judgment task respectively and showed that three factors can explain the counter-examples: the properties of non-heads (abstractness), the meaning of head nouns (heterogeneity) and the regular-irregular dichotomy. Still, those factors cannot account for the fact that native English speakers use plural non-heads. Both nativist and connectionist accounts did not examine how native English speakers interpret non-heads but simply assume the meaning of bare non-heads as kinds versus a single individual, but it is not entirely clear what would be the meaning of plural non-heads. Considering the fact English bare plurals can also denote KINDs we need to first ask how native English speakers interpret both bare non-heads and plural non-heads.
3.1 Korean plural -tul

In this Chapter, I will first review the Korean nominal system to set the grammatical foundations for an examination of how L2 learners’ L1 grammatical knowledge might influence the processing of English plural non-heads. As noted in Section 1.5, Korean does not have a grammatically expressed singular-plural distinction as in English. Korean is a generalized classifier language, like Chinese and Japanese, meaning that grammatical number is marked via classifiers. It is well known that Korean bare nouns are unspecified for number and thus can be used to refer to both single and multiple entities. However, according to semantic analyses, Korean bare nouns also can denote KINDs (Kang 2007). Interestingly, similar to Japanese, Korean has an optional plural marker -tul and which is used to denote multiple entities when it co-occurs with nouns that denote THING-or INDIVIDUAL-concepts (Jackendoff 1983).

There are some notable differences between the Korean plural -tul and the English plural suffix. First, when the Korean plural -tul appears in an NP, its appearance does not require agreement with verbs. Secondly, there is only one form of the plural marker with no inflectional change on the co-occurring noun. Thirdly, it is not used as a syntactic cue to differentiate nouns that might variably refer to either INDIVIDUAL-concepts or SUBSTANCE-concepts. The English regular plural -s crucially marks flexible nouns (Barner & Snedeker 2005; Gillon 1999). English flexible nouns (e.g. string/strings) can appear as both mass nouns (with mass syntax) and count nouns (with count syntax). When occurring with mass syntax, flexible nouns denote SUBSTANCE-concepts; when occurring with count syntax, they denote INDIVIDUAL-concepts. Accordingly, native English speakers (English NSs) quantify flexible nouns over number when they are presented with plural morpheme -s (e.g., Who has more stones?) but quantify over
volume when presented with a bare noun (e.g., *Who has more stone?*) (MacDonald 2010). In English, plural-marking is obligatory with count nouns, and therefore frequent; Korean *-tul* is infrequent. The use of *-tul* with nouns occurred only 2.72% of the time in a Korean corpus of 5.5 million words (Kang 2007).

Korean plural *-tul* is considered to be an optional plural marker because bare nouns can denote both single and multiple entities. However in some contexts, only a NP containing *-tul* can denote plural entities while bare nouns denote a single entity (Kang 2007; No 2008; MacDonald 2014) as exemplified in (23) below. In this example, *holangi* ‘tiger’ is interpreted as one tiger even though it is a bare noun (Kang 2007) while *mulkoki.tul* ‘fish’ is interpreted as more than one fish.

(23) Coce holangi kuliko mulkoki.tul

Cocene tiger and fish.PL

‘Cocene, a tiger and fish’

Source: Kang, 2007

According to Kang (2007, 2008), if a speaker wants to express more than one tiger, s/he would usually use *-tul* in (23). Thus *holangi* ‘tiger’ in (23) intuitively denotes only one tiger. He argues that Korean *-tul* is a marked form while bare nouns are unmarked forms in terms of plurality since *-tul* only can refer to multiple entities while bare nouns can refer to both single and multiple objects. Thus, *-tul* is comparable to the English word *bitch* which in its technical use can only denote a female dog, as compared to the word *dog* which, as a hyperonym, can refer to either

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22 MacDonald (2009) tested how Korean learners process their L1 count nouns (i.e. bare nouns) and showed that Koreans also quantified bare nouns, which refer to INDIVIDUAL-concepts, over number, however, we do not know how Koreans would quantify when processing nouns marked with *-tul*. Based on the results of MacDonald’s (2014) experiment, I only assume that *-tul* marked nouns will quantify over number.

23 There is only one Korean corpus called the Sejong Corpus which consists of 10 million words.
male or female dogs. However an experimental study of MacDonald (2014)’s showed that -tul is required on a plural reading while bare nouns only allow a singular reading in most cases when she tested Korean speakers to see how they make judgment on both bare nouns and -tul marked nouns in various semantic and morpho-syntactic conditions. Thus how Koreans interpret Korean bare nouns is also under much debate (Kang 2007, 2008; No 2008; MacDonald 2014).

According to Kang (2007), bare nouns are commonly used when the speaker does not need to specify number, such as when referring to KINDs (or generic uses) as in (24).

(24) kay.nun /#kay.tul.un myelcong ha.yet.ta
   Dog.NOM / dog.PL.NOM extinct become.PAST.DECL
   ‘Dog/*dogs were extinct.’ Source: Kang, 2007

However, this grammaticality judgment is controversial since for some Koreans kay.tul ‘dogs’ also sounds natural in (24) as well. If my intuition is correct, Korean bare nouns and -tul marked nouns both can denote KINDs just as English singular- and plural-marked nouns do (e.g., A beaver builds a dam vs. Beavers build a dam). Therefore, the apparent difference is that Korean bare nouns can denote both single entities and multiple entities while -tul can only denote multiple entities. Since there have been various opinions on what the meaning of the Korean plural (Im 2000; Baek 2002; Chun 2004; Kang 2007, 2008; No 2008) is.

Kang (2007) finds two different patterns of -tul and bare nouns use in Korean corpus data (Kang 2007). First, -tul tends to appear mostly with human nouns (e.g. nouns denoting people) rather than with nouns denoting objects and animals. The most frequent 100 common nouns in a Korean corpus demonstrate this tendency as Table 3.1 shows.
Table 3.1 The use of Korean plural -tul with the most frequent common nouns (Kang 2007)

<table>
<thead>
<tr>
<th>Semantic hierarchy of nouns</th>
<th>Number of -tul occurrences in 100 nouns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human (e.g., person, student, child, etc.)</td>
<td>77</td>
</tr>
<tr>
<td>Animal (e.g., bird, rabbit, dog, etc.)</td>
<td>1</td>
</tr>
<tr>
<td>Thing (e.g., book, trees, etc.)</td>
<td>22</td>
</tr>
</tbody>
</table>

Languages with optional plural markers often display a person-hierarchy effect such that only nouns denoting human or nouns bearing [+animate] semantic feature mark plurality while other nouns do not (Corbett 2000 cited in Wiltschko 2008). Another interesting difference between bare nouns and -tul in corpus data is that -tul tends to be used with vague number expressions such as manhun ‘many’ while bare nouns denoting multiple entities are used with numerals or exact number expressions (e.g., se salam ‘three persons’). Some have suggested that the Korean number system might be in a transition to the mass-count distinction system or simply is changing (MacDonald 2014).

3.2 Previous L2 studies

Most previous L2 studies have replicated two studies of Gordon’s (1985) and Alegre & Gordon’s (1996) with some minor modification such as task modality (e.g., from an orally presented task to written tasks). One exception was a visual on-line lexical decision task of Murphy & Hayes (2010) who tried to explain the regular-irregular dissociation in terms of a competition between regular plurals and possessive -s in noun-noun synthetic compounds.

In a replication experiment of Gordon’s compound study (1985), Cunnings (2003) showed that Chinese L2 learners with upper-intermediate proficiency level produced both irregular plural non-heads (51%) and regular plural non-heads (39%), while British NSs used some irregular plural non-heads (69%), but did not use any regular plural non-heads. Cunnings
also conducted a phrasal compound comprehension task replicating Alegre & Gordon’s (1996) study. Results showed that L2ers were not sensitive to the presence of regular non-heads when interpreting phrasal compounds; English NSs preferred the recursive interpretation with regular plural non-heads (i.e. English NSs chose the recursive interpretation 81% of the time).

Similarly, Lardiere (1995) showed that both L2 Spanish learners of English and L2 Chinese speakers exhibited different patterns to that of English NSs. English NSs produced hardly any plural non-heads in the elicited production task. Again, English NSs did not produce any regular plural non-heads but produced irregular plural non-heads 4.8% of time. Results showed that L2ers inserted both regular and irregular plural non-heads similar to Cunnings’ (2003) results, thus Lardiere (1995) concluded that the dislike of regular plural non-heads cannot be an innate constraint. This result has been consistently confirmed by bilingual research (Nicoladis 2003) and other L2 studies (Cunnings 2003; Pilar & Mayo 2006). Counterevidence for the claim of innateness can be also found in languages such as German, Spanish and Dutch which systematically allow regular plural non-heads as exemplified in (25).


\[
\text{un lavaplatos} \quad \text{boek.en kast}
\]

\[
\text{un lav-a} \quad \text{plato-s}
\]

\[
\text{a wash-3SG} \quad \text{plate-PL}
\]

\[
\text{‘a dishwasher’} \quad \text{‘book case’}
\]

This cross-linguistic evidence against Gordon's claims is compelling. Pilar & Mayo (2006) further showed that less proficient L3 learners in an EFL setting (i.e. 49 Basque-Spanish bilinguals) tended to produce more plural non-heads than high-proficient groups while the
proficiency effect was not found in Murphy’s (2000) elicited written production study with 100 French speakers. Given the fact that Spanish permits plural-marked non-heads, this might be a transfer effect for the Spanish learners of English. Another interesting finding from Lardiere’s study (1995) was that the tendency to include plural non-heads was different between the two L2 groups because of L1 influence. L2 Spanish learners of English produced significantly more plural non-heads than L2 Chinese speakers whose L1 does not have plural inflection. We expect transfer effects in SLA. In this case, they buttress the argument that there is no universal constraint against plurals in compound non-heads.

In a nutshell, L2 studies have shown that adult English NSs, in elicited production tasks, produced no regular plural non-heads but did produce some irregular plural non-heads. This result is as expected since regular plural non-heads are not permissible in English compounding (Gordon 1985; Pinker & Prince 1997). However, adult L2ers produced both regular and irregular plural non-heads. If the Level Ordering Hypothesis were a universal innate constraint, even beginner L2ers should obey it (Lardiere 1995). However, we have seen compelling cross-linguistic evidence against the Level Ordering Hypothesis, as it applies to plurals inside compounds, and, moreover, we have some evidence that L2ers transfer L1 patterns permitting plurals inside compounds. One thing to note is that L2ers included more irregular plural non-heads than regular plural non-heads.

3.3 Emergentism

Emergentism is a general approach to language acquisition which explains it in terms of domain-general cognitive mechanisms (associative memory). It posits no specific language faculty, and obviously, no Universal Grammar (Gregg 2003). Emergentism tends to rely on connectionist formal models. Emergentist theories vary from researcher to researcher however, the central idea
is that language emerges from input without any rule-making mechanisms, without symbolic structural representations, or abstract linguistic categories. In this section, I will examine what is claimed about L2 learning in this approach and how it predicts learning plural non-heads by L2ers.

3.3.1 How does learning take place in an emergentist approach?

As noted, the basic idea is that language learning results from associative learning (Ellis 1998; Gregg 2003). Also as noted, emergentists tend to formalize learning using connectionist neural networks which are networks of sub-symbolic nodes linked only by associative frequencies. “Units” in the network are distributed over sets of nodes, rather than being directly represented in the nodes themselves (Rumelhart & McClelland 1986). It is important to note several central theses of this approach that are critical for interpreting language acquisition data. First of all, language is neither symbolic nor combinatorial (Cleeremans & McClelland 1991; Bybee & McClelland 2005). This means that notions like “phone”, “phoneme”, “syllable”, “word” or “prepositional phrase” are merely terminological conveniences for linguists; they have no psychological reality and no theory of language acquisition must explain acquisition in terms of such constructs. Secondly, all aspects of language are gradient; no categories are discrete. Thirdly, pattern regularities seen in natural languages result solely from patterns in the input, in particular, from the statistical analysis of distributional properties input (Kempe & MacWhinney 1998; Ellis 2002). Accordingly, developmental changes over time are all about strengthening distributional “weights” of each unit. With back-propagation learning algorithms24, errors in outputs decrease overtime. It is a necessary consequence of the adoption of connectionist formalisms that all

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24 This algorithm “modifies the connection weights so as to minimize the difference between the output of the network and a desired target signal” (Kempe & MacWhinney 1998).
language learning takes place gradually and solely on the basis of the analysis of input (Rumelhart et al. 1986). Thus frequency of input, that is, how frequently particular combinations occur in linguistic input, is critical (Ellis 2002). While the statistical properties of linguistic input and the frequency with which learners are exposed to them are important for some kinds of language learning, this cannot be the whole story. Consider the case of learning English determiners such as the (O’Grady et al. 2009). Despite their high frequency, English NSs and L2ers have difficulties learning them, presumably because the form-meaning mapping is not a simple 1:1 mapping. Thus, learners exhibit biases in terms of how they map forms to meaning and emergentism has nothing to say about the origins of those biases25.

MacWhinney’s Unified Competition Model is yet another functionalist approach that considers L1 and L2 acquisition as fundamentally the same thing (MacWhinney 2008)26. The Unified Competition Model is based on the Competition Model of Bates and MacWhinney (1987). See also MacWhinney (1987). It differs from frequency-based models and/or connectionist-based emergentist models in several ways. First, it has developed a rich set of proposals regarding how “cues” emerge from analysis of the input and biases to map forms to meaning. Thus, it sees language learning as competition among linguistic cues. Secondly, cues are defined in terms of symbolic notions (“words”, “nouns”, “sentences”, “agent” etc.). Cues are mappings between forms and functions which might be 1:1 mappings but more often will be many-to-one or one-to-many. For example, the English pronoun him is a form which expresses male sex and accusative case. Learners have to learn to map the form him to the complex concept

25 We do not need to be terribly impressed by the fact that connectionist modelling can be tweaked to model biases. Ad hoc intervention by the computational modeller is not a theoretical account of human linguistic cognition. For further discussion, see Carroll (1995) and Gregg (2003).
26 This model recognizes the fact that there are differences between L1 and L2 acquisition as adult L2ers have established L1 language systems. Accordingly they cognize L1-based cues, cue strength (validity, etc.) which they can apply to interpret given L2 stimuli.
MALE (presumably involving both culturally-specific cues such as typical types of clothing, haircuts, and so on, as well as biological properties such as size and primary sexual traits).

Accusative case, in contrast, must emerge from distributional and structural properties (it is rarely marked on subjects; subjects are daughters of Infl Phrases or Sentences). Some cues are both frequent in the input and reliable cues. Learners will more easily learn cues that are frequent than cues that are infrequent. They will more easily learn cues that are reliable over cues that are not so reliable (e.g., if a pronoun is marked for Nominative Case in English, then it is a Grammatical Subject versus sometimes when a pronoun is marked for Accusative Case in English, then it is a Direct Object). In short, cues must be acquired by learners and they compete based on their strength and validity. See MacWhinney (1989) for more discussion.

In MacWhinney’s Unified Competition Model (2008), second language learning is about acquiring novel L2 cues, and increasing their cue validity. “Cue validity depends on how often [a marker, say] an inflection occurs as a cue for a certain underlying function (cue availability) and how reliably it marks this function (cue reliability)…. [In the case of markers of Subject-hood such as nominative case] Cue reliability is computed as the ratio of sentences in which a cue correctly indicates the agent, divided by the number of sentences in which the cue is present” (Kempe & MacWhinney 1998:545, 550). Thus cue validity is a simple calculation, it results from multiplying cue reliability and cue availability. In a study focused on the learning German and Russian case-marking by English speakers, its authors showed that cue validity is a key factor in learning L2 grammatical functions like Subject and Direct Object (Kempe & MacWhinney 1998). The case-marking paradigm is simpler in German than Russian, however, English speakers learned Russian case marking faster. According to Kempe and MacWhinney, this is because Russian case-marking has higher cue validity than German case-marking which involves numerous cases of homophony (e.g., the pre-nominal determiner die marks both nominative and
accusative of the feminine singular nouns as well as the nominative and accusative of all plural nouns). Thus if cue validity is high, the Unified Competition Model predicts that a given mapping will be easy to learn by L2ers, just as it is by L1ers. On this view, L2 learning is gradual because the increase in cue strength is gradual, being “a direct function of cue validity” (MacWhinney 2008).

The Unified Competition Model also has a well-motivated set of assumptions about transfer from the L1. Since cues and cues strengths are deeply “entrenched” in the L1 (as a direct result of strengthening of the cues over time), the model claims that “whatever can transfer will” (MacWhinney 2008). Since the model assumes massive L1 transfer, if a certain linguistic structure is not available, that structure will be hard to learn by L2ers. Accordingly, we predict that Korean children will have serious difficulties such as in the case of learning English plurals (Shin & Milroy 1992 cited in Ellis 2006). Interestingly, the Unified Competition Model hypothesizes that morphological marking or inflections are not themselves subject to transfer, these forms not being independently encoded in memory. For example, a Spanish learner of Chinese cannot use their L1 knowledge of how entities are individuated or expressed as SUBSTANCEs to learn the Chinese classifier system expressing the same concepts, as their L1 Spanish does not have classifiers and, crucially, Spanish marks these concepts in complex ways through the use of the determiners, quantifiers, numeral and plural-marking (what we think of as the count/mass system), which cannot be mapped to the classifiers. The model also claims that only partial L1 transfer will be available if L2 structures express similar concepts, semantically-grounded grammatical distinctions or something structurally mappable to L2ers’ L1.

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27 This is one point on which the (Unified) Competition Model differs significantly from Pinker &Prince’s Dual Route model of morphological processing and other approaches to inflectional processing. The psycholinguistic literature supports the inflectional decomposition and storage view, not the idea of the Competition Model that only words are stored in memory. See Caramazza et al. (1988), Laine (1996) and Laine et al. (1995, 1999).
3.3.2 Predictions

Both emergentism and the Unified Competition Model predict that learning plural non-heads will be difficult for Korean L2ers for several reasons. First, L1 studies based on connectionist modelling have shown that plural non-heads are not preferred regardless of the regularity of the plural inflection (Haskell et al. 2003; Ramscar & Dye 2011). According to their accounts, English NSs dislike sibilants at the right-edge of non-heads in compounds as a result of associative learning. In the same manner, emergentism predicts L2ers will not learn the constraint (i.e. dislike of regular plural non-heads) since there is, in fact, no such innate constraint in the first place.

Second, plural non-heads are infrequent therefore they will be hard to learn. Third, the Haskell et al.’s (2003) model suggested a gradual dispreference for regular plural non-heads. If this type of connectionist account were adopted, we expect L2ers will learn exactly those plural non-heads that occur in the input, with those forms that are most frequent being learned sooner and better than those that are infrequent. However, cue validity is assumed to be low as -s in regular plural non-heads itself cannot be a strong cue because of the following reasons. First, the phonology constraint in the Haskell et al.’s model states that English NSs disfavours medial sibilant sound. Thus it cannot be a reliable cue since there are permissible plural non-heads such as fox in fox hunter. Moreover, the semantic constraint of the Haskell et al.’s model assumes that non-heads will not be permitted if they indicate more than one entity. However, this constraint itself has not been tested yet thus we cannot simply conclude that regular plural non-heads are not permissible due to the fact that they are semantically plural as the constraint hypothesizes. Lastly, the Korean plural marker is not a structurally comparable form as it has not the same function/meaning that of English plural. In terms of L1 transfer, the Unified Competition Model claims that there is no transfer from the L1 in the case of inflectional morphology. Thus, the theory predicts that English
NSs would not transfer the functions of English plural-marking to -tul when they learn Korean. Similarly, Korean learners of English will not transfer the various functions of -tul when exposed to regular English plural-marked nouns. Additionally, only bare non-heads are permissible in Korean compounding. Thus Korean L2ers should produce only bare non-heads and should learn plural-marked non-heads only late or not at all.

3.4 Autonomous Induction Theory (AIT)
The Autonomous Induction Theory (AIT) is a theory of second language acquisition which integrates speech perception and language processing frameworks with structural representation-building into SLA (Carroll 2001, 2002, 2004). Like all approaches to language acquisition, this learning theory must make assumptions about the functional architecture of language and about the nature of speech and language processing. It builds on the tri-partite functional architecture of language proposed by Jackendoff (1990, 1996, 1997, 2002), an approach to linguistic cognition which postulates that phonetics/phonology, morpho-syntax, and semantics are cognitively modular. Modular systems of processing create autonomous representations. Accordingly, the AIT postulates that linguistic representations are acquired as the result of interactions across these autonomous levels of linguistic components. It also assumes that novel linguistic representations are created from existing linguistic endowment, which includes symbolic, language-specific elements, such as phonological or morpho-syntactic features, along with principles of category-formation, and constraints there on, provided by UG (Universal Grammar). The difference from other generative L2 accounts is that the content of representations reflects both structural and frequency properties of language. Like the Unified Competition Model, and consistent with much research on bilingual processing, the AIT assumes that both the content of L1 representations and language-specific (L1) parsing procedures will transfer to the task of forming initial L2
representations. For example, even on first exposure to a second language, L2 speech samples can automatically activate L1 words (Carroll 2012, 2013, 2014). The AIT proposes therefore that as L2 language acquisition takes place and as L2 learners develop parsing procedures appropriate to L2 stimuli (based on their newly formed L2 representations), L2 parsing procedures will compete for activation with L1 procedures (Carroll 2002, 2004). This not only explains specific types of errors in L2 processing (Bates & MacWhinney 1981, Cutler et al. 1986; Cutler 2010), it explains the fact that SLA processing is often much slower than processing in the native language (McDonald 2006, Gollan et al. 2008; Hopp 2010). Entrenched L1-specific perceptual and processing procedures are often the starting point for analyzing L2 input and an important part of L2 learning involves learning novel L2 processing procedures, such as procedures which will permit English NSs to process verbs in sentence-final position in languages like German, Japanese or Turkish or procedures which will permit Koreans to process determiners and plural-markers. The challenge for any theory of SLA, however, is not to explain transfer of L1 processing procedures or the content of L1 representations to the L2, it is to explain how L2ers create completely novel representations appropriate to the L2, if they, in fact, do. The AIT proposes that some novel L2 learning problems can be solved while others will not be.

The following sections will illustrate how the AIT works and how it predicts learning plural non-heads by L2ers.28

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28 Thus, Carroll (1989) has suggested that in L1 acquisition of French, for prosodic reasons, the sound forms of L1-words will come to include a left-edge syllable slot that, at least in some cases, will be filled by the phonetic content of what will ultimately be a determiner (un/une or le/las). See Allen (1985). As the child’s vocabulary grows, this left-edge slot will be re-analysed as a recurrent form that is not present for phonological reasons. Its presence will trigger a grammatical analysis, by hypothesis one which results in the encoding of a gender feature (say [+/- feminine]), perhaps along with a phonological analysis of the right-edge of the word (Harley 1989; Meisel submitted). This feature will then be automatically activated subsequently during sentence processing (Grosjean et al. 1994). Carroll then speculates that even as early as 4 years of age, however, Anglophone children in French immersion will segment French nouns by stripping off the determiners (because this is what their English-based parsing procedures require), meaning that their lexical entries will not encode any direct marking of gender that can be automatically activated during lexical processing. However, according to Carroll (p.c., 2014) this does not prevent
3.4.1 I-learning, processing assumptions and correspondences

The transfer of L1 processing procedures frequently leads to L2 parsing failure. The evidence for this involves everything from failure to detect specific sounds, through the failure to know what a new word means or what grammatical category it belongs to, to the failure to analyse and interpret inflections because either no morpho-syntactic representation has been formed or else it cannot be activated and processed fast enough (Clahsen & Felser 2006; Clahsen et al. 2010).

According to the AIT, when transferred L1 parsing procedures “do the job” in that they lead to lexical activation, morpho-syntactic and semantic analysis, then no learning will occur. This hypothesis explains how speakers of a particular dialect may be able to correctly understand and respond to speakers of a distinct dialect without actually learning that dialect. It will also explain instances where speakers of distinct E-languages (say, Swedish and Norwegian, or Spanish and Portuguese) can communicate, each in his or her own language, without becoming bilingual (Braunmüller 2002; Werter 2002, in press). In other words, when the L2 activates L1 lexical entries (both lexemes and functional categories), parsing can lead to the creation of accurate conceptual representations. When this parsing fails, communication will not be possible and i-learning must begin if the situation is to change. I-learning is defined as follows. “I-learning is a process that leads to the revision of perceptual and parsing procedures so that they can analyse novel stimuli made available to the organism through the perceptual systems…. I-learning changes procedures that result in unit detection and unit storage, word recognition and sentence parsing. I-learning is simultaneously an encoding process capable of altering parsing procedures

Anglophones from incrementally segmenting and storing phonological sequences likes [ynmuʃ] une mouche ‘a fly’, [lamuʃ] la mouche ‘the fly’, [ynmuʃvɛʁt] une mouche verte ‘a green fly’ and so on, gradually building up a large list of stored forms that will do the job of producing “correct” gender markers. This ersatz representational system will not, however, include morpho-syntactic gender categories or features, assumed to be inaccessible after a critical period. See Meisel (2010).
so that they can construct representations” (Carroll 2002: 229). Since proficiency changes over time, given both adequate input and opportunities to practice both listening and speaking skills, how a learner changes his/her processing procedures by adjusting mental representations depends on the assumptions one makes about both what processing procedures are doing and what kinds of representations they compute. In Jackendoff’s tripartite Parallel Architecture (2002), two basic types of processor are assumed to operate: integrative processors build linguistic representations (acoustic, phonological, morpho-syntactic or conceptual representations) within a modular sub-system, and, correspondence processors, which equate (formally co-index) linguistic units across autonomous levels of representation. Thus, for example, there is an integrative processor that builds a morpho-syntactic representation during comprehension from activated words. Essentially, it combines morphemes into phrases and sentences through unification of features. The relevant morphemes will be co-indexed to prosodic words that are (part of ) the output of prosodic parsing and which are linked to corresponding morphemic representations by correspondence rules that associate prosodic words to morphemes (in the construction of lexical entries). During speech production, a distinct integrative processing will construct a morpho-syntactic representation this time using as inputs, concepts made available from a conceptual representation through concept-morpheme correspondences. Thus, minimally, there are five integrative processors (two each for prosodic parsing and morpho-syntactic parsing, and one for building conceptual representations). Correspondence processors essentially equate units in distinct modules. Correspondences are required to ensure that a Prosodic Word or Prosodic Phrase, outputs of the Prosodic Structure rules, can be “read” by the Syntactic Structure rules. However, these Syntactic Structure rules only read morpho-syntactic features and units. Accordingly, prosody/morpho-syntax correspondences are needed to turn processing “outputs” at one level into processing “inputs” at another level. This is handled formally simply by co-indexing autonomous units in the
independent structures. Figure 3.1 gives a simplified idea of how the Parallel Architecture is organized.

![Figure 3.1 The Parallel Architecture (Culicover & Jackendoff 2005)](image)

To re-phrase the matter, integrative processors integrate processor-specific features and constituents to create hierarchical structures and read the relevant input from the correspondence processors. For example, configurations like [+N, -V, COUNT] cannot be read by the phonological processor as input but are read by the morpho-syntactic processor. Because each processor is modular, it accepts an extremely restricted kind of input. Any information that cannot be expressed in a correspondence equation (by a correspondence processor) will not be “passed on”. The system is thus severely constrained in the way it works. To illustrate, let us return to an issue discussed briefly above. Anglophones have severe difficulties learning French gender (Carroll 1999a,b; Sabourin 2003, inter alia). According to Carroll (1989), to be relevant for grammatical agreement processes in the syntax, morphemes belonging to distinct gender classes must bear some kind of diacritic marking (i.e., a gender “feature”). Features on a head noun will then trigger agreement on a limited number of agreeing categories (which, in French, include determiners, adjectives, passive participles, relative pronouns, and personal pronouns) under specific syntactic conditions (which vary depending on the agreeing category and which include
in some cases c-command\textsuperscript{29}). If Anglophones acquire French gender, then their L2 grammars will exhibit the relevant morpho-syntactic constraints on agreement and locality of agreement. In other words, it is not enough to show that Anglophones can comprehend or produce concatenated sequences of French sound forms, such as [latabl] \textit{la table} ‘the table’ or even [latablvert] to show that they have acquired French gender. One needs to show that they have constructed morpho-syntactic representations of the same words and have actually represented the morpho-syntactic constraints on gender agreement. To the best of my knowledge (p.c. Carroll 2014), no L2 studied has actually investigated whether Anglophone L2 grammars meet these constraints. Given the considerable variability in gender marking that shows up in the speech of Anglophone L2 learners of gendered languages, it is at least plausible to postulate that the relevant morpho-syntactic features and constraints have become inaccessible. In short, representational deficits are predicted by the modularity of the tri-partite modular architecture.

To date, the AIT has not gone much beyond discussion of various aspects of word learning. In Jackendoff’s Parallel Architecture, “a lexical item can be seen as a correspondence between well-formed fragments of phonological, syntactic, and conceptual structure” (Jackendoff 2002: 11). The AIT therefore conceptualizes words such as \textit{a book} and \textit{books} as represented in memory\textsuperscript{30} as in (26) (Carroll & Widjaja 2013).

\textsuperscript{29} A category $a$ $c$-commands a category $\beta$ iff the first branching category dominating $a$ also dominates $\beta$ (Reinhart 1983). Notice that c-commands regulate morpho-syntactic processes; it is not known to be relevant to either prosodic processes or conceptual ones.

\textsuperscript{30} Each of these configurations in (26) and (27) is simplified for expository purposes.
(26) a. *a book*

\[ PW_i \leftrightarrow NP_i \leftrightarrow \begin{cases} \text{BOOK} \\ \text{INDEF}_j \end{cases} \]

\[ \sigma \quad \sigma \quad [+] \text{Count} \]

\[ \sigma \quad [+] \text{Singular} \]

PW = Prosodic Word, Cli = Clitic, \( \sigma \) = Syllable

The left diagram displays a prosodic word and the middle shows morpho-syntactic properties. The rightmost diagram indicates the word’s conceptual structure based on Conceptual Structure Semantics (Jackendoff 1983, 1990). As the diagrams make clear, cross-level correspondences are expressed across the three levels by indices such as i, j and k. For example, the clitic contained within the Prosodic Word in (26a) maps to the Determiner morpheme in the morpho-syntactic structure (26b). This is expressed through the index “j”. The Determiner, morpho-syntactic category, in turn maps to a conceptual structure shown on the right in terms of a concept INDEF(INITE)\(^{31}\). Similarly the Prosodic Word [b\( \tilde{\text{u}} \text{k} \)] maps to the syntactic category Noun, which bears a [+Count] feature. In turn, this feature will be read in the Conceptual Structure as an AMOUNT whose value “1” is provided by the feature [+Singular].

Conceptual Semantics makes significant use of ontological categories used to classify entities we perceive and experience (e.g., THING, PERSON, PLACE, EVENT, PATH, etc.). For

\(^{31}\) Thus, Jackendoff treats the contrast between indefinites and definites in the semantics, not in the morpho-syntax.
example, when we speak about “individuating” entities in visual perception, that is seeing something as a bounded object, as opposed to a heap or glob of “stuff”, Conceptual Structure Semantics captures this fact by postulating that we construct a THING-conceptual category. “Stuff” would correspond to a distinct conceptual category SUBSTANCE. Thus, English mass syntax (bare nouns) will map, in part, to the ontological category SUBSTANCE, while count syntax (determiners, numerals, plural-marking etc.) will map to THING-concepts.

According to Jackendoff (1983), we infer meaning in visual input on the basis of pre-existing conceptual categories. He argues (based on an analysis of deixis, which has a rich set of ontological categories expressed through the same words this, that) that language learning depends on a rich set of ontological categories that are provided as semantic primitives, “corresponding to different categories of projected entities” (Jackendoff 1983: 56). The L2 acquisition literature suggests that learners can make use of such conceptual structures to correctly interpret what they hear even in the absence of correct morpho-syntactic representations (MacDonald 2010).

3.4.2 Predictions
Korean L2ers will transfer the meaning of the Korean plural when processing L2 input. More precisely, this means that -tul - Conceptual Structure correspondences will transfer. These will not be identical to (26b) because the Korean plural marker is not comparable either semantically or syntactically to the English plural. Precisely where the English Plural morpheme and -tul differ, Koreans will need to learn new distributions (new constraints on position and structural combinations) and new correspondences if they are to acquire native-like English competence. Additionally, universal primitives (features, unification of features, and constraints on unification such as X-bar theory) will be available as these are both provided by Universal Grammar and
instantiated in the L1 grammar and processing procedures. Because plural non-heads are not permissible in Korean (and hence will not be transferred), and are infrequent in the L2 input, the AIT, like other input-based approaches to SLA predicts that they will be hard to learn. However, stating that a phenomenon is hard to learn entails that it is at least learnable in principle. Learning non-head plurals would require three things: (i) that Koreans be able to accurately encode the regular Plural morpheme -s as an Affix in a Prosodic Structure (see (26b); (ii) that this Prosodic Structure consists of three Prosodic Words (see (27) below); that the Affix dominating the consonant [s] be indexed to a Plural morpheme in the Morpho-syntactic Structure (see (26b) and (27)); (iii) that both the Affix and the Plural morpheme be indexed to the relevant numerical concept in the Conceptual Structure. If plural non-heads in noun compounds denote KINDs, they are represented by ontological categories but lack such indices (Carroll & Widjaja 2013).

(27) an admissions office

There are independent prosodic constraints that Koreans must overcome, namely that Korean does not permit consonant clusters within the syllable (Kim 2002), and they insert vowels when perceiving English words (e.g., /ˈbrʌŋk/ ‘brunch’) as loanword phonology studies have shown (Kang 2003, 2010, 2011; Heo 2010), this problem would have to be solved before Koreans would
be expected to encode plurals inside of compounds. This permits a testable prediction, namely that all Korean learners of English who do mark plurals on non-heads should show clear evidence of having mastered the regular English plural on simple nouns.\(^{32}\) In the literature that I have reviewed, plural non-heads are regarded as infrequent constructions (Gordon 1985; Haskell et al. 2003; Ramscar & Dye 2011). I assume that this is a claim about types, and that even L2ers may encounter individual words that illustrate the construction if those tokens are frequent (e.g. *Parks Canada, rewards program, frequent flyer points program*, etc.). A Google search\(^{33}\) reveals that English speakers do allow both bare non-heads and plural non-heads in the very same compounds (e.g. *admissions office/admission office, or enemy list/enemies list*). We might therefore establish frequency counts for various compounds of this sort and base our predictions on what Koreans learn of such counts. While such research can be informative in providing us with some grounds for speculating about the likelihood of Koreans being exposed to a given word, they are no substitute for tests of vocabulary knowledge. This is because, as Carroll (2005) indicates, what learners are in fact sensitive to reflects the internal organization of their current mental grammar. Extant mental representations provide the basis for the learner’s processing procedures. Accordingly, from the fact that some English morpheme, such as the regular Plural -s is obligatory and frequent in just about any sizable corpus of English text, we must not infer that learners can actually process and represent it. These are facts that second language acquisition research must first establish, and then provide a plausible account of how the learner has constructed the correct mental representations.

\(^{32}\) Alternatively, we predict that Koreans would only mark the regular Plural morpheme on English nouns that end in vowels, a distribution that should also appear on the compounds.

\(^{33}\) Google Trends (www.google.com/trends) is used to analyze a portion of Google web searches to compute how many searches have been done for the words that people enter, relative to the total number of searches done on Google over time.
Chapter 4: Experiment 1 – A forced-choice study

4.1 Research questions

One area of language acquisition known not to be subjected to a critical period is word learning. We continue to learn words in our native languages long after our knowledge of grammar and sound has reached stasis. This suggests that adult L2 learners should readily learn L2 words. However, current linguistic theories tell us that grammars do not consist of lists of words, on the one hand, and rules of grammar, on the other. On the contrary, specific properties of words are embedded as knowledge of grammar that, in turn, represents systematic grammatical contrasts. In this regard, my two experimental studies try to show whether learning plural non-heads is a rather simple process of associative learning or a complex process of mapping linguistic features and properties into different linguistic modules to adult L2ers.

As to learning plural non-heads, there has been little agreement and contradictory findings in first language acquisition studies. Gordon (1985), on the one hand, argued that the regular-irregular plural non-heads dissociation is universal. On the other hand, Ramscar & Dye (2011) demonstrated that Gordon’s experiment had a design flaw and results could be explained as a priming effect. They concluded that English NSs dislike plural non-heads in general regardless of the regularity of the plural inflection. L2 experimental studies that have replicated Gordon’s experiment (1985) have shown that the constraint of regular plural non-heads is not universal and L2 participants’ L1 affects their performance.

As we saw earlier, the question of how English NSs constrain the presence of regular plural non-heads has not been thoroughly investigated. Figuring out how English NSs process non-heads will establish a necessary first step, that is, in fixing the L2 target and in providing a baseline against which to measure what L2ers do and do not learn. Korean exhibits similarities
and differences to English in terms of number and compounding, so it will be interesting to see whether the constraints, if any, are learnable and if it is not, what factors explain failure to learn them.

This study seeks to answer two main research questions:

(1) How do native English speakers and Korean second language learners analyze bare non-heads and plural non-heads? Does the difference between the two non-heads constrain how native English speakers process compounds? These questions can be broken down into two sub-questions:

(1a) Bare nouns are semantically ambiguous; do participants analyze them as uninflected forms or as singular nouns? As we saw earlier, English bare non-heads denote KINDs while Korean bare nouns can be singular or plural or KINDs depending on context. If Koreans transfer their L1 knowledge to the task of parsing and interpreting English, they may arrive at somewhat different interpretations to those of native speakers.

(1b) Plural noun non-heads semantically could denote both KINDs and multiple INDIVIDUALs. How do they interpret plural non-heads? Do native English speakers and Korean second language learners whose mother tongue has an optional plural marker prefer bare noun non-heads over plural ones? If Koreans transfer their Korean plural, they may show a different pattern to that of native speakers.

(2) When do participants prefer plural non-heads? Is the selection of plural non-heads affected by linguistic properties? Specifically, by (a) sub-classes of non-heads (count, flexible and collective nouns) (b) morphological type of compounds (synthetic vs. root compounds) (c) structural type of compounds (compounds vs. phrasal compounds) (d) type of inflection of non-heads (regular vs. irregular) (e) ontological category of non-heads (non-THING (HUMAN, ANIMAL) vs. THING).
4.2 Hypotheses

To see how participants process bare non-heads and plural non-heads and what factors affect them, Experiment 1 was designed to explore how participants process a picture denoting either a single object or multiple objects with two given written linguistic stimuli: bare non-head compounds and plural non-head compounds.

Before going into hypotheses, I will introduce two processing assumptions used in my study. First, people must arrive at two representations from pictures and language which have to be integrated. I will assume that people first construct spatial structures by seeing a picture then they can map them to given linguistic stimuli (Jackendoff 2002). According to Jackendoff (1983), to understand what the referent is in This is my pen, we cannot rely on the sense of this since it means different things. Rather, we infer meaning based on visual input and then represent the meaning of the referent as THINGs. When we look at a dog or the picture of a dog, we experience the dog with specific properties such as size, shape and colour and this experience can be affected by the viewer’s internal state or knowledge. In looking at the picture of a dog, we construct spatial structures (Jackendoff 2002, cited in Carroll & Widjaja 2013). I will assume that participants have the correct inference from the given picture which has either single or multiple objects and it also can be encoded into a conceptual structure of the given written stimuli. Second, if the number of objects in the picture affects participants’ processing, I expect that their reaction times will be faster when there is a match (i.e. a congruent condition) or slower when there is a mismatch (i.e. conflict in given information). As for visual processing and word, a stroop test demonstrated that if color of an ink and a testing word denoting the colour is matched, reaction times were faster while reaction times were slower when mismatched (van Maanen et al. 2009). This effect was further found in a number study of Berent et al.’s (2005). The authors showed that Hebrew speakers took longer time to respond when the numerical number of words was
incongruent with their morphological number. By analyzing various response time studies, Townsend & Bever (2001) claimed that semantic information is available in an early stage of processing and semantic plausibility led to faster response times. Further, they argued that semantic information is processed before well-formedness constraints. On the basis of these findings, I will assume that if the number of objects depicted in a picture affects their processing, we could also find a reaction time effect which can speed up (i.e. congruence) or slow down (i.e. incongruence) participants’ performance.

Now, let’s turn to hypotheses. First, the findings of previous L1 and L2 studies (Gordon 1985; Lardiere 1995; Cunnings 2003) suggest that English NSs did not use regular plural non-heads while they use a small number of irregular plural non-heads. L2ers, however, included more plural non-heads compared to English NSs. One possibility is that the same patterns will be found in Experiment 1. However, if English NSs use plural non-heads, we need to find what factors make them favour plural non-heads over bare non-heads. Different linguistic factors affect the use of plural non-heads. Recall that the Korean plural marker -tul denotes multiple entities and tends to combine with nouns denoting HUMAN and vague number expressions. The AIT predicts that Korean L2ers will transfer L1 semantic and statistical properties of the Korean plural marker. At the same time, if the construction is learnable as the AIT predicts, we could find similar performance patterns in using non-heads between English NSs and KL2ers. However, if the Unified Competition Model is correct, KL2ers will prefer bare non-heads most of the time.

Second, considering the fact that there is no consensus on how both bare non-heads and plural non-heads map to semantic representations, I make assumptions based on what we have discussed so far. If bare non-heads are considered as singulars by English NSs (Haskell et al. 2003; Ramscar & Dye 2011), their response latencies (RT) should increase when there is a mismatch between what is presented visually and what is processed semantically. In other words,
the RTs of English NSs will increase when a picture of multiple objects is displayed with bare non-heads in comparison to a control condition. If plural non-heads denote multiple entities, RTs should decrease in comparison to a control condition when the picture of multiple objects is presented. As for KL2ers, they might not show the same RT effects if they transfer their L1 knowledge, that is, knowledge that Korean bare nouns can denote both single entities and multiple entities. Thus, the picture type might not help KL2ers to process bare non-heads faster when the picture of a single entity is presented. The incongruence effect nevertheless ought to be found when K2L2ers process plural non-heads with a picture of a single entity.

4.3 Participants

19 native speakers of English and 18 Korean learners of English participated in this study. All English speakers were recruited through the LING 203 class pool34. The Korean learners were recruited through advertisements posted on the University of Calgary campus and at a Korean website in Calgary. All Korean subjects participated voluntarily in the experiments. In return for participation in the study, I provided Koreans with editing services or a campus tour. The recruitment of participants, and the methodology and design of the study were approved by the Conjoint Faculties Research Ethics Board of the University of Calgary35.

4.3.1 English subjects

The 19 English-speaking participants were all native speakers of Canadian English speakers, aged between 18 and 39 (M = 21.7). There was 1 male and 18 females, all born and raised in Canada.

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34 Subjects can receive course credit for participating in linguistics experiments in this class.
35 The CFREB file number is 7537.
4.3.2 Korean subjects

The 18 Korean learners of English ranged in age from 21 to 40 (M = 28.3; 8 male; 10 female). English proficiency levels ranged from lower to upper-intermediate, as established by scores on the Oxford Placement Test\(^{36}\). All participants reported that the language they spoke at home with their families when they were children and as adults was Korean. They allocated time to read books, watch TV shows and talk with friends in both English and Korean almost equally, except for watching news which they preferred to do in Korean. Table 4.1 summarizes subject data with their second language experience.

Table 4.1 Korean subject profile

<table>
<thead>
<tr>
<th>Age</th>
<th>Sex</th>
<th>Age of first exposure</th>
<th>Length of Study (yrs)</th>
<th>Length of residence(^{37}) (mths)</th>
<th>Current exposure to English /wk (hrs)</th>
<th>Proficiency levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>range: 21-40 mean: 28.3</td>
<td>M: 8 F: 10</td>
<td>range: 7-23 mean: 12.6</td>
<td>range: 2-15 mean: 10.7</td>
<td>range: 1-72 mean: 24.8 (= 1 year)</td>
<td>range: 0.5-80 mean: 20.3</td>
<td>lower intermediate: 12 upper intermediate: 6</td>
</tr>
</tbody>
</table>

One thing to note is that Korean English education focuses on reading skills and grammar rather than listening, speaking and writing skills. Students are required to memorize grammatical patterns and rules in public school systems.

4.4 Experimental design

The first experiment used a forced-choice task and was designed to see how English NSs

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\(^{36}\) The test consists of 100 listening questions and 100 grammar questions.

\(^{37}\) This column shows the length of residence in an English-speaking country.
interpret non-heads and whether KL2ers process number in compounding. Experiment 1 tested findings from previous studies such as the dissociation of regular and irregular plurals, the meaning of bare non-heads and morphological types in compounding. In addition, to investigating how KL2ers’ L1 affects their learning of L2 complex construction, the ontological category of non-heads was also included as a variable.

In my study, English NSs and KL2ers chose between two visually presented written stimuli either with bare non-heads or plural non-heads (e.g., baby caregiver vs. babies caregiver), while simultaneously looking at a picture. The picture depicted a single non-head item (e.g., one baby) or multiple non-heads items (e.g., more than one babies). The logic of the experiment is that participants ought to construct a semantic representation based on the information in the picture and then use the contents of that semantic representation to choose between the two written variants. The order of the two experiments was counter-balanced for both English NSs and KL2ers.

4.4.1 Procedures

All testing was done in the Second Language Studies lab located in the Language Research Centre of the University of Calgary. Participants were given a brief description of the experiment and signed an ethical consent form. They also filled in a questionnaire answering questions on their sex and age, and the languages that they spoke if they were native English speakers. While Korean learners additionally answered questions on previous and current language learning experiences including age of first exposure to English, length of residence in an English-speaking country, and hours of exposure to English and Korean. After that, Korean participants completed

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38 To eliminate possible bias from stress or pause of an experimenter (Gordon 1985; Alegre & Gordon 1996), only visual cues were provided.
the Oxford Placement Test to establish their proficiency levels.

The experimental task was computer-controlled, using the E-prime platform 2.0 to present the visual stimuli. Instructions were presented in written English. The first experiment consisted of two phases. In the first phase, participants sat at a computer console and then completed a simple training session which was designed to help participants understand the task. They saw a picture and chose a word that describes the picture by pressing either the F1 key (if they preferred the written stimulus on the left-hand sign of the slash bar) or the F12 key (if they preferred the written stimulus on the right-hand sign of the slash bar). In the second phase, the targeted stimuli were presented. In Experiment 1, participants decided which word was more appropriate to describe the picture presented. Participants looked at a picture of a single object or a picture of multiple objects with two visual stimuli under the picture: bare noun non-head compounds and plural noun non-head compounds. They saw one picture with two words on a screen at a time. Once they completed their selection, the next item was automatically displayed to participants.

Stimuli consisted of 128 trials: 64 trials for a picture of a single object and 64 trials for a picture of multiple objects with two written testing items below the presented pictures. Items were randomized per subjects by E-Prime in the experiment and the order of written testing items on each picture was counter-balanced\(^{39}\). Reaction time was recorded.

\textbf{4.4.2 Stimuli}

Microsoft clip art images and Photoshop brush tools were used to create 128 visual stimuli with the added linguistic stimuli. As noted, according to the logic of the task, participants must

\(^{39}\) Linguistic stimuli (i.e. written stimuli) were embedded in pictures when I created them in Photoshop. When I created testing items, the order of linguistic stimuli manually randomized and this information was encoded in E-Prime 2.0.
construct a semantic representation of single or multiple objects based on the pictures and then compare this representation to an independently constructed representation of the possible meanings of the written labels presented beneath the pictures. Accordingly, each picture presented either a single object contrasted with a picture showing multiple objects of the same kind (i.e. non-heterogeneous items). Sample pictures are given in Figure 4.1. See Appendix 1 for more sample pictures. Participants either saw a written version of a compound with a single object or multiple objects or saw a written version of phrasal compounds with single/multiple objects. As these examples (c) and (d) show, the size of the single object/multiple objects was not always the same in some examples 40.

40 If a participant preferred the bigger picture, he would systematically select the single object. However, this tendency was not found.
c. A phrasal compound with a single object  
d. A phrasal compound with multiple objects

Figure 4.1 Picture examples from Experiment 1

The linguistic stimuli were sub-categorized as follows. Morphologically, they were divided into two compound types: root compounds and synthetic compounds. Structurally, they were divided into compounds (e.g. injury list) and phrasal compounds (e.g. national engineers institute). As for the sub-classes of non-heads, they were sub-classified as count nouns including both irregular and regular inflections, flexible nouns and collective nouns. Flexible noun non-heads were included to see whether count syntax (i.e. -s) plays a role in the preference of specific non-head types. If plural noun non-heads semantically denote multiple individuals, we might find that flexible nouns with count syntax are preferred as non-heads when a picture denotes multiple entities. If plural non-heads semantically denote something else, we might not find any effect with flexible nouns. As Senghas et al. (2007) showed, a collective interpretation (i.e. when a noun is interpreted as a GROUP) can increase the acceptance of regular plural non-heads. If this is consistently found with collective nouns, plural collective nouns can be preferred as non-heads as Sproat (1985 cited in Senghas et al. 2007) suggested. As for count nouns, both regular and irregular non-heads are included as testing factors to see whether the dissociation is found in a task other than the elicited production task or a grammaticality judgment task. Lastly, the
ontological category of non-heads was included to see whether KL2ers transfer their L1 statistical pattern of the plural marker to process plural non-heads. It was categorized into THING vs. non-THING then into HUMAN and ANIMAL within non-THING. All linguistic stimuli were presented in a set of bare non-head compounds and plural non-head compounds with either a picture of a single object or multiple objects, namely, the same set of linguistic stimuli were used with two different picture types. The linguistic stimuli used in Experiment 1 and the details of their structures are given in Tables 4.2 and 4.3.
Table 4.2: Root compounds stimuli list

<table>
<thead>
<tr>
<th>Compound type</th>
<th>Sub-classes of non-heads</th>
<th>Inflection</th>
<th>Ontological category of non-heads (# of stimuli)</th>
<th>Linguistic stimuli</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Compound</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Count noun</td>
<td></td>
<td>Regular</td>
<td>Human (4)</td>
<td>Injury(s) list</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Nurse(s) education</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Animal (4)</td>
<td>Turtle(s) fishbowl</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Rabbit(s) shoes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Thing (4)</td>
<td>Printer(s) shelf</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Toy(s) basket</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Irregular</td>
<td>Human (4)</td>
<td>Fisherman (fishermen) gloves</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Alumnus (alumni) association</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Animal (4)</td>
<td>Mouse (mice) alert</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ox(en) thief</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Thing (4)</td>
<td>Stimulus (stimuli) design</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Aquarium (aquaria) pamphlet</td>
</tr>
<tr>
<td></td>
<td>Flexible noun</td>
<td>N/A</td>
<td>N/A (4)</td>
<td>Stone(s) wall</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Chocolate(s) cafe</td>
</tr>
<tr>
<td></td>
<td>Collective noun</td>
<td>N/A</td>
<td>N/A (4)</td>
<td>School(s) booklet</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Audience(s) assessment</td>
</tr>
<tr>
<td><strong>Phrasal compound</strong></td>
<td></td>
<td>Regular</td>
<td>Human (4)</td>
<td>National engineer(s) institute</td>
</tr>
<tr>
<td>Count noun</td>
<td></td>
<td></td>
<td></td>
<td>Devout Buddhist(s) books</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Animal (4)</td>
<td>Suspected kitten(s) thief</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Small squirrel(s) house</td>
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<td></td>
<td></td>
<td></td>
<td>Thing (4)</td>
<td>School bag(s) delivery</td>
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<td></td>
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<td></td>
<td>Big laptop(s) show</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Irregular</td>
<td>Human (4)</td>
<td>Nice fireman (firemen) helmet</td>
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<td></td>
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<td></td>
<td></td>
<td>Local milkman (milkmen) newspaper</td>
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<td></td>
<td></td>
<td></td>
<td>Animal (4)</td>
<td>On-line octopus (octopi) catalogue</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>Endangered cactus (cacti) project</td>
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<td></td>
<td></td>
<td></td>
<td>Thing (4)</td>
<td>New oasis (oases) expedition</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Statistical datum (data) analysis</td>
</tr>
<tr>
<td></td>
<td>Flexible noun</td>
<td>N/A</td>
<td>N/A (4)</td>
<td>Bean salad(s) party</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pink ribbon(s) cloth</td>
</tr>
<tr>
<td></td>
<td>Collective noun</td>
<td>N/A</td>
<td>N/A (4)</td>
<td>New department(s) news</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Black navy(s) jacket</td>
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<td><strong>The total number of stimuli</strong></td>
<td></td>
<td></td>
<td></td>
<td>64</td>
</tr>
<tr>
<td>Compound type</td>
<td>Sub-classes of non-heads</td>
<td>Inflection</td>
<td>Ontological category of non-heads (# of stimuli)</td>
<td>Linguistic stimuli</td>
</tr>
<tr>
<td>---------------</td>
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<td>-------------------------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td><strong>Compound</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Count noun</td>
<td></td>
<td>Regular</td>
<td>Human (4)</td>
<td>Baby(s) caregiver</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Volunteer(s) hirer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Irregular</td>
<td>Human (4)</td>
<td>Businessman(businessmen) trainer</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Alumnus (alumni) hirer</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Animal (4)</td>
<td>Goose (geese) breeder</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Mouse (mice) grabber</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Thing (4)</td>
<td>Tooth (teeth) cleaner</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Die (dice) crusher</td>
</tr>
<tr>
<td>Flexible noun</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A (4)</td>
<td>Cake(s) baker</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pie(s) purchaser</td>
</tr>
<tr>
<td>Collective noun</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A (4)</td>
<td>Team(s) coordinator</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Company(s) investigator</td>
</tr>
<tr>
<td><strong>Phrasal compound</strong></td>
<td></td>
<td>Regular</td>
<td>Human (4)</td>
<td>Soccer player(s) reporter</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Efficient newcomer(s) educator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Irregular</td>
<td>Animal (4)</td>
<td>Beautiful cat(s) feeder</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lovely horse(s) trainer</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Thing (4)</td>
<td>Big bed(s) cleaner</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Fountain pen(s) seller</td>
</tr>
<tr>
<td>Flexible noun</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A (4)</td>
<td>Cup cake(s) maker</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Final paper(s) reader</td>
</tr>
<tr>
<td>Collective noun</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A (4)</td>
<td>Consumer society(s) inspector</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Joint committee(s) adviser</td>
</tr>
<tr>
<td><strong>The total number of stimuli</strong></td>
<td></td>
<td></td>
<td></td>
<td>64</td>
</tr>
</tbody>
</table>
Token frequency\(^{41}\), number of syllables\(^{42}\) and letters\(^{43}\) were controlled in both heads and non-heads. In eliminating frequency differences in the non-heads between singular/plural forms\(^{44}\) and regular/irregular forms\(^{45}\), the results will not be affected by frequency itself. Accordingly, if a participant systematically selects compounds with irregular non-heads, we at least can say that their choice is not dependent on the frequency of the selected forms. As for the heads, root compounds are more frequent than synthetic compounds \((t(30) = 3.04, p = .004)\).

### 4.5 Coding of stimuli

A picture type (whether it denotes a single object or multiple objects) and the order of linguistic stimuli (whether bare non-heads were on the left or right) were coded in E-Prime. Since the order of linguistic stimuli was counter-balanced, I manually re-coded them when I analyzed data. If participants choose F1 (i.e. choosing the left word), it was coded as Bare (i.e. bare non-heads) and if F12, it was coded as Plural (i.e. plural non-heads).

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\(^{41}\) Frequency data of stimuli used in Experiment 1 is from a book written by Geoffrey et al. (2001). Their data were collected from the British National Corpus. There are no such data available for Canadian English. The Koreans were likely exposed to British English as a target rather than American English.

\(^{42}\) For the number of syllables of the non-heads (i.e. regular, irregular, flexible and collective nouns), there was no significant difference across non-heads \((F(2, 29) = 0.4, p = .66, n.s.)\). Head nouns of root and synthetic compounds also do not show any significance \((t(30) = -1.22, p = .23, n.s.)\).

\(^{43}\) As for the number of letters of non-heads (i.e. regular, irregular, flexible and collective nouns), there was no significant difference across non-heads \((F(2, 29) = 0.314, p = .73, n.s.)\). Head nouns of root and synthetic compounds also did not show any significance \((t(30) = -0.57, p = .58, n.s.)\).

\(^{44}\) T-test results for both regular and irregular non-heads in terms of plurality follow. Regular non-heads: \(t(14) = -1.021, p = .32, n.s.\) / Irregular non-heads: \(t(17) = -0.0419, p = .68, n.s.\) The results show that there are no differences between singular and plural forms of regular non-heads and irregular non-heads respectively. T-tests conducted on flexible and collective nouns with respect to plurality revealed that their singular and plural token frequencies are not significantly different from each other \((t(10) = 1.465, p = .17, n.s.)\).

\(^{45}\) T-test were conducted to see if there is any frequency difference between regular and irregular non-heads. Singular forms of regular and irregular: \(t(13) = 1.751, p = .10, n.s.\); plural forms of regular and irregular: \(t(20) = 0.769, p = .45, n.s.\)
4.6 Results for native English speakers

All English NSs selected one of the non-heads and no one exhibited a response bias such as systematically pushing only one of the keys. With respect to the type of non-head, English NSs tended to choose more bare non-heads (n=1735, 71.3%) than plural non-heads (n=697, 28.7%). This result suggests that Canadian English speakers selected more plural non-heads compared to other English NSs who hardly used any plural non-heads (Lardiere 1995; Cunnings 2003; Pilar & Mayo 2006). A generalized estimation equation (GEE) was used to see how independent variables (i.e. six criteria in my thesis) predict the binary categorical dependent variable (i.e. bare non-heads and plural non-heads). This statistical method is useful when there might be a possible correlation between outcomes, particularly if the responses are binary (Hanley et al. 2003). In my experiment, every participant had 128 trials thus their binary outcome possibly were correlated. The GEE also provides a post-hoc analysis, a pair-wise comparison of means of given factors.

A GEE revealed that morphological types of compounds, inflection type, the number of objects and the ontological category of non-heads were significant factors in opting for selecting plural non-heads as Table 4.4 shows.

Table 4.4 GEE results for plural non-heads selection (English NSs)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Type III</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wald Chi-Square</td>
</tr>
<tr>
<td>Inflection</td>
<td>57.522</td>
</tr>
<tr>
<td>NumObject</td>
<td>47.264</td>
</tr>
<tr>
<td>Ontological category</td>
<td>57.363</td>
</tr>
<tr>
<td>Compound type</td>
<td>5.061</td>
</tr>
</tbody>
</table>

df = degrees of freedom, Sig. = significance
To see whether the factors of each independent variable were significantly different from each other, the results of pair-wise comparisons were calculated as a post-hoc test\textsuperscript{46} See Table 4.5.

Table 4.5 Pair-wise comparisons of the factors of each independent variable (English NSs)

<table>
<thead>
<tr>
<th>Speakers</th>
<th>Independent variable</th>
<th>Mean difference</th>
<th>Std. Error</th>
<th>df</th>
<th>Bonferroni sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Compound type</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>root</td>
<td>.04</td>
<td>.016</td>
<td>1</td>
<td>.024</td>
</tr>
<tr>
<td></td>
<td>synthetic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inflection type</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>irregular</td>
<td>.26</td>
<td>.027</td>
<td>1</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>regular</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of objects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>multiple</td>
<td>.24</td>
<td>.039</td>
<td>1</td>
<td>.000</td>
</tr>
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<td>single</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Ontological category</td>
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</tr>
<tr>
<td></td>
<td>animal</td>
<td>-.14</td>
<td>.027</td>
<td>1</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>human</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>thing</td>
<td>.00</td>
<td>.024</td>
<td>1</td>
<td>1.000 (n.s.)</td>
</tr>
<tr>
<td></td>
<td>animal</td>
<td>.14</td>
<td>.027</td>
<td>1</td>
<td>.000</td>
</tr>
<tr>
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<td>human</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>thing</td>
<td>.14</td>
<td>.018</td>
<td>1</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>animal</td>
<td>.00</td>
<td>.024</td>
<td>1</td>
<td>1.000 (n.s.)</td>
</tr>
<tr>
<td></td>
<td>human</td>
<td>-.14</td>
<td>.018</td>
<td>1</td>
<td>.000</td>
</tr>
</tbody>
</table>

When we look at this pair-wise comparison data in detail, we find the following results. First, English speakers chose more plural non-heads with root compounds as the post-hoc test of a GEE showed ($p=.024$). Also see Figure 4.2. As noted, however, the frequency of root compounds was higher than synthetic compounds, thus we need additional data to see whether this variable is indeed a significant factor.

\textsuperscript{46} In this analysis, bare non-heads were treated as a reference category as the dependent variable is categorical and binary. Thus all post-hoc tests of a GEE will show which independent variables had a significant effect on selecting plural non-heads.
Second, GEE parameter estimates showed that for every one point increase in irregular plurals there is a 1.236 increase in the log odd of selecting plural non-heads compared to regular plurals. In other words, English NSs chose more plural non-heads when non-heads were irregular. This was further confirmed by a chi-square analysis\textsuperscript{47}. A chi-square analysis indicated that selecting non-heads was dependent on the regularity of inflection ($\chi^2(1) = 140.925, p=.000$). As Figure 4.3 shows, English NSs still chose regular plural non-heads 20\% of the time. Even though irregular plural non-heads were readily permitted in both compounds and phrasal compounds compared to regular plural non-heads, this result suggests that the Level Ordering Hypothesis did not correctly predict the performance of English NSs in Experiment 1.

\textsuperscript{47} A chi-square analysis is used to check either the goodness-of-fit of a model or the independence of two variables. In my analysis, all chi-square analyses were used to see the independence of two variables.
When we look at plural non-head data separately, English NSs chose plural non-heads 70% of the time when non-heads were irregular while they chose regular plural non-heads only 30% of the time. This disproportion was predicted by the Dual Route Model (Pinker & Prince 1997; Senghas et al. 2007) while connectionist analyses cannot account for this disproportion (Haskell et al. 2003; Ramscar & Dye 2011) as the frequency of inflection was controlled.
Third, the selection of non-heads was dependent on ontological category (THING vs. non-THING: $\chi^2(1) = 8.364$, $p=.004$ and HUMAN vs. ANIMAL: $\chi^2(1) = 27.981$, $p=.000$). As Figure 4.5 shows, participants selected plural non-heads when non-heads denoted non-THING.

![Bar chart showing non-heads selection](image)

Figure 4.5 Non-heads selection (ontological category: THING vs. non-THING - English NSs)

In the category of non-THING entities (see Figure 4.6), English speakers chose more plural non-heads referring to HUMAN as the post-hoc test of a GEE indicated ($p = .000$) in Table 4.5.
Finally, English NSs chose more plural non-heads when the picture described multiple objects as the post-hoc test of a GEE showed ($p = .000$) in Table 4.5. A chi-square analysis also confirmed that responses were dependent on the picture type ($\chi^2 (1) = 167.968, p = .000$). Interestingly, bare non-heads were highly preferred when the picture denoted a single object, as a GEE analysis revealed (wald chi-square = 47.264, df = 1, $p = .000$). However, when we consider the fact that English NSs chose plural non-heads with a picture depicting one object 17% of the time, we cannot claim that plural non-heads were not permitted. Their performance in this task favoured a singular interpretation when the picture showed a single object, suggesting that the bare form was analyzed as a singular form.

Figure 4.6 Non-heads selection (ontological category: HUMAN vs. ANIMAL - English NSs)
This preference was further confirmed by RT data\textsuperscript{48}. When the picture depicting a single object was displayed, English NSs were faster to choose bare non-heads than when the picture of multiple objects was presented ($t(1508) = 4.498, p<.000$). However, the picture with multiple objects did not make English NSs respond faster when selecting plural non-heads ($t(404) = 0.837, p=.40$, n.s.). See Figure 4.8. Overall, bare non-heads were responded to significantly faster than plural non-heads regardless of the properties of the picture types ($t(2338) = -9.52, p<.000$). In terms of selecting plural non-heads, English NSs tended to choose more plural non-heads when a picture depicted multiple objects even though the objects were non-heterogeneous (compared to Alegre & Gordon 1999b) but their RTs suggest that multiple objects in pictures did not help them to react faster.

\textsuperscript{48} Since RT data were not normally distributed, a log transformation was used on all RT data.
The other linguistic criteria that we discussed earlier were not significant predictors for English NSs: structural types of compounds (compounds vs. phrasal compounds) and sub-class of non-heads (collective, count and flexible nouns) were irrelevant to responding to stimuli in this experiment.

4.7 Results for Korean learners

No KL2ers exhibited a response bias by systematically pushing the key associated with only one of the non-head types. However, 30 responses were missing in Experiment 1 since participants did not answer within the given response time. Those non-responses were excluded from the
analysis. Recall that Korean phonology does not allow complex consonants. This possible L1 transfer effect did not affect their performance. Among 40 linguistic stimuli containing non-heads (24 irregular stimuli are excluded in the analysis), 9 stimuli ended in vowels. However, there were no Korean participants who consistently chose plural non-heads in words ending in vowels over words ending in consonants.

Surprisingly, unlike learners of previous L2 studies (Lardiere 1995; Murphy 2000; Cunnings 2003; Pilar & Mayo 2006), KL2ers showed nearly the same pattern as the English NSs when analyzing non-heads. The difference between the two participant groups regarding the selection of non-heads was not significant according to a GEE analysis (wald chi-square =0.249, df=1, p=.618, n.s.). The comparison data can be found in Table 4.6.

Table 4.6 The frequency data of non-head selection by group (percentage in parentheses)

<table>
<thead>
<tr>
<th>Speakers</th>
<th>Bare non-head</th>
<th>Plural non-head</th>
</tr>
</thead>
<tbody>
<tr>
<td>English Speakers</td>
<td>1735 (71.3)</td>
<td>697 (28.7)</td>
</tr>
<tr>
<td>Korean L2ers</td>
<td>1662 (73.1)</td>
<td>612 (26.9)</td>
</tr>
</tbody>
</table>

A GEE analysis revealed that only inflection and the number of objects in pictures had significant effects on plural non-heads choice as Table 4.7 shows.

Table 4.7 GEE results for plural non-heads: KL2ers

<table>
<thead>
<tr>
<th>Tests of model effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variables</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Korean Inflection</td>
</tr>
<tr>
<td>Korean NumObject</td>
</tr>
</tbody>
</table>
A post-hoc analysis of a GEE showed, the results of pair-wise comparisons were calculated as given in Table 4.8.

Table 4.8 Pair-wise comparisons of the factors of each independent variable (KL2ers)

<table>
<thead>
<tr>
<th>Speakers</th>
<th>Independent variable</th>
<th>Mean difference</th>
<th>Std. Error</th>
<th>df</th>
<th>Bonferroni sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Korean</td>
<td>Inflection type</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>irregular regular</td>
<td>.26</td>
<td>.027</td>
<td>1</td>
<td>.000</td>
</tr>
<tr>
<td>Number of objects</td>
<td>Independent variable</td>
<td>Mean difference</td>
<td>Std. Error</td>
<td>df</td>
<td>Bonferroni sig.</td>
</tr>
<tr>
<td></td>
<td>multiple single</td>
<td>.17</td>
<td>.047</td>
<td>1</td>
<td>.000</td>
</tr>
</tbody>
</table>

Figure 4.9 shows the general pattern of non-heads choice by the regularity of inflection for KL2ers.

The pattern of regular non-heads looks similar to that of English NSs ($\chi^2 (1) = 3.163, p=.075$, n.s.) as group comparison data also revealed (see Table 4.9). This result is interesting since KL2ers
disfavoured regular plural non-heads.

Table 4.9 Group comparison data: Non-heads selection (bare/regular plural contrast - percentage in parentheses)

<table>
<thead>
<tr>
<th></th>
<th>Frequency of non-heads selection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Korean learners</td>
</tr>
<tr>
<td>Bare non-heads</td>
<td>655 (77)</td>
</tr>
<tr>
<td>Plural non-heads</td>
<td>198 (23)</td>
</tr>
</tbody>
</table>

However the selection of irregular non-heads gives a different picture to that provided by the data of English NSs as a chi-square analysis showed ($\chi^2 (1) = 21.467, p=.000$). See Table 4.10 for the frequency data. KL2ers chose more bare non-heads compared to English NSs when an irregular plural was included in compounds and phrasal compounds.

Table 4.10 Group comparison data: Non-heads selection (bare/irregular plural contrast - percentage in parentheses)

<table>
<thead>
<tr>
<th></th>
<th>Frequency of non-heads selection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Korean learners</td>
</tr>
<tr>
<td>Bare non-heads</td>
<td>552 (65)</td>
</tr>
<tr>
<td>Plural non-heads</td>
<td>297 (35)</td>
</tr>
</tbody>
</table>

The results of the number of object in pictures showed that whether a picture denotes a single object or multiple objects was a significant factor when choosing plural non-heads as Table 4.8 showed. Again, numerical values inferable from the pictures showed a pattern similar to that of English NSs. See Figure 4.10.
However, a chi-square analysis revealed that this pattern was only applicable to the picture with a single object ($\chi^2(1) = 1.458, p = .227, \text{n.s.}$) but not to that multiple objects ($\chi^2(1) = 6.745, p = .009$).

In other words, Korean learners chose more bare non-heads than English speakers even when the picture depicts multiple objects as Tables 4.11 and 4.12 show.

Table 4.11 Group comparison data: Non-heads selection with a single object in pictures (percentage in parentheses)

<table>
<thead>
<tr>
<th></th>
<th>Frequency of non-heads selection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Korean learners</td>
</tr>
<tr>
<td>Bare non-heads</td>
<td>923 (81)</td>
</tr>
<tr>
<td>Plural non-heads</td>
<td>212 (19)</td>
</tr>
</tbody>
</table>
Table 4.12 Group comparison data: Non-heads selection with multiple objects in pictures

(percentage in parentheses)

<table>
<thead>
<tr>
<th></th>
<th>Frequency of non-heads selection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Korean learners</td>
</tr>
<tr>
<td><strong>Bare non-heads</strong></td>
<td>732 (65)</td>
</tr>
<tr>
<td><strong>Plural non-heads</strong></td>
<td>400 (35)</td>
</tr>
</tbody>
</table>

When it comes to KL2ers’ reaction times, their reaction times were in general slower than those of English speakers. This result is to be expected since L2ers are known to perform more slowly in their L2 than in their L1 (Favreau et al. 1980; Favreau & Segalowitz 1983) and to be slower than native speakers (McDonald 2006). In other words, both bilingualism and lower proficiency appear to correlate with lower response times on various kinds of psycholinguistic tasks. What is more important for us are the patterns of response. The Korean RT data (Figure 4.11) shows a pattern opposite to that of English NSs. The number of objects in pictures did not help them choose faster either bare non-heads ($t(1558) = 0.524, p=.60, n.s.$) or plural non-heads ($t(367) = 0.604, p=.547, n.s.$). See Figure 4.11. In other words, there was no difference which picture (either a picture of a single object or multiple objects) was presented to KL2ers when they processed bare non-heads. This was the same for when they processed plural non-heads. The pattern of bare non-heads might be due to the fact that Korean bare nouns can denote both a single entity and multiple entities (i.e. general number) thus the number of objects in pictures did not help them to react faster when there was a match between visual stimuli (= a single object) and linguistic stimuli (= bare non-heads). Overall, selecting plural non-heads took much longer than bare non-heads ($t(1062) = -6.654, p <.000$).
Ontological category was not a significant predictor for KL2ers, although they chose more plural non-heads when non-heads denoted HUMANs within a non-THING category as Figure 4.12 shows. This might be due to the Koreans using the Korean plural which tends to combine with HUMAN-entities rather than ANIMAL or THING-entities.
Finally, with respect to KL2er’s second language experience, the current second language exposure and grammar score had a significant effect on selecting plural non-heads as Table 4.13 shows.

Table 4.13 GEE results for second language experience of KL2ers

<table>
<thead>
<tr>
<th>Variables</th>
<th>Type III</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Wald Chi-Square</td>
<td>df</td>
</tr>
<tr>
<td>Current exposure to L2 per week (hr)</td>
<td>18.886</td>
<td>1</td>
<td>.000</td>
</tr>
<tr>
<td>Grammar score</td>
<td>16.498</td>
<td>1</td>
<td>.000</td>
</tr>
</tbody>
</table>

The parameter estimates in Table 4.14 revealed for every one point (in hours) increase in the current exposure to English there is a 0.28 increase in the log odd of selecting plural non-heads. This means that if KL2ers were exposed to more English, they tended to choose more plural non-
heads. The opposite pattern was found in grammar scores, namely, KL2ers chose fewer plural non-heads (resulting in a -0.74 decrease in selecting plural non-heads) when their grammar score increased. By hypothesis, bare non-heads should be preferred (Gordon 1985; Lardiere 1995; Haskell et al. 2003; Ramscar & Dye 2011), therefore we can say that KL2ers’ higher grammar score helps them to learn compound restrictions.

Table 4.14 Parameter estimates for plural non-heads selection (KL2ers)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>B</th>
<th>Std. Error</th>
<th>95% Wald Confidence Interval</th>
<th>Hypothesis Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lower</td>
<td>Upper</td>
</tr>
<tr>
<td>(Intercept)</td>
<td>1.877</td>
<td>2.8661</td>
<td>-3.740</td>
<td>7.495</td>
</tr>
<tr>
<td>First exposure</td>
<td>-.012</td>
<td>.0181</td>
<td>-.047</td>
<td>.024</td>
</tr>
<tr>
<td>L of Study</td>
<td>-.041</td>
<td>.0274</td>
<td>-.095</td>
<td>.013</td>
</tr>
<tr>
<td>L of Residence</td>
<td>.001</td>
<td>.0071</td>
<td>-.013</td>
<td>.015</td>
</tr>
<tr>
<td>Current exposure*</td>
<td>.028</td>
<td>.0071</td>
<td>-.013</td>
<td>.015</td>
</tr>
<tr>
<td>Listening score</td>
<td>.015</td>
<td>.0063</td>
<td>.015</td>
<td>.040</td>
</tr>
<tr>
<td>Grammar score*</td>
<td>-.074</td>
<td>.0181</td>
<td>-.109</td>
<td>-.038</td>
</tr>
<tr>
<td>(Scale)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.8 Discussion

With respect to English NSs, Experiment 1 showed that they prefer bare non-heads over plural non-heads but they did use plural non-heads over bare non-heads as opposed to what previous studies have shown (Gordon 1985; Lardiere 1995; Cunnings 2003; Pilar & Mayo 2006).

Considering the fact that there are existing compounds with plural non-heads, the results of Experiment 1 suggest that the constraints are gradient and not absolute (contrary to the Level Ordering Hypothesis). However, neither nativist accounts nor connectionist accounts can fully explain what was found in Experiment 1. First, we found that there is a dispreference for regular plural non-heads, namely, English NSs chose irregular plural non-heads significantly more than
regular plural non-heads (i.e. 70% vs. 30%). Even though Senghas et al. (2007) showed that irregular plural non-heads sound more natural than regular plural non-heads, the Dual Route model also cannot fully account for the findings in Experiment 1 since the model assumes that only irregular plural non-heads can participate in compounding. Connectionist accounts claim that both regular and irregular plural non-heads are dispreferred thus the preference for the irregular plural non-heads cannot be explained. In addition, the dislike of sibilant sounds (Haskell et al. 2003; Ramscar & Dye 2011\(^{49}\)) also cannot account for the results of Experiment 1 since English NSs use bare non-heads ending in sibilant sounds such as *mouse alert* and *nurse education*\(^{50}\). Why do English NSs sometime use plural non-heads and sometimes not? Alegre & Gordon (1999b) suggested that English NSs use regular plural non-heads if non-heads involve abstractness when head nouns are heterogeneous. However, the results of Experiment 1 showed that English NSs use regular plural non-heads even though the presented picture consisted of the same kind of non-abstract objects as in Banga et al. (2013). Even though English NSs preferred to treat bare non-heads as singular non-heads in my experiment, it is not clear how they interpret plural non-heads semantically.

Considering the gradient status of the constraint, I adopt Jackendoff’s (1983, 1989) preference rule system. Briefly, let’s see how this system works. One of central ideas is that if the meaning of a word is fuzzy (e.g. colour terms\(^{51}\)), such word involves a prototype. Accordingly, if there is a case deviating from the prototype, we can observe slowness, context-dependence and

\(^{49}\) Ramscar & Dye (2011) claimed that if the singular form is frequent, the likelihood of being a non-head is reduced. Accordingly, since irregular forms are more frequent than regular forms, regular forms will occur far more frequently in compounding than irregular forms. Thus, English NSs are sensitive to the sibilant sound in compounding according to their analysis.

\(^{50}\) English NSs chose bare forms of irregular non-heads and plural forms of irregular non-heads almost equally when non-heads end in sibilants: selecting of bare non-heads 52% of the time (n=239). As for regular plural non-heads (there was only one case in the stimuli), English NSs chose *nurse education* 68% of the time (n=26) compared to *nurses education*.

\(^{51}\) For example, even though *red* and *orange* have focal values there is no sharp dividing line between them because of a smooth transition of hues between the two.
variability of judgments. In addition, there are other cases which are typical but subject to exceptions such as the redness of apples. In this case, “since there are yellow and green apples, the redness of apples is a typicality condition… the typicality conditions for apple color specify a number of focal values, with red being most typical or highest valued” (Jackendoff 1983: 122). The question is how people judge when there are marginal cases. This question is directly linked to the question of what kinds of conditions decide whether the case is acceptable or not. Consider the example of a word like see (Jackendoff 1983, 1989). “The two preference conditions for x sees y are roughly that (1) x’s gaze makes contact with y, and (2) x has a visual experience of y. Stereotypical seeing, i.e. veridical seeing, satisfies both these conditions: x makes visual contact with some object and thereby has a visual experience of it” (Jackendoff 1989: 94). However, see in Bill saw a vision of dancing devils violates the condition (1) but still speakers can use a word see in the sentence. If the both conditions are violated (e.g., Bill saw a vision of dancing devils, but he didn’t notice it at the time) the use of see is not acceptable. Thus these two conditions from a preference rule system in which typical cases satisfy both conditions while less typical cases satisfy one of the conditions (Jackendoff 1989). We can assume that this can be applied to the linguistic phenomenon at hand. Bare non-heads can be a typical case of non-heads while plural non-heads can be preferred in some conditions. However, we do not know what would be the conditions that preference occurs with plural non-heads yet. Possibly, meaning of non-heads, the regularity of inflection, ontological category (HUMAN) can be conditions, but we need more data to find the proper preference rule system. Jackendoff also notes that his approach is not statistical and so makes no predictions about preferences based on, e.g., frequency in the input.

With regard to KL2ers, results suggest that they showed a pattern similar to that of

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52 Preference rules show up in many cognitive systems, for example one can find them in musical grouping, discussed in Jackendoff (1983). For examples, proximity, well-formedness, symmetry, similarity, prototype, etc.
English NSs. First, they disliked regular plural non-heads. Second, they chose plural non-heads over bare non-heads when the picture depicted multiple objects. Even though this pattern was not entirely the same as English NSs, nevertheless, the constraint is learnable as the AIT predicts. We also can find a L1 transfer effect when we look at RT data and the ontological category of non-heads. Again, this result is not predicted by the Unified Competition Model which posits no L1 transfer in terms of inflectional morphology. RT data showed that the number of objects in the picture presented did not affect KL2ers’ processing speed. It suggests that there might be an L1 transfer effect as Korean bare nouns can denote both single and multiple entities thus the number of objects did not help their performance while this effect was found in English NSs. In terms of proficiency, KL2ers’ L2 learning experience indicated that they got confused as they were exposed to more L2 stimuli while higher grammatical proficiency seems to help them learn the constraint.
Chapter 5: Experiment 2 – A phrasal compound study

5.1 Research questions

In Experiment 1, we found that irregular plural non-heads were preferred by English NSs over regular plural non-heads for both compounds and phrasal compounds. Is this effect due to the qualitative difference between regular plural and irregular plural (Pinker & Prince 1999)? On the one hand, Alegre & Gordon (1996) and Cunnings (2003) showed that the presence of regular plurals made English NSs prefer a recursive reading (= NP+N reading), claiming that this interpretation arises because regular plural is not permitted in English compounding. On the other hand, Ramscar & Dye (2011) showed that interpreting phrasal compounds depends on the semantic plausibility of combined words within phrasal compounds. This leaves us with inconclusive results. Experiment 2 attempts to clarify these two different findings. How do English NSs and KL2ers interpret phrasal compounds? This broad question can be broken down into two sub-questions as follows:

(1) Do English NSs and KL2ers choose a recursive reading on phrasal compounds due to a dislike of regular plural non-heads?

(2) If not, do English NSs and KL2ers follow the pattern of probabilities or meaning plausibility of combined words in phrasal compounds?

5.2 Hypotheses

As we saw in Section 2.3.2, Ramscar & Dye (2011) showed that a pre-nominal adjective occurring to the left of two nouns in phrasal compounds, as in modernized ducks farm or fat ducks farm, will vary in scope, depending on the plausibility of a given modification. Hence, modernized ( ) farm is the preferred interpretation (i.e. a non-recursive interpretation) over modernized ducks (i.e.
a recursive interpretation) but fat ducks (i.e. a recursive interpretation) is preferred over fat ()
farm (i.e. a non-recursive interpretation). Ramscar & Dye (2011) claimed that the plausibility of
the modification can account for the preference for a recursive interpretation, not the presence of
regular plurals in phrasal compounds as nativist accounts argued (Alegre & Gordon 1996; Berent
& Pinker 2007). As noted, however, we need both an implicit form of testing and better, non-
skewed, items such as torn receipt envelope (Berent & Pinker 2007) to see whether the presence
of regular plural plays a role in the preference for recursive interpretations. Accordingly,
compounds must be constructed with great care not to bias results for reasons that have nothing
to do with the morpho-syntax of plurality in compounds. I adopted in Experiment 2 a priming
task and controlled the frequency of combined words within phrasal compounds. Priming is the
name given to an effect of exposure to a word which speeds up behavioural responses to a related
lexical stimulus (Tulving & Schachter 1990). In lexical priming, a target word yields a faster
response after a context (e.g., a single word, complex words or even sentences) that is related
than after an unrelated context (Jones & Estes 2012). Among the various types of priming,
semantic priming was found by Meyer & Schvaneveldt (1971) who showed that participants
responded faster on a lexical decision task if the prime and the target words were semantically
associated (e.g. doctor-nurse) as compared to a pair of non-associated words (e.g. nurse-butter).
This effect has also been found when participants are not consciously aware that they have seen
the prime word, which happens when the prime is shown very briefly, less than 100ms (so-called
masked priming tasks; see Van den Bussche 2008 for a meta-analysis of existing semantic
masked priming studies). Masked priming studies of compounding with head/non-head priming
have demonstrated the same effect (Shoolman & Andrews 2003; Duñabeitia et al. 2009). There is
one study showing that masked compound words can prime target compound words regardless of
the position of the target word in the compound, i.e., either head or non-head (Duñabeitia et al.
In this particular study, the authors tested to see whether *postman* can prime *milkman* or *mankind* as well as in the case of non-heads (e.g. *milkman* priming *milkshake*). Non-heads-heads combinations were also tested (e.g., two Basque compounds *mendikate-sumendi* ‘mountain chain’-‘fire mountain’). Results showed a priming effect was found for all conditions which the authors accounted for by claiming that participants decompose constituents of compounding early and fast (Rastle et al. 2000; Rastle, Davis & New 2004; Duñabeitia et al. 2007). On the basis of these findings, I will assume that compound words can prime target phrasal compounds since they share constituents. Considering the nature of the task, I will also assume that if the meaning of the prime word leads to the activation of semantically related target phrasal compounds, reaction times to the phrasal compounds will be faster.

If the presence of regular plural is a key to interpreting phrasal compounds recursively (Alegre & Gordon 1996; Berent & Pinker 2007), speakers will prefer a recursive interpretation when regular plural occurs inside phrasal compounds regardless of semantic priming effects. However, if the presence of regular plural does not affect the processing of phrasal compounds but rather is dependent on the plausibility of the meaning (Ramscar & Dye 2011) or the frequency of combined words within phrasal compounds or the semantic priming effect, the strong preference for a recursive reading when regular plural present will disappear. In Experiment 2, the semantic prime word thus was a part of phrasal compounds (e.g., *modernized duck* was used as a recursive semantic prime word and *modernized farm* as a non-recursive semantic prime word for a phrasal compound word, *modernized ducks farm*). Therefore, if the exposure to the recursive semantic prime word affects the preference for a recursive interpretation, reaction times will be faster, accordingly, we can find a semantic priming effect.

As for the frequency effects, the sequence *jumping kangaroo* has higher frequency than *jumping specialist* in *jumping kangaroo(s) specialist*. If the frequencies of two different combinations of
words within phrasal compounds do affect the interpretation of phrasal compounds, we will find the frequency effects. In the case of neutral phrasal compounds which lack any frequency effect or meaning bias (e.g. a torn receipt envelope can have both recursive and non-recursive interpretations and the frequency of torn receipt and torn envelope is the same), nativist accounts predict that English NSs will prefer to read a torn receipts envelope as an envelope containing torn receipts (i.e. the recursive reading) because of the presence of regular plural. Connectionist accounts, however, predict that there will be no preference since both interpretations should be equally possible but can be affected by the priming type (i.e. a recursive semantic prime type vs. a non-recursive semantic prime type). As for phrasal compounds with bare non-heads, they should allow both interpretations equally or participants might prefer a non-recursive reading, as Alegre & Gordon (1996) assumed.

As for L2ers, both the Unified Competition Model (MacWhinney 2008) and the AIT (Carroll 2001) predict that the frequency of lexical items will play a role in interpreting phrasal compounds. Both theories assume that frequency cannot be the sole factor that influences the processing of L2 stimuli. In the case of the Unified Competition Model, cue validity depends not only on frequency but also on the reliability of a cue. When a form like the Plural morpheme has multiple forms ([s], [z] and [ǝz], in this case phonetically conditioned) and multiple functions (Plural-marking and Possessive-marking on nouns, Number-marking on verbs), it will have a lower cue validity than a cue with a single form or a single function. The AIT acknowledges the complexity of linguistic form-function mappings, but it also assumes that L2ers processing procedures will be constrained by the nature of mappings across autonomous levels of representations and the nature of structure-building within an autonomous level. Learners have to discover that the phones [s], [z] or [ǝz] project a prosodic Affix-constituent in the Prosodic Structure and this Affix-constituent must then map to the Plural morpheme in the morpho-syntax.
and to a plurality-meaning in the Conceptual Structure. Successful learners will need multiple exposures to relevant stimuli to construct such representations, but success is not guaranteed.

5.3 Participants

The same participants that participated in Experiment 1 also participated in Experiment 2.

5.4 Experimental design

Experiment 2 involved a priming task. In this task, prime words were presented visually for a very short time (50ms). Participants saw 60 phrasal compound words with two possible interpretations. They were then asked to determine which interpretation was more appropriate. This experiment was designed to see how three independent variables, the type of non-heads (bare non-heads vs. plural non-heads), the frequency of combined words and the semantic priming type (a recursive semantic prime word vs. a non-recursive semantic prime word), affect the dependent variable, that is, the interpretation of phrasal compounds.

5.4.1 Procedures

Recall that the order of Experiments 1 and 2 was randomized across participants. For half of the participants this means that they first carried out the same pre-experimental procedures (e.g., filling out the questionnaire) as described for Experiment 1. Half of the participants proceeded directly to the priming task. Procedures were the same as in Experiment 1, except for the contents of training and the experimental task. In the training phase, they saw a simple noun phrase and were then asked to select the right meaning of the given phrase, choosing between the two meanings offered by pressing either the F1 key (if they thought that the first interpretation was right) or the F12 key (if they thought that the second interpretation was right). In the second test
phase, the targeted stimuli were presented. In Experiment 2, a prime word was presented for 50ms so that participants could not consciously recognize the presence of the prime word\(^5\) (Silva & Clahsen 2008; Van den Bussche 2008). After the prime word was displayed, a printed phrasal compound was presented with two possible interpretations under the target compounds. The two possible interpretations were manually randomized when coding the stimuli\(^4\).

Participants were then asked to determine which meaning was more appropriate for the presented phrasal compounds by pressing either F1 key or F12 key as they did in the training phase. The task included 60 trials. Items were randomized by E-Prime 2.0. Participants’ response latencies (RT) were measured from the onset of prime to the time that participants made a choice.

### 5.4.2 Linguistic stimuli

Semantic prime words were sub-categorized into two types: *recursive semantic priming* and *non-recursive semantic priming*. Following the terminology that was used in Alegre & Gordon (1996), a recursive priming interpretation was taken to indicate that an adjective scopes over the noun immediately to its right in phrasal compound (e.g., *red rat* in *red rats eater*), while a non-recursive priming interpretation was taken to indicate that an adjective scopes over the last noun in phrasal compounds (e.g., *red eater* in *red rats eater*). As noted, these two interpretations result from different scopal properties of the adjective. For example, in Experiment 2, *registered dentist* was used as a recursive semantic prime word while *registered group* was a non-recursive semantic prime word when *registered dentist(s) group* was presented:

\(^5\) If the prime word is presented for 100ms or more, participants can consciously see the word (Van den Bussche 2008) thus an invisible prime word is typically presented for 30-60ms in masked priming tasks (Silva & Clahsen 2008).

\(^4\) However, a recursive interpretation was associated to the F1 key more rather a non-recursive interpretation. So I conducted a statistical analysis to see whether this skewed ordering tendency affected the test results. A GEE analysis indicated that it did not affect participants’ decision (wald chi-square=.054, \(p=.817\), n.s. for English NSs vs. wald chi-square=.189, \(p=.664\), n.s. for KL2ers).
[registered]A[dentist]NNP]s[NN]NP[group]NN = ‘a group for registered dentists’, versus [registered]A[[[dentist]NNN-s]N group]NNP = ‘a registered group for any dentists’. Therefore, if the recursive prime word affects the processing of the meaning of phrasal compounds, participants’ RT will be faster when selecting a recursive interpretation. To see whether there is any semantic priming effect, the same 30 stimuli were presented to participants two times with a recursive semantic prime word and a non-recursive semantic prime word respectively.

To see if the presence of regular plural plays a role in choosing a recursive interpretation, 15 bare non-heads (e.g. house cocktail party) and 15 plural non-heads (e.g. house cocktails party) were used as stimuli. As discussed earlier, if the frequency of the internally combined words plays a role, the frequency type will help participants to choose a frequency-matched interpretation. To test this hypothesis, phrasal compounds were classified as three types of frequency: the recursive frequency (type 1), the non-recursive frequency (type 2) and the neutral frequency (type 3). If the NP in NP+N phrasal compounds has higher frequency than the A+N in the same phrasal compounds, this type was classified as the frequency type 1. For example, the sequence professional services appear 38 times in the British National Corpus (BNC) while professional group appear 25 times within a phrasal compound, professional service(s) group, thus this phrasal compound word was classified as the frequency type 1. If A+N has a higher frequency than NP, it was classified as type 2. The frequency type 3 included the case where there is no frequency difference between NP and A+N in phrasal compounds. For example, there was no frequency difference between big tiger (frequency in the BNC = 0) and big cage (frequency in the BNC = 0) for a phrasal compound, big tiger cage thus this word was classified as the frequency type 3. The testing stimuli were reviewed by a volunteer native English speaker. The list of stimuli and their semantic priming types, non-head types and frequency types are provided in Table 5.1.
Table 5.1 The list of linguistic stimuli

<table>
<thead>
<tr>
<th>Semantic priming</th>
<th>Non-head type</th>
<th>Frequency type (# of items)</th>
<th>Stimuli</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recursive priming</td>
<td>Bare non-head</td>
<td>Frequency type 1 (5)</td>
<td>professional service group, silk handkerchief rack, wild plant catalogue, registered dentist group, jumping kangaroo specialist</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Frequency type 2 (5)</td>
<td>house cocktail party, new scientist society, famous tower painting, long soldier list, quick table sketch</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Frequency type 3 (5)</td>
<td>torn receipt envelope, red rat eater, plastic duck house, big tiger cage, Korean car exporter</td>
</tr>
<tr>
<td></td>
<td>Plural non-head</td>
<td>Frequency type 1 (5)</td>
<td>professional services group, silk handkerchiefs rack, wild plants catalogue, registered dentists group, jumping kangaroos specialist</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Frequency type 2 (5)</td>
<td>house cocktails party, new scientists society, famous towers painting, long soldiers list, quick tables sketch</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Frequency type 3 (5)</td>
<td>torn receipts envelope, red rats eater, plastic ducks house, big tigers cage, Korean cars exporter</td>
</tr>
<tr>
<td>Non-recursive priming</td>
<td>Bare non-head</td>
<td>Frequency type 1 (5)</td>
<td>Same as bare non-head frequency type 1 with recursive priming</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Frequency type 2 (5)</td>
<td>Same as bare non-head frequency type 2 with recursive priming</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Frequency type 3 (5)</td>
<td>Same as bare non-head frequency type 3 with recursive priming</td>
</tr>
<tr>
<td></td>
<td>Plural non-head</td>
<td>Frequency type 1 (5)</td>
<td>Same as plural non-head frequency type 1 with recursive priming</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Frequency type 2 (5)</td>
<td>Same as plural non-head frequency type 2 with recursive priming</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Frequency type 3 (5)</td>
<td>Same as plural non-head frequency type 3 with recursive priming</td>
</tr>
</tbody>
</table>
The frequency data were obtained from the British National Corpus database provided by the University of Leeds\(^{55}\), searchable for the frequency of noun phrases.

The stimuli were presented in the following test frame as in (28). See Appendix 2 for a complete set of testing frames. Before the testing stimuli were presented, either a recursive word (e.g. *silk handkerchief*) or a non-recursive prime word (e.g. *silk rack*) was presented to participants.

(28) The testing frame used in Experiment 2

Stimuli: silk handkerchief rack

This rack is for silk handkerchiefs.

This handkerchief rack is made of silk.

Since the F1 key corresponded to the first interpretation and the F12 key corresponded to the second interpretation, I manually re-coded them treating the F1 key as a recursive reading response and the F12 key as a non-recursive reading response.

5.5 **Results for native English speakers**

All English NSs selected one of the interpretations and no one exhibited a response bias (such as systematically pushing only one of the keys). A GEE\(^{56}\) showed that frequency type and non-head type were significant factors in opting for a recursive interpretation as Table 5.2 shows.

---

\(^{55}\) Web address: http://corpus.leeds.ac.uk/protected/query.html

\(^{56}\) In a GEE analysis for English NSs, a non-recursive reading response was treated as a reference category. Thus all post-hoc tests in a GEE will show which independent variables had a significant effect on selecting a recursive reading response.
Table 5.2 GEE results when choosing a recursive interpretation (English NSs)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Type III</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wald Chi-Square</td>
<td>df</td>
<td>Sig.</td>
</tr>
<tr>
<td>Frequency</td>
<td>67.03405</td>
<td>2</td>
<td>.000</td>
</tr>
<tr>
<td>Non-head</td>
<td>18.71355</td>
<td>1</td>
<td>.000</td>
</tr>
</tbody>
</table>

With respect to the frequency type, a pair-wise comparison post-hoc test of a GEE indicated that all three frequency types were significantly different from each other ($p=.000$ for all factors). As shown in Figure 5.1, regardless of whether phrasal compounds contain a plural or not, English NSs chose the recursive interpretation 83% of the time when the frequency type was recursive while 70% of the time, they chose the non-recursive interpretation when the frequency type was non-recursive. This result suggests that they were sensitive to the frequency type when they processed the meaning of the phrasal compounds.

![Figure 5.1 Selection of a recursive interpretation (the frequency type - English NSs)](image)

As parameter estimates data revealed (see Table 5.3), for every one point increase in the
frequency type 1 (= recursive) there was a 1.439 increase in the log odd of selecting the recursive interpretation compared to the frequency type 2 & 3 while for one point increase in the frequency type 2 (= non-recursive), there was a -1.018 decrease in the log odd of selecting the recursive interpretation compared to the frequency type 1 and 3. What this means is that English NSs chose more recursive interpretations (the recursive interpretation, ‘a group providing professional services’ was selected when professional service(s) group was presented as a target linguistic stimulus) with the frequency type 1 which showed the sequence professional service (NP) had a higher frequency than professional group (A+N). But they chose fewer recursive interpretations when phrasal compounds were classified as the frequency type 2. In other words, the recursive interpretation, ‘a painting of famous towers’ was not preferred over the non-recursive interpretation, ‘a famous painting depicting towers’, when a word famous tower(s) painting (i.e. the frequency type 2 phrasal compounds) was presented.

Table 5.3 Parameter estimates for choosing a recursive interpretation (the frequency type - English NSs)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>B</th>
<th>Std. Error</th>
<th>95% Wald Confidence Interval</th>
<th>Hypothesis Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lower</td>
<td>Upper</td>
</tr>
<tr>
<td>(Intercept)</td>
<td>.158</td>
<td>.1418</td>
<td>-.120</td>
<td>.436</td>
</tr>
<tr>
<td>[FrequencyType=1]</td>
<td>1.439</td>
<td>.2569</td>
<td>.935</td>
<td>1.942</td>
</tr>
<tr>
<td>[FrequencyType=2]</td>
<td>-1.018</td>
<td>.1648</td>
<td>-1.341</td>
<td>-.695</td>
</tr>
<tr>
<td>[FrequencyType=3]</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Scale)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

When we look at the non-head type (see Figure 5.2), English NSs chose the recursive interpretation more often when non-heads were plural as a pair-wise comparison post-hoc test of a GEE showed (p=.000). Even though this difference was significant, plural non-heads do not
always force English NSs to choose the recursive interpretation. Parameter estimates data revealed that for every one point increase in the bare non-heads there was a -0.193 decrease in the log odd of selecting the recursive interpretation compared to plural non-heads. Simply put, English NSs tended to choose fewer recursive interpretations when bare non-heads were presented in phrasal compounds.

![Bar graph showing percentage of English NSs choosing recursive and non-recursive interpretations.](image)

**Figure 5.2 Selection of a recursive interpretation (the non-head type - English NSs)**

With respect to RT results, I looked at how the independent variables affected selecting the recursive interpretation and the non-recursive interpretation respectively since this is the place where we can find how the frequency and semantic priming effects work. Specifically, connectionist accounts predict that we should find the semantic priming effect. In other words, a recursive semantic prime word should yield faster reaction times when English NSs chose a recursive interpretation as well as a non-recursive semantic prime word should yield faster reaction times when selecting a non-recursive interpretation. However, such effect is not predicted by nativist accounts because the presence of regular plural non-heads decides which interpretation should be preferred.
RT results showed, when selecting the recursive interpretation, there was a significant effect of the frequency type, as well a significant interaction between the frequency and non-head type. See Table 5.4 for a GEE analysis.

Table 5.4 GEE results on reaction times when selecting a recursive interpretation (English NSs)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Type III</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wald Chi-Square</td>
<td>df</td>
<td>Sig.</td>
</tr>
<tr>
<td>Frequency</td>
<td>9.290</td>
<td>2</td>
<td>.010</td>
</tr>
<tr>
<td>Frequency*non-head</td>
<td>9.361</td>
<td>2</td>
<td>.009</td>
</tr>
</tbody>
</table>

As for the frequency type, a post-hoc pair-wise comparison test of a GEE showed that English NSs responded significantly faster to the frequency type 1 stimuli than to the frequency type 2 stimuli ($p=.008$) when selecting the recursive interpretation. Parameter estimates also confirmed this tendency (see Table 5.5). For every one point increase in the frequency type 1 (=recursive) there was a -0.045 decrease in the log odd of reaction times when selecting the recursive interpretation compared to the frequency type 2 & 3 while for every one point increase in the frequency type 2 (=non-recursive) there was a 0.089 increase. In other words, English NSs reacted faster to the frequency type 1 stimuli while they reacted slower to the frequency type 2 stimuli when selecting the recursive interpretation.
Table 5.5 RT data: Parameter estimates of the frequency type when selecting a recursive interpretation (English NSs)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>B</th>
<th>Std. Error</th>
<th>95% Wald Confidence Interval</th>
<th>Hypothesis Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lower</td>
<td>Upper</td>
</tr>
<tr>
<td>(Intercept)</td>
<td>8.505</td>
<td>.0644</td>
<td>8.378</td>
<td>8.631</td>
</tr>
<tr>
<td>[FrequencyType=1]</td>
<td>-0.045</td>
<td>.0576</td>
<td>-0.158</td>
<td>0.068</td>
</tr>
<tr>
<td>[FrequencyType=2]</td>
<td>0.089</td>
<td>.0564</td>
<td>-0.021</td>
<td>0.200</td>
</tr>
<tr>
<td>[FrequencyType=3]</td>
<td>0</td>
<td></td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>(Scale)</td>
<td>.327</td>
<td></td>
<td>.</td>
<td>.</td>
</tr>
</tbody>
</table>

As for the interaction between the frequency and non-head type, it showed that there was a significant difference between the frequency type 1 stimuli and the frequency type 2 stimuli ($p=.000$) and the frequency type 1 stimuli and the frequency type 3 stimuli ($p=.032$) respectively when non-heads were regular plural. Bare non-heads did not elicit any frequency effect as Figure 5.3 shows. In other words, English NSs responded faster when the frequency type 1 stimuli were given with plural non-heads, but there is no frequency effect found with bare non-heads. When we look at frequency type 3 stimuli, the type of non-head plays a role, namely, English NSs were significantly faster on responses when the frequency type 3 was given with bare non-heads than when it appeared with plural non-heads (a pair-wise comparison test of a GEE, $p=.032$). In short, English NSs responded faster with the presence of plural non-heads when the presented phrasal compounds were classified as the frequency type 1 stimuli (e.g., in a phrasal compound, *professional services group*, the frequency of *professional service* > the frequency of *professional group*).
Figure 5.3 RT data of the interaction between frequency type and non-head type when selecting a recursive interpretation (English NSs)

Considering that English NSs selected the recursive interpretation only 58% of the time when regular plural was presented (see Figure 5.2), this result is interesting. It suggests that English NSs were sensitive to the presence of plural non-heads when selecting the recursive interpretation with the recursive frequency type stimuli. This tendency cannot be explained by (non-symbolic) connectionist accounts of processing since they predict that the presence of regular plural will not affect the scope of the modifying element, which, as we saw above, reflects the structure (c-command domain) of the constituents. Nativist accounts predicted that English NSs should be sensitive to the presence of regular plural within phrasal compounds even the phrasal compounds were classified as the frequency type 2 stimuli. However, English NSs were not sensitive to the
presence of regular plural non-heads when frequency type 2 stimuli were presented. Thus the RT difference between frequency 1 and frequency 2 with plural non-heads in Figure 5.3 cannot be explained by nativist accounts.

When it comes to RT results when selecting the non-recursive interpretation, there was a significant interaction between the frequency type and the priming type as a GEE analysis showed (wald chi-square = 11.622, df=2, p=.003). A post-hoc pair-wise comparison test of this interaction showed that only a non-recursive prime word led to faster reaction times by English NSs when there were the frequency type 3 stimuli presented compared to the frequency type 2 stimuli (p=.006) and as well as compared to the frequency type 1 stimuli (p=.012). As Figure 5.4 shows, when the frequency type 3 phrasal compounds were presented, a semantic priming effect was found while this effect was not found when English NSs selected the recursive interpretation (refer to Table 5.4). In other words, English NSs reacted faster when a non-recursive semantic prime word was presented with the frequency type 3 stimuli (a post-hoc pair-wise comparison test of a GEE, p=.006) even though the semantic priming effect itself was not a significant factor in deciding between the two interpretations (recursive versus non-recursive). This RT result also indicated that when there is no frequency bias, the non-recursive semantic priming words made English NSs react faster but it did not help them choose more non-recursive interpretations (see Figure 5.1). In addition, we cannot find a semantic priming effect when non-recursive semantic prime word was presented. It did not yield faster reaction times when selecting the non-recursive interpretation.
In a nutshell, English NSs demonstrated a frequency effect however there was no clear/full semantic priming effect. However, there was no frequency effect found when English NSs selected the non-recursive interpretation as RT data revealed. Thus we also can say that there was no complete frequency effect found in Experiment 2. At the same time, the performance of English NSs also suggested that the presence of regular plural non-heads partially affected to select more recursive interpretations.
5.6 Results for Korean learners

All KL2ers selected one of the two interpretations provided, and no one exhibited a response bias by systematically pushing the key associated with only one of the interpretations. A GEE showed that only the frequency type was a significant factor for Korean learners (wald chi-square=11.203, df=2, \( p=.004 \)). Figure 5.5 shows that the general tendency was similar to that of English NSs. However, when we examine the results of a post-hoc analysis of a GEE, the frequency type 1 stimuli and frequency type 3 stimuli were not significantly different from each other (\( p=.695 \), n.s.). In other words, when Korean learners selected the recursive interpretation, the frequency type 1 was not a factor, contrary to the English NSs who preferred the recursive interpretation 83% of the time with the recursive frequency type stimuli (type 1). As a post-hoc test with pair-wise comparisons of a GEE revealed, the difference between the frequency type 1 and type 2 stimuli (\( p=.008 \)), and frequency type 2 and type 3 stimuli (\( p=.005 \)) were significant. A chi-square analysis of independence test also showed that the frequency type was dependent on the type of speakers (\( \chi^2 (2) = 10.910, p=.004 \)). KL2ers and English NSs differed in their pattern of choosing the recursive interpretation.

![Figure 5.5 Selection of a recursive interpretation (the frequency type - KL2ers)](image-url)

Figure 5.5 Selection of a recursive interpretation (the frequency type - KL2ers)
Contrary to English NSs, the non-head type was not a significant factor when selecting the recursive interpretation (wald chi-square = 2.726, df= 1, p= .099, n.s.). However, KL2ers indeed chose more recursive interpretation when plural non-heads were presented (plural non-heads: 52.5% (n=275) vs. bare non-heads: 47.5% (n=249)).

With regard to the RT data, not surprisingly, KL2ers reacted significantly slower than English NSs ($t (2085) = 12.25, p<.000$, Favreau et al. 1980; Favreau & Segalowitz 1983; McDonald 2006). RT results showed, when selecting the recursive interpretation, there was a significant effect of the frequency type, as well as a significant interaction between the frequency and priming type (see Table 5.6).

Table 5.6 GEE results on reaction times when selecting a recursive interpretation (KL2ers)

<table>
<thead>
<tr>
<th>Tests of Model Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variables</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Frequency</td>
</tr>
<tr>
<td>Frequency*priming</td>
</tr>
</tbody>
</table>

As for the frequency type, a post-hoc pair-wise comparison test of a GEE showed that KL2ers responded significantly faster to the frequency type 3 stimuli than to the frequency type 2 stimuli ($p=.012$) when selecting the recursive interpretation. In other words, when there is no frequency bias, KL2ers reacted faster when selecting the recursive interpretation.

With regard to the interaction between the frequency and priming type, a post-hoc analysis of a GEE showed that again KL2ers responded faster to the frequency type 3 stimuli than to the frequency type 1 stimuli when the recursive prime word was given. ($p=.028$). When there is no frequency bias (= the frequency type 3), KL2ers performed faster to the recursive semantic prime word than to the non-recursive semantic prime word ($p=.034$). In short, both the
frequency type and the interaction effect suggest that KL2ers performed faster when the frequency type 3 stimuli were presented when selecting the recursive interpretation.

Figure 5.6 RT data of the interaction between frequency type and priming type when selecting a recursive interpretation (KL2ers)

When we look at the RT data elicited with selecting the non-recursive interpretation, this frequency-priming interaction was again found (wald chi-square=8.625, df=2, \( p=.013 \)), however, KL2ers exhibited a different pattern, which is, when there is no frequency bias (= the frequency type 3), KL2ers performed faster to the non-recursive semantic prime word than to the recursive semantic prime word as a post-hoc analysis of a GEE revealed \( (p=.001) \). This pattern is the same
as the pattern of English NSs when selecting the non-recursive interpretation. See Figure 5.7.

![Graph showing RT data interaction between frequency type and priming type when selecting interpretations](image)

Figure 5.7 RT data of the interaction between frequency type and priming type when selecting a non-recursive interpretation (KL2ers)

### 5.7 Discussion

The results of Experiment 2 showed that English NSs demonstrated a frequency effect but not a full semantic priming effect when they selected between the two interpretations of a phrasal compound (recursive versus non-recursive). English NSs, at the same time, were sensitive to the presence of regular plural non-heads and the presence of the plural morpheme made them favour the recursive interpretation more often than the non-recursive interpretation, and to react faster
(when the recursive interpretation was elicited) than when they were presented with compounds without the plural morpheme\textsuperscript{57}. Connectionist models assume a frequency effect however the nodes in the sub-symbolic versions of connectionist models are not WORDs, and therefore it is not at all obvious that they predict frequency effects involving WORDs (MacWhinney 2000). In addition, if the scope of the modifying element resulting in the plausibility of a given modification was a sole factor to determine to select the given two interpretations, we should expect a semantic priming effect as Ramscar & Dye (2011) showed. In other words, a non-recursive prime word should speed up the selection of the non-recursive interpretation while a recursive prime word should speed up the selection of the recursive interpretation. However, such effect was not found. In short, both nativist accounts and connectionist accounts partially account for the results of Experiment 2. It suggests that we need to do more research on how English NSs process regular plural non-heads.

As for KL2ers, they did not show the same pattern as English NSs in terms of the frequency and semantic priming effects on those responses where both the recursive and non-recursive interpretations were elicited. However, they selected the non-recursive interpretation 65% of the time with the frequency type 2 stimuli (= the non-recursive frequency type) even though RT results did not support such effect. In other words, the frequency of combined words in phrasal compounds partially worked on their performance. Ellis (1994, 2002; Ellis & Schmidt1998) argues that frequency is a fundamental cognitive mechanism in language processing, however, the results of L2ers in Experiment 2 suggest that the frequency effect does not always play a role (Gass & Mackey 2002; Rohde 2008). Indeed, frequency interacts with other factors such as L1 transfer, morphological regularity or semantic complexity (Gass &

\textsuperscript{57} A GEE analysis on RT showed that type of non-heads was not a significant factor (wald chi-square = .775, df=1, $p= .385$, n.s.) as follows: bare non-heads (mean RT: 8.514) vs. plural non-heads (mean RT: 8.489).
Mackey 2002).

As for the semantic priming effect, KL2ers showed a partial semantic priming effect, namely, neutral phrasal compounds which lack any frequency effect or meaning bias were affected by two different prime words (recursive vs. non-recursive). For example, if a phrasal compound was classified as the frequency type 3 (e.g. the frequency of plastic duck = the frequency of plastic house, in a word plastic duck(s) house), the non-recursive prime word (e.g. plastic house) made KL2ers reacted faster than when the recursive prime word was presented (e.g. plastic duck) when selecting the non-recursive interpretation while this effect was reversed when selecting the recursive interpretation. However, such effect was not found across the whole data. Moreover, KL2ers selected the recursive interpretation 51.4% of the time with those neutral phrasal compounds. Thus it is not entirely clear why KL2ers reacted faster in the case of the frequency type 3 phrasal compounds only.

With regard to the non-head type, the presence of regular plural non-heads was not a significant factor to KL2ers this time. This suggests that the presence of regular plural did not affect KL2ers when selecting the recursive interpretation thus the constraint which asserts that the dislike of regular plural non-heads is universal was not warranted in my study. In short, KL2ers demonstrated partial frequency and semantic priming effects in Experiment 2.

Results of Experiment 2 suggest that both the presence of regular plural non-heads and frequency type play a role in selecting interpretations for English NSs while such effect was not clearly found for KL2ers. However, the choice of interpretation was not entirely random for KL2ers and they tended to choose more recursive interpretations with plural non-heads even though it was not statistically significant. The results of Experiment 2 suggest that KL2ers need more exposure to relevant stimuli. To see which factors work in selecting of a specific interpretation, we need further research on this linguistic issue for both with L1 and L2 groups.
Chapter 6: Conclusions and future research

6.1 Summary of findings

With respect to L1 performance, my experimental studies showed that irregular plural non-heads were preferred over regular plural non-heads but this result did not support the claim of nativist accounts which argued that only irregular plural non-heads can participate in English compounding (Gordon 1985; Pinker & Prince 1994; Berent & Pinker 2007; Senghas et al. 2007). However, it also did not support connectionist accounts as non-heads ending in sibilants were acceptable. In addition, plural non-heads were used 30% of the time by English NSs. Unfortunately, the condition(s) under which English NSs use plural non-heads were not identified in Experiment1. It only showed that bare nouns were processed as singular non-heads but it did not clearly show that how plural non-heads were processed. In addition, the presence of regular plural did make English NSs prefer a recursive interpretation but only sometimes (Alegre & Gordon 1996; Cunnings 2003). In addition, the frequency of internally combined words in phrasal compounds affects the interpretation of phrasal compounds, however there was no semantic priming effect found. Since sub-symbolic connectionist accounts do not posit any type of symbolic representations, even words, it is not entirely clear how their accounts explain this type of frequency effect involving combined words.

The data from KL2ers showed that the dislike of regular plural non-heads is learnable. Even though compounds with plural non-heads are infrequent in English, Koreans can learn some part of the restrictions on their distribution, including the dislike of regular plural non-heads. Even though KL2ers’ L1 does not allow plural non-head compounds, they indirectly demonstrated that they transferred the phonological and conceptual correspondences of the Korean plural marker -tul. Their performance showed that they processed symbolic
representations, such as morphemes, by using their L1 knowledge and processing procedures (Carroll 2001), as opposed to the predictions of the Unified Competition Model predicted (MacWhinny 2008). Nevertheless, Koreans did not show native-like performance, which is perhaps not surprising, given the low frequency of the structures in question.

6.2 Conclusions

Findings from the two experiments suggest that the dislike of regular plural non-heads is not universal and thus the constraint against the regular plural non-heads cannot be a good example of the POV. Both nativist accounts and connectionist accounts partially account for the results of my experiments. However, the results also provide indirect evidence that both English NSs and KL2ers process symbolic representations, namely, both groups of participants were sensitive to the presence of plural non-heads (inflectional morphology) and preferred regular plural non-heads over irregular plural non-heads (regularity of inflection). Specifically, KL2ers could process and map the information of a given picture of multiple objects to the English plural morpheme and to the relevant numerical concept in the conceptual structure. These findings cannot be explained by sub-symbolic connectionist accounts which posit only distributed patterns of associative links and the strength of established connections. Moreover frequency effects are not straightforward but rather complex. The L2 learners demonstrate not only frequency effects but also L1 transfer effects, as well as complexity of morpho-syntactic or semantic conditions among others.

I have tested various conditions on the use of English plural non-heads such as the meaning of plural non-heads and the semantic priming effect, however, my attempts only account for a part of this linguistic phenomenon. My results suggest that using plural non-heads involves various complex conditions requiring “rules” that make use of symbolic processing. Nevertheless,
the two experiments showed that if there is a constraint, it is not absolute but rather gradient. This kind of non-typical cases can be explained by Jackendoff’s preference rule system (Jackendoff 1983). Given that Canadian speakers of English accepted plural non-heads to a surprisingly large extent, it is still not clear which conditions let English NSs prefer plural non-heads. Further descriptive research on this topic comparing Canadian to American and British varieties is required. This needs to be done to establish the first step in understanding what L2ers might learn through L2 input. From an L2 perspective, my research suggests that input is not only about salience (Carroll 2005) or frequency (Gass & Mackey 2002). How L2ers process L2 input depends on their L1 processing procedures, grammatical knowledge or universal properties of language and cognition as the AIT predicts.

6.3 Future research

Complex and inconsistent findings from various studies including my experimental study suggest that we need to first understand why English NSs sometimes use plural non-heads. So far, the following conditions have been investigated: the regular-irregular dichotomy, heterogeneity and abstractness of head nouns, the collective reading of regular plural non-heads, morphological type of compounds (synthetic compounds vs. root compounds), different frequencies of internally combined words in phrasal compounds and the meaning of plural non-heads as denoting multiple entities. None of these conditions fully account for the English NSs’ preference for plural non-heads. I demonstrated that a different task can yield different results so we should implement different types of tasks to see how some linguistic conditions work or whether their interactions affect the preference for plural non-heads. By increasing sample size and testing various L2 groups, we might get more stable results. We also can test how pragmatics or the frequency of plurals over singulars interacts with other linguistic factors.
References


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Appendix 1: Sample pictures used in Experiment 1

1. Root compounds

(1) Regular count nouns with a HUMAN-entity (e.g. injury(s) list)

![Regular count nouns with a HUMAN-entity](image)

(2) Irregular count noun with an ANIMAL-entity (e.g. ox(en) thief)

![Irregular count noun with an ANIMAL-entity](image)

(3) Collective noun non-heads (e.g. black navy(s) jacket)

![Collective noun non-heads](image)
2. Synthetic Compounds

(1) Regular count noun with a THING-entity (e.g. gown(s) maker)

(2) Irregular count noun with an ANIMAL-entity (e.g. excellent ox(en) trainer)

(3) Flexible noun non-heads (e.g. cup cake(s) maker)
Appendix 2: Testing frames used in Experiment 2

**Frequency type1**

1. *professional service(s) group*

   This services group is very professional.
   
   This group provides professional services.

2. *silk handkerchief(s) rack*

   This rack is for silk handkerchiefs.
   
   This handkerchief rack is made of silk.

3. *wild plant(s) catalogue*

   This catalogue is about wild plants.
   
   This plant catalogue is somewhat wild.

4. *registered dentist(s) group*

   This group is for registered dentists.
   
   This dentists group is registered.

5. *jumping kangaroo(s) specialist*

   He is a specialist for jumping kangaroos.
   
   The kangaroo specialist is now jumping with kangaroos.
**Frequency type 2**

1. *house cocktail(s) party*

   This is a party that serves house cocktails.

   This is a house party that serves cocktails.

2. *new scientist(s) society*

   This society is for new scientists.

   This is a new society for scientists.

3. *famous tower(s) painting*

   She draws famous towers.

   This tower painting is famous.

4. *long soldier(s) list*

   This list is for long soldiers.

   The list of soldiers is long.

5. *quick table(s) sketch*

   This sketch is for quick tables.

   Here is the quick sketch for tables.

**Frequency type 3**

1. *torn receipt(s) envelope*

   The envelope which contains receipts is torn.
This envelope contains torn receipts.

2. **red rat(s) eater**

The rat eater is red.

The eater eats red rats.

3. **plastic duck(s) house**

This house is designed to contain plastic ducks.

This plastic house is designed for ducks.

4. **big tiger(s) cage**

This cage is specially made for big tigers.

This tiger cage is big.

5. **Korean car(s) exporter**

Amy exports Korean cars to other countries.

The car exporter is a Korean.