THE PROCESSING OF ENGLISH NUMBER AGREEMENT BY TURKISH SPEAKERS OF ENGLISH: AN EYE-TRACKING STUDY

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DECLARATION OF ORIGINALITY

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ABSTRACT

The Processing of English Number Agreement by Turkish Speakers of English: An Eye-tracking Study

This study investigates how Turkish learners of English process subject-verb number (S-V) agreement and whether linear or syntactic distance affects processing of S-V agreement in the L2. Two eye-tracking experiments and a pen-and-paper gap-fill task were performed. Experimental sentences were declarative with complex subject NPs made of one head noun (singular - Experiment 1, plural - Experiment 2) and two post-modifying PPs following (Franck et al., 2002; Pearlmutter, 2000). The number feature of the middle and the local noun was manipulated. In Experiment 2, singular nouns were modified by *one* to make them marked (Eberhard, 1997) and to test the effect of lexical information. The pen-and-paper gap-fill task contained the same experimental sentences as in Experiments 1 and 2 but with gaps in the verb position.

Ninety-five advanced Turkish learners of English participated in the study, forty-eight of which took part in Experiment 1 and forty-seven participated in Experiment 2. All participants took a pen-and-paper gap-fill test to ensure their knowledge of S-V agreement after the eye-tracking experiments.

The results showed that when there are no lexical cues, Turkish learners of English are sensitive to linear distance, unlike native speakers who were sensitive to syntactic distance (Pearlmutter, 2000) for similar constructions. Given lexical information (i.e., *one*), they show sensitivity to both linear and syntactic distance, suggesting that L2 speakers can do complex syntactic processing, similar to native speakers, when semantic cues are present (Cunnings, 2017).

ÖZET

İngilizce Sayı Uyumunun İngilizce Konuşan Türkler Tarafından İşlemlenmesi: Bir Göz İzleme Çalışması

Bu çalışma, İngilizce öğrenen Türklerin özne-yüklem sayı uyumunu nasıl işlemlediğini ve lineer veya sözdizimsel mesafenin ikinci dildeki özne-yüklem sayı uyumunun işlemlenmesini etkileyip etkilemediğini araştırmaktadır. Bu çalışmada, iki göz izleme deneyi ve bir kalem-kâğıt boşluk doldurma testi uygulanmıştır. Deney cümleleri (Franck v.d., 2002; Pearlmutter, 2000'deki yapılara benzer şekilde) özne pozisyonunda birinci deneyde tekil, ikinci deneyde çoğul olmak üzere birer tamlanan ve iki tamlayan edat öbeğinden oluşan karmaşık isim tamlamaları içermektedir. Birinci ve ikinci tamlayanın tekilliği veya çoğulluğu manipüle edilmiştir. İkinci deneyde, tekil isimlerin sayı özelliğini belirtili yapmak (Eberhard, 1997) ve semantik ipuçlarının etkisini test etmek için tamlayanlar "*one"* (bir) sayısal niceleyicisi ile tanımlanmıştır. Kalem-kâğıt boşluk doldurma testi, birinci ve ikinci deneydeki deneysel cümleleri içermekle birlikte fiil pozisyonunda boşluklar bulunmaktadır.

İleri düzey İngilizce konuşan doksan beş Türk öğrenciden kırk sekizi birinci deneye, kırk yedisi ikinci deneye dâhil olmak üzere çalışmaya katılmışlardır. Göz izleme deneylerinden sonra tüm katılımcılar İngilizce'de özne-yüklem sayı uyumu bilgisine hâkimiyet durumlarını göstermek üzere kalem-kâğıt boşluk doldurma testine katılmışlardır.

Yapılan deneyler ve deney sonunda uygulanan testlerden elde edilen sonuçlara göre, semantik ipucu olmadığında, İngilizce öğrenen Türklerin benzer yapılar için sözdizimsel mesafeye duyarlı olan anadil konuşmacılarının aksine (Pearlmutter, 2000), lineer mesafeye duyarlı oldukları görülmüştür. Semantik ipucu

verildiğinde ise, “*one*” (bir), İngilizce öğrenen Türklerin hem doğrusal hem de sözdizimsel mesafeye duyarlılık gösterdikleri gözlemlenmiştir. Bu durum, ikinci dil konuşan kişilerin semantik ipuçlarına sahip olmaları halinde anadil konuşmacılarına benzer şekilde karmaşık yapıları sözdizimsel olarak işlemleyebildiklerini gösterir (Cunnings, 2017).

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DEDICATION

I dedicate this thesis to my loving parents, Ümmiye Serin and Mehmet Serin.

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ABBREVIATIONS

1	first person
2	second person
3	third person
ABL	ablative case
ACC	accusative case
DAT	dative case
FEM	feminine gender
GEN	genitive case
MASC	masculine gender
NEG	negation
NOM	nominative case
PAST	past tense
PL	plural
POSS	possessive
Q	question word
REFL	reflexive voice
REP.PAST	reported past tense
SG	singular

CHAPTER 1

INTRODUCTION

1.1. Introduction

This thesis investigates the processing of English subject-verb (S-V) number agreement by Turkish learners of English who have advanced proficiency in English. Second language (L2) learners have notoriously been reported to have difficulty (occasional incorrect use or elimination of S-V agreement markers) and to show variation in their production of S-V number agreement[1] in speaking and writing (Haznedar & Schwartz, 1997; Lardiere, 2008; Prévost & White, 2000).

S-V number agreement inflection errors have been reported to be made both by native speakers and second language speakers and hence they have been much studied in the first language (L1) both in production and processing as well as in the L2. Studying S-V agreement inflection errors or sensitivity to agreement is important because of its potential to provide insights into the operations of syntactic processing mechanisms (Bock & Cutting, 1992; Bock & Eberhard, 1993; Bock & Miller, 1991; Bock, Nicol & Cutting, 1999; Bock & Miller, 1991; Dillon, Mishler, Sloggett & Phillips, 2013; Eberhard, 1997; Franck, Vigliocco & Nicol, 2002; Hartsuiker, Anton-Méndez & Van Zee, 2001; Nicol, Forster & Veres, 1997; Pearlmutter, Garnsey & Bock, 1999; Pearlmutter, 2000; Vigliocco, Butterworth & Semenza, 1995; Vigliocco & Nicol, 1998). S-V agreement is considered to be a straightforward syntactic operation (Bock & Miller, 1991). Consider the example in (1):

[1] Although there are other types of S-V agreement (*e.g.*, gender), in this thesis I will use the term S-V agreement or number agreement to refer to the S-V number agreement between the subject and the verb.

(1) a. The mother of the girls who was…

b. The mother of the girls who were…

(Bock, 1995, p. 56)

A speaker uttering the sentences in (1) probably aims to talk about the mother in (1a) and the girls in (1b) and listeners can understand this by the elements of English which linguistically mark number (*was* and *were*). Upon hearing these utterances in example (1), for sentence (1a) the listeners understand *was* is singular and therefore it is linked to *the mother* and in (1b) *were* is plural and therefore it is linked to *the girls*. That is, S-V number agreement connects arbitrary linguistic markers with elements of nonlinguistic thought (Bock, 1995). This integral role of agreement makes it possible to observe how speakers apply basic conceptual and linguistic dependencies when errors occur.

One of the most common S-V agreement errors is illustrated in the sentence in (2).

(2) The key to the cabinets were rusty.

(Bock & Miller, 1991, p. 56)

In English, the verb and the head noun in the subject position have to agree in terms of number but in (2), the verb (*were*) takes its number feature from the plural local noun (*the cabinets*) instead of the singular head noun (*the key*), resulting in an S-V agreement error. It has been reported in the literature that such errors usually occur when there is another noun that intervenes between the head noun and the verb, whose number feature does not match the head noun's number feature (Bock & Miller, 1991). In such cases, the verb tends to agree with the number feature of the intervening noun, causing an S-V number agreement error.

Research in L1 number agreement has investigated S-V agreement errors mostly in language production (Bock & Cutting, 1992; Bock & Eberhard, 1993; Bock et al., 1999; Bock & Miller, 1991; Franck et al., 2002). The results of these studies consistently showed that when there is a number mismatch between the head noun and the local noun (e.g., *the key to the cabinets* or *the keys to the cabinet*), especially when the local noun is plural and the head noun is singular as in (2), the verb erroneously agrees with the local noun instead of the head noun. This pattern of errors was observed with native speakers of English (Bock & Cutting, 1992; Bock & Eberhard, 1993; Bock et al., 1999; Bock & Miller, 1991), native speakers of Italian (Vigliocco et al., 1995), native speakers of Spanish (Vigliocco, Butterworth, & Garrett, 1996) and native speakers of Dutch and French (Vigliocco, Hartsuiker, Jarema, & Kolk, 1996). Several hypotheses have been proposed to explain the causes of these errors: the linear distance hypothesis (Bock & Cutting, 1992; Bock & Miller, 1991; Jespersen, 1924; Quirk, Greenbaum, Leech & Startvik, 1972), syntactic distance hypothesis (Franck et al., 2002; Kempen & Hoenkamp, 1987; Levelt, 1989; Pearlmutter, 2000; Pollard & Sag, 1994; Vigliocco & Nicol, 1998), markedness hypothesis (Eberhard, 1997), head-overwriting (Pearlmutter et al., 1999) and interference in cue-based retrieval from memory (Lewis & Vasisth, 2005; Lewis, Vasisth & Van Dyke, 2006; Tanner & Bulkes, 2015; Wagers, Lau & Philips, 2009). See Chapter 3 for more details.

L1 speakers' sensitivity to number agreement has also been investigated in language processing. Studies examining L1 speakers' sensitivity to S-V agreement errors showed that native speakers slow-down in their processing of the verb when there is a local noun that mismatches the head noun in number. The slow-down is more prominent if the mismatching local noun is plural as in (2) (Nicol, Forster &

Veres, 1997; Pearlmutter et al., 1999). Details of these studies will also be presented in Chapter 3.

The subject noun phrase (NP) can occasionally be more complex and include more than one intervening NP as in (3).

(3) The picture(s) on the door(s) of the room(s)

In such cases, it is not clear whether the mismatching number feature of the intermediate NP (*the door(s)* in (3)) or the mismatching number feature of the local NP (*the room(s)* in (3)) will lead to S-V agreement errors. Some researchers argue that the linear proximity of the intervening noun to the verb determines the probability of an agreement error (Bock & Cutting, 1992; Bock & Miller, 1991) whereas others claim that the syntactic proximity of the intervening noun to the head noun is the determinant of a potential agreement error (Franck et al., 2002; Lago & Felser, 2018; Pearlmutter, 2000; Vigliocco & Nicol, 1998).

In the linear proximity account, the local NP, *the room(s)* in (3), may attract agreement because it is the noun which immediately precedes the verb. In this case, the verb could take its agreement features from the local noun (*the room(s)*) instead of the head noun (*the picture(s)*). This is because maintaining the number feature of the head noun is a challenge for the working memory (WM) when there is an intervening local noun; thus, the verb erroneously agrees with the local noun instead of the head noun (Fayol, Largy and Lemaire, 1994; Jespersen, 1924; Quirk, Greenbaum, Leech & Startvik, 1972).

In syntactic proximity account, the linear distance between the intervening noun and the verb is not important. Rather, the proximity of the intervening noun to the head noun in the hierarchical sentence structure is relevant in predicting potential

number agreement errors. This would predict the number feature of the intermediate noun, *the door(s)* in (3), to percolate up to the head noun and the verb to agree with the number feature of the intervening noun (e.g., *the door(s)*) instead of the head noun (e.g., *the picture(s)*).

The cue-based memory retrieval model by Lewis and Vasishth (2005), maintains that processing all dependencies including S-V agreement occurs at the retrieval stage of previously encountered items where a set of cues (representational elements which denote subjecthood such as nominative case, to occur before the verb, specifier position in the verb phrase, number and person) that are defined by the verb are checked against all representations in the working memory and the most suitable controller candidate is retrieved.

Research in L1 production and processing examining the role of linear and syntactic distance in assigning S-V agreement showed syntactic proximity of the intervening noun to be more influential than its linear proximity in assigning verbal inflection (Franck et al. 2002; Lago & Felser, 2018; Pearlmutter, 2000; Vigliocco & Nicol, 1998).

The predictions of the linear proximity and the syntactic proximity accounts provide interesting comparison conditions to examine L2 speakers' language processing routines. The Shallow Structure Hypothesis (SSH; Clahsen & Felser, 2006a; 2006b; 2006c), one of the most prominent hypotheses in the L2 processing literature, maintains that while L1 speakers use syntactic (as well as other) cues when processing sentences, L2 speakers resort to lexical and pragmatic cues, especially when faced with complex structures. For constructions such as (3), the SSH would predict for L2 speakers to be less sensitive to the mismatches created by the

syntactically closer intermediate noun (the door(s) in (3)). The SSH does not make specific predictions with respect to linear proximity but given the predicted insensitivity to syntactic details, L2 speakers might be sensitive to the mismatches caused by the local noun (the room(s) in (3)).

The linear proximity account derives mostly from WM limitations (Ellis, 2005; Fayol et al. 1994; Jespersen, 1924; Quirk et al., 1972; Harrington & Sawyer, 1992). Because S-V agreement errors occur in sentences with subjects in the form of complex NPs, mostly due to working memory limitations; the number feature of the head noun cannot be kept in the WM due to WM limitations and therefore the verb erroneously agrees with the local noun instead of the head noun (Fayol et al. 1994; Jespersen, 1924; Quirk et al., 1972). It has been shown in independent research that WM in the L2 lags behind that in the L1. If that is the case, there is reason to predict that limited WM capacity in the L2 may lead to better sensitivity to mismatches that involve linear distance than syntactic distance in S-V agreement. But, there is also research suggesting that L2 speakers are sensitive to syntactic details in complex structures (Lago & Felser, 2018; Song, 2015). This thesis aims to disentangle these two possibilities via an investigation of the effects of linear and syntactic distance on S-V agreement.

Following Franck et al. (2002) and Pearlmutter (2000), experimental sentences in the present study include complex NPs which have one head noun and two post modifying prepositional phrases (PPs) as in (3). The structure in (3) includes one head NP, *the picture* and two distractor (or intervening) nouns, one in intermediate position, *the door*, and the other noun, *the room*, local to the VP. A complex NP with two distractor NPs allows for manipulating the number feature of the second and the third noun and therefore makes it possible to investigate L2

learners' sensitivity to S-V agreement and to linear or the syntactic distance. If L2 speakers use syntactic information, then in three NP constructions such as (3), they will be affected by the number feature on the intermediate noun (e.g. the door(s)) just like the L1 speakers in the previous studies (Franck et al. 2002; Lago & Felser, 2018; Pearlmutter, 2000; Vigliocco & Nicol, 1998). But if their computations are less detailed and they cannot use syntactic cues in complex structures as proposed by the SSH, they may not be sensitive to number mismatches associated with the intermediate, syntactically closer noun (the door(s)). They may still be sensitive to the number mismatches associated with the local noun (e.g. the room(s)). This would also be predicted by WM accounts.

The participant group in the present study is Turkish speakers of English. Investigating the S-V agreement behavior of Turkish speakers of English is interesting in the sense that English and Turkish differ in their number marking of the verb. As can be observed in the examples reviewed so far, English marks number agreement on the verb especially with copula *be,* auxiliary *be* and *have.* Although Turkish is otherwise morphologically very rich, there is usually (but not always) no overt number marking on similar constructions in Turkish. This will further allow us to test whether or not unavailability of particular morphological marking in the L1 will result in insensitivity to it in the L2 for speakers coming from an otherwise morphologically rich L1 background. Chapter 2 will present further details on number marking for both English and Turkish.

Two eye-tracking experiments (Experiment 1 and 2) and one pen-and-paper gap-fill (sentence completion) task were conducted to investigate the number agreement behavior of Turkish L2 learners of English. Experiment 1 employed experimental sentences with complex subjects similar to those in the example in (3):

a complex subject including three NPs where the head noun is singular and the distracting nouns are plural (or singular). The number features of the intermediate and local nouns were manipulated. If the SSH correctly predicts how L2 speakers process these structures, then the participants will be insensitive to the number mismatch in the intermediate (syntactically closer) noun as it involves computation of complex syntax. They may still be sensitive to the number mismatch in the local (linearly closer) noun, though.

Experiment 2 also employed constructions similar to those in (3), with the exception that this time the head noun was plural and the distracting nouns were singular (or plural). It has been reported in the literature that plural nouns are marked and therefore cause more interference when they occur in intervening positions compared to their singular counterparts in the same positions (Eberhard, 1997). To ensure comparable or even enhanced saliency in singularity similar to plurality, the singular quantifier *one* instead of the definite article *the* was used to modify the intermediate and local nouns. Some previous research reported L2 speakers to be insensitive to S-V agreement errors (Jiang, 2004). But all previous studies testing S-V agreement have employed structures in which the number feature of the subject or intervening nouns was marked via nominal morphology (i.e., plural suffix). In these studies, insensitivity to S-V agreement could as well be explained by insensitivity to the morphological marking of plurality but not necessarily due to a failure to compute the agreement relations between the subject and the verb. In line with the markedness account ((Eberhard, 1997), more details in Chapter 3), using a singular quantifier, hence, is predicted to make the otherwise unmarked singular nouns marked and make the number mismatch between the head noun and the intervening nouns more salient. Thus, any (in)sensitivity to S-V agreement observed in

Experiment 2 can only be attributed to S-V agreement computations, but not to nominal morphology on the nouns in the complex subject. Use of a singular quantifier to enhance singularity also allows us to further test the predictions of the Shallow Structure Hypothesis, which predicts for L2 speakers to be more dependent on lexical information in their processing. The results of Experiment 1 and 2 together will allow us to examine the role of lexical and morphosyntactic cues, computation of number agreement between the subject and the verb, and the role of syntactic and linear factors in L2 speakers' sentence processing.

Finally, the pen-and-paper sentence completion test aims to test the participants' offline sensitivity to S-V agreement in their final interpretations of the sentences.

1.2. Organization of the thesis

The rest of the thesis is organized around the following five chapters. Chapter 2 presents number agreement in English and in Turkish. Chapter 3 reviews previous studies examining number agreement in production and processing in the L1 and the theoretical models for first language number agreement. In Chapter 4, the theoretical models for production and processing of number agreement in the L2 and studies testing these models are reviewed. Chapter 5 presents the present study investigating processing of English number agreement by Turkish L2 speakers of English and reports on the two eye-tracking experiments and one pen-and-paper gap-fill sentence completion task. Chapter 6 concludes the thesis with a general discussion on how the findings in the present study make contact with the broader literature in L2 processing.

CHAPTER 2

SUBJECT-VERB AGREEMENT IN ENGLISH AND TURKISH

2.1. Subject-verb agreement in English

English is a head-initial language which has a strict word order (Quirk et al., 1972). It does not have a rich inflectional system. All the subjects in English must be overt subjects, except for those in imperative sentences. As was mentioned in the Introduction, although there is both gender and number agreement, subjects and verbs agree only with respect to their number feature in English. Hence, I will be using the term S-V agreement (or number agreement) to refer to S-V number agreement.

S-V number agreement in English is rather straightforward: singular subjects (those referring to a single entity) require singular verbs while plural subjects (those referring to multiple entities) require plural verbs (Quirk et al., 1972, p. 756).

Some very general rules of S-V agreement in English can be summarized as follows: for all verbs, except for the auxiliary *be*, the copula *be* and the auxiliary *have*, S-V agreement is morphologically marked only in the simple present tense. In the simple present tense, a third person singular subject requires the verb to be marked with the suffix *–s*; all other subjects require the verb to be in the base form in morphology. The auxiliary and the copula *be* are inflected as *am/is* after singular nouns and as *are* after plural nouns in the present tense. Singular subjects require the verb *be* to be inflected as *was and* plural subject require the verb be to be inflected as *were* in the past tense. The auxiliary *have* is inflected as *has* after singular subjects and is used in its bare form *have* after plural subjects and first person singular

pronoun *I* expressing perfect aspect in present. It is inflected as *had* for all subjects expressing perfect aspect in the past (Greenbaum, 1991).

When the subject is a complex NP, the verb must agree with the head noun which is syntactically the highest noun within the subject NP. The head noun is referred to as the *controller* of agreement since it controls the agreement process and the verb is called the *target* (Nicol, Teller & Greth, 2001; Vigliocco et al., 1996). Since English is a head-initial language, any type of modifying prepositional phrases follows the head noun. Even if there are some intervening phrases as exemplified in (1) below, the verb must agree with the head noun (i.e. *the key*). Singularity (S) and plurality (P) of the head and local nouns as well as the verb are provided in parentheses in their order of occurrence in the sentence.

(1) a. The key to the cabinet was lost. (SS-S)

b. The key to the cabinets was lost. (SP-S)

c. The keys to the cabinets were lost. (PP-P)

d. The keys to the cabinet were lost. (PS-P)

(Bock & Miller, 1991, p. 56)

Studies investigating S-V agreement have reported two processes for S-V number agreement inflection: feature-copying and feature-unification. The inflectional processes including number agreement are assumed to be realized via feature-copying (Hartsuiker et al., 2001; Nicol et al., 2001) or feature-unification (Franck et al. 2002; Hartsuiker et al. 2001; Kaplan & Bresnan, 1982; Nicol et al., 2001; Vigliocco et al. 1996).

2.1.1. The feature-copying account

In languages such as English, the subject precedes the verb. The feature-copying account relies on this linear order and predicts that the verb of the sentence, not having its own number feature, copies its number feature from the subject NP (Gazdar, Klein, Pullum & Sag, 1985; Hartsuiker et al., 2001; Nicol et al., 2001). The subject head in which the number information is fully specified occurs before the verb and the verb receives its inflectional feature from the subject NP. The head noun in English is higher in the tree structure than any non-head NP and therefore the head noun is the controller of agreement (Franck et al. 2002; Nicol et al., 2001). The feature-copying account is supported with the observation that while verbs carry the characteristics of the subject (i.e., person, number, gender) subjects do not contain the characteristics of the verb (e.g., tense). This is taken as an evidence for the 'rightward' feature copying process from the subject to the verb (Gazdar et al., 1985). Figure 1 shows agreement through feature copying.

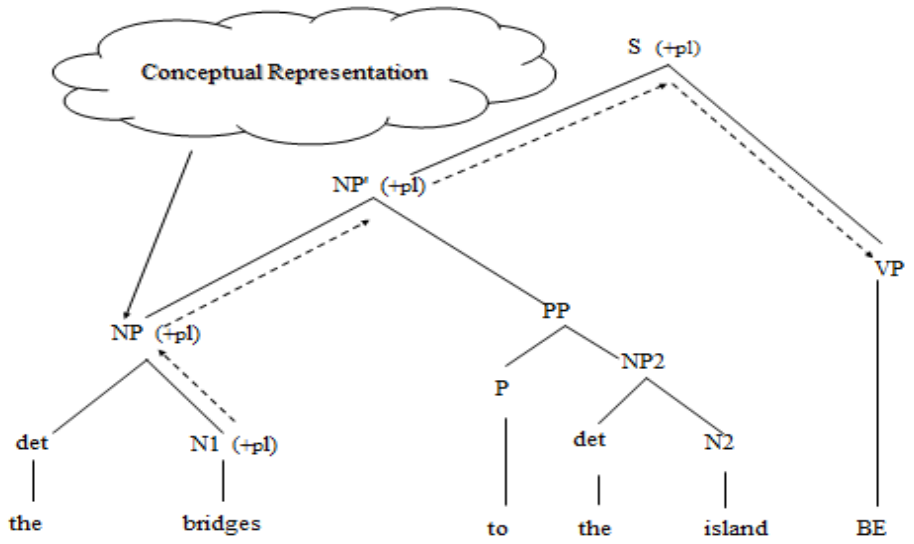


Figure 1. Agreement through feature-copying (Taken from Nicol & Greth, 2003, p. 202.). Conceptual representation shows the intended number feature in the speaker's mind. Dashed arrows show the migration of number feature from the head noun to the verb

In complex subjects such as *the key to the cabinets* (Bock & Miller, 1991), *the key* is the head NP and *the cabinets* is the local NP. The verb's (*be*) inflection should agree with that of the head noun (*the key*) but the intervening local noun (*the cabinets*) might cause distraction while the structure is being computed and the verb might mistakenly agree with the local noun. Agreement errors usually occur when agreement features are copied from the local noun instead of the head noun (Nicol et al., 2001).

2.1.2. The feature-unification account

Unlike the feature-copying account, the feature-unification account predicts the number features of the subject and the predicate to be realized separately. For the subject and the predicate to unify, they have to agree in their number feature (Franck et al. 2002; Hartsuiker et al., 2001; Kaplan & Bresnan, 1982; Nicol et al., 2001; Pollard & Sag, 1994; Vigliocco et al., 1996).

Figure 2 shows agreement via feature unification. It has been argued that the specific language determines whether agreement is realized via feature-copying or via feature-unification (Nicol & Greth, 2003; Pollard & Sag, 1994). The existence of *pro*-drop subjects requires the verb to be independently specified for number. The reason is that in such situations the number feature cannot be copied from the subject to the verb because the copying process would necessitate the subject to precede the verb.

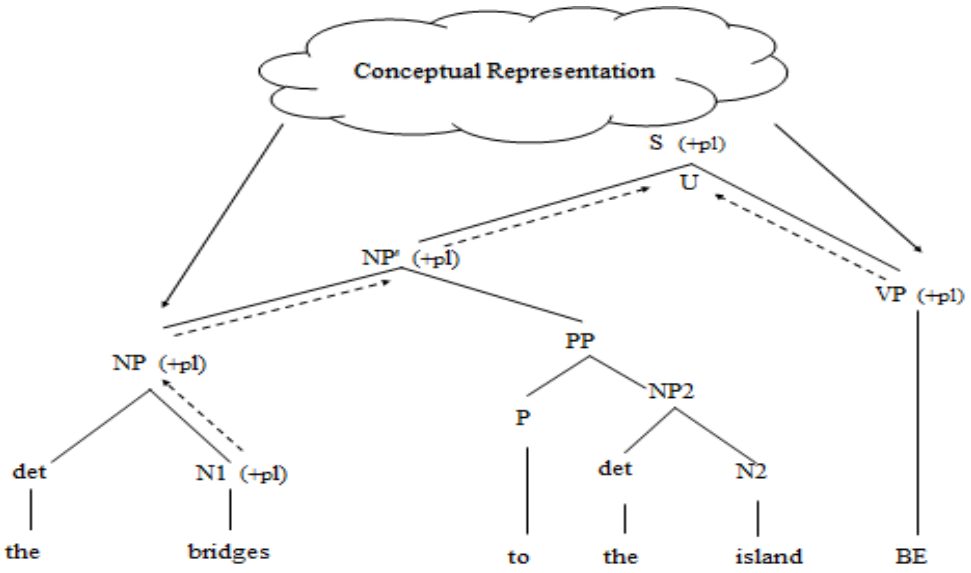


Figure 2. Agreement through feature-unification (Taken from Nicol & Greth, 2003, p. 202). Conceptual representation shows the intended number feature in the speaker's mind. The dashed arrows show the number feature's migration. The specified number features migrate from the subject and the verb separately and they are unified at the highest level. Unification is represented with "U" in the figure

If there is no overt subject, the verb would not be able to copy any features from the subject. The languages which have *pro*-drop also generally have rich-inflection, where the specific (agreement) features of the subject are recoverable from the verb. Hence, the verb must be independently specified for number in these languages. This leads to the arguments that agreement is realized via feature unification in languages with rich inflection (e.g., Italian, Spanish, Russian, Turkish) but for languages with poor-inflection, fixed word-order and overt subjects (e.g., English), agreement is considered to be realized via feature-copying (Nicol et al., 2001; Vigliocco et al., 1996).

2.2. Subject-verb agreement in Turkish

Turkish is a head-final *pro*-drop language, with a rich inflectional system. Since it is a *pro*-drop language subjects do not need to be overtly mentioned in Turkish (Göksel & Kerslake, 2005; Kornfilt, 1997). The verbal inflection allows for recovering

person and number features of the subject as is the case in other *pro*-drop languages (Göksel & Kerslake, 2005; Kornfilt, 1997). Table 1 illustrates verbal inflection for all simple tense forms (the present progressive, the aorist, the reported past and the future) except for definite past (for more detailed information covering different tenses of Turkish see Kornfilt, 1997, p. 382). Third person singular and third person plural are important for the discussion of morphological number agreement on the verb.

Table 1. Person Agreement in Turkish

Subject-Verb Person	Agreement in Turkish
1.sg.	-Im
2.sg.	-sIn
3.sg.	-Ø
1.pl.	-Iz
2.pl.	-sInIz
3.pl.	-lAr

(Kornfilt, 1997, p. 382)

As can be seen from Table 1, singular and plural marking are realized via verbal inflection in Turkish. Overt marking of number agreement is always realized on the verb except for third singular person in Turkish (Göksel & Kerslake, 2005).

The marking of third person plural (-lAr)[2] is divergent depending on whether or not there is an overt subject, and the specificity and the humanness of the subject NP. If the plural subject is null, the verb has to be marked for plurality as in (2) (Göksel & Kerslake, 2005):

[2] Third person plural suffix –lAr undergoes changes according to vowel harmony. As its vowel is non-high, it undergoes backness harmony. The morpheme can alternate between –lar and –ler according to the backness of the last vowel in the stem (Kornfilt, 1997, p. 268)

(2) Ø Bodrum-a git-ti-ler.

Pro Bodrum-DAT go-PAST- 3 PL

They have gone to Bodrum.

(Göksel & Kerslake, 2005, p. 116)

In the case of a plural subject such as *haydut-lar* (robber-PL), if the verb is not marked for plurality, the subject is considered to be non-specific or non- referential (e.g., *haydutlar* (robbers) in (3)) but if the verb is marked for plurality, the subject is considered to be definite (e.g., *haydutlar* (the robbers) in (4)) (Kornfilt, 1997).

(3) Köy-ü haydut -lar bas-mış.

Village-ACC robber -PL raid-REP.PAST

They say that robbers raided the village.

(Kornfilt, 1997, p. 385)

(4) Köy-ü haydut -lar bas-mış-lar.

Village-ACC robber -PL raid-REP.PAST-3 PL

They say that the robbers raided the village.

(Kornfilt, 1997, p. 386)

When the subject is human and specific such as *öğrenci-ler* (student-PL) as in (5), marking the verb for plurality is optional but it is not common.

(5) Öğrenci-ler bahçe-ye gir-di(-ler.)

Student-PL garden -DAT enter-PAST(-3 PL)

The students entered the garden.

(Kornfilt, 1997, p. 386)

In the case of non-human third person plurals such as *köpek-ler* (dog-PL) in (6) overt plural agreement is usually omitted. The use of overt plural agreement with inanimate subjects such as *taş-lar* (stone-PL) in (7) is even less common.

(6) ?? Köpek-ler bahçe-ye gir-miş-ler.
Dog-PL garden -DAT enter-REP. PAST-3 PL
They say the dogs entered the garden.

(Kornfilt, 1997, p. 387)

(7) ??/* Taş-lar yamaç -tan vadi-ye doğru yuvarla-n-dı-lar.
Stone-PL slope-ABL valley-DAT towards roll-REFL-PAST-3 PL
The stones rolled down the slope (of the mountain) towards the valley.

(Kornfilt, 1997, p. 387)

However, when the plural inanimate subject is null in the sentence, the verb is required to be marked with plural inflection. As can be seen in example (8a), although in the verb *gelmedi* (not arrived) third person plural is omitted, the null subject in (8b) with the same features as the overt subject in (8a) requires third person plural inflection on the verb (Kornfilt, 1997).

(8) a. Bavul-lar-ın hala gel-me -di-ø -mi?
Suitcase-PL-POSS still come-NEG-PAST-3 SG-Q?
Have your suitcases still not arrived?

b. Ø Bu sabah gel-di-ler.

Pro this morning come-PAST-3 PL

They arrived this morning.

(Kornfilt, 1997, p. 387)

When the plural subject is modified by a numeral or a determiner such as *elli iki* (fifty-two) in (9), again, the verb is not marked for plurality (Göksel & Kerslake, 2005).

(9) Bu sınıf -ta elli iki öğrenci var.

This class-DAT fifty two pupil-PL exist

There are fifty-two pupils in this class.

(Göksel & Kerslake, 2005, p. 117)

To sum up, in Turkish, third person plural agreement depends on the overtness, specificity and humanness of the subject in Turkish (Göksel & Kerslake, 2005; Kornfilt, 1997). This is rather different from English where a plural subject requires the verb to be also marked for plurality.

Another difference between Turkish and English might be in the way S-V agreement is realized. Recall that, in line with feature-unification account (Gazdar et al., 1985Hartsuiker et al., 2001), the existence of *pro*-drop subjects require the verb to be independently specified for number because if there is no overt subject, the verb would not be able to copy any features from the subject. As Turkish is a *pro*-drop language, the verb must be independently specified for number but as English has poor-inflection, fixed word-order and overt subjects, agreement is considered to be realized via feature-copying (Nicol et al., 2001; Vigliocco et al., 1996). Therefore,

the different mechanisms in realizing S-V agreement between English and Turkish may create difficulties in computing S-V agreement in English for Turkish speakers.

Having summarized the most important points about S-V agreement in English and Turkish, Chapter 3 will report on first language sentence production and processing accounts and studies investigating S-V agreement in sentence production and processing.

CHAPTER 3

SUBJECT-VERB AGREEMENT IN THE FIRST LANGUAGE

The ultimate aim of sentence processing is assigning meaning to the sentences (Frazier, 1987) that are spoken or written. Understanding how number agreement is assigned during language production and how it is processed in comprehension is important in understanding the mechanisms underlying language use. Section 3.1 below presents models of sentence production and how S-V agreement is handled under these models. Section 3.2 will review models on sentence processing in general and processing S-V agreement in particular.

3.1. Sentence production and S-V agreement

S-V agreement in production will not be investigated in this study but to understand S-V agreement in sentence processing, it is important to first examine the processes underlying sentence production. This will allow us to study when and why errors occur while producing agreement morphology.

To produce an utterance, a speaker formulates a message, chooses words, organizes words in the correct syntactic order and articulates the sentence (Taylor, 1990, p. 112). It is not clear whether those stages operate autonomously in a serial fashion or they operate interactively in a parallel fashion.

In the Top-down Serial Models by Fromkin (1973), Garrett (1975), Bock and Levelt (1994), levels of sentence production progress serially. In these models, upon selecting the message, the speaker must construct the syntactic structure and sentential prosody. Once the syntactic structure and prosody are constructed, content words should be selected and then affixes and function words should be formulated.

As the last stages, phonetic segments are specified and finally the utterance is articulated. It is assumed in the top-down serial model that processing at one level must end before it is possible for processing to start at the next level.

One of the most prominent serial models of sentence production is Bock and Levelt's model of sentence production (1994). Although Levelt, Roelofs and Meyer (1999) later proposed a revised version of this model for sentence production (more specifically word retrieval) (i.e., Weaver ++, Levelt et al., 1999), in Weaver ++, Levelt et al. refrain from discussing the mechanisms of agreement assignment during sentence production because the main purpose of Weaver ++ is to unravel the mechanisms behind word retrieval from lemma selection to phonetic encoding, not subject-verb agreement. And they refer to the earlier model of Bock and Levelt (1994) for grammatical encoding: "A verb's number feature, for instance, is set by agreement, in dependence on the sentence subject's number feature. Here we must refrain from discussing these mechanisms of grammatical encoding (but see Bock & Levelt, 1994)…".

The Bock and Levelt Model (1994) consists of four levels: message, functional processing, positional processing and phonological encoding. The functional and positional processing are grouped under grammatical encoding (see Figure 3). In this model, grammatical encoding is an unconscious stage in which the basic structure of utterances is constituted (Bock & Levelt, 1994). Figure 3 shows the levels of Bock and Levelt's sentence production model in detail.

As can be seen in Figure 3, the first level is the Message level. In this level, the main idea to be conveyed is formed. The next level, functional processing level is subdivided into two sections: lexical selection and function assignment. Lemmas

(abstract conceptual form of a word in our minds) are sorted out in the lexical selection level. Syntactic processes that control the grammatical encoding of a sentence are represented by the nodes of lemma level (Bock & Levelt, 1994; Vigliocco & Franck, 1999). In functional assignment, syntactic roles and grammatical functions are delegated.

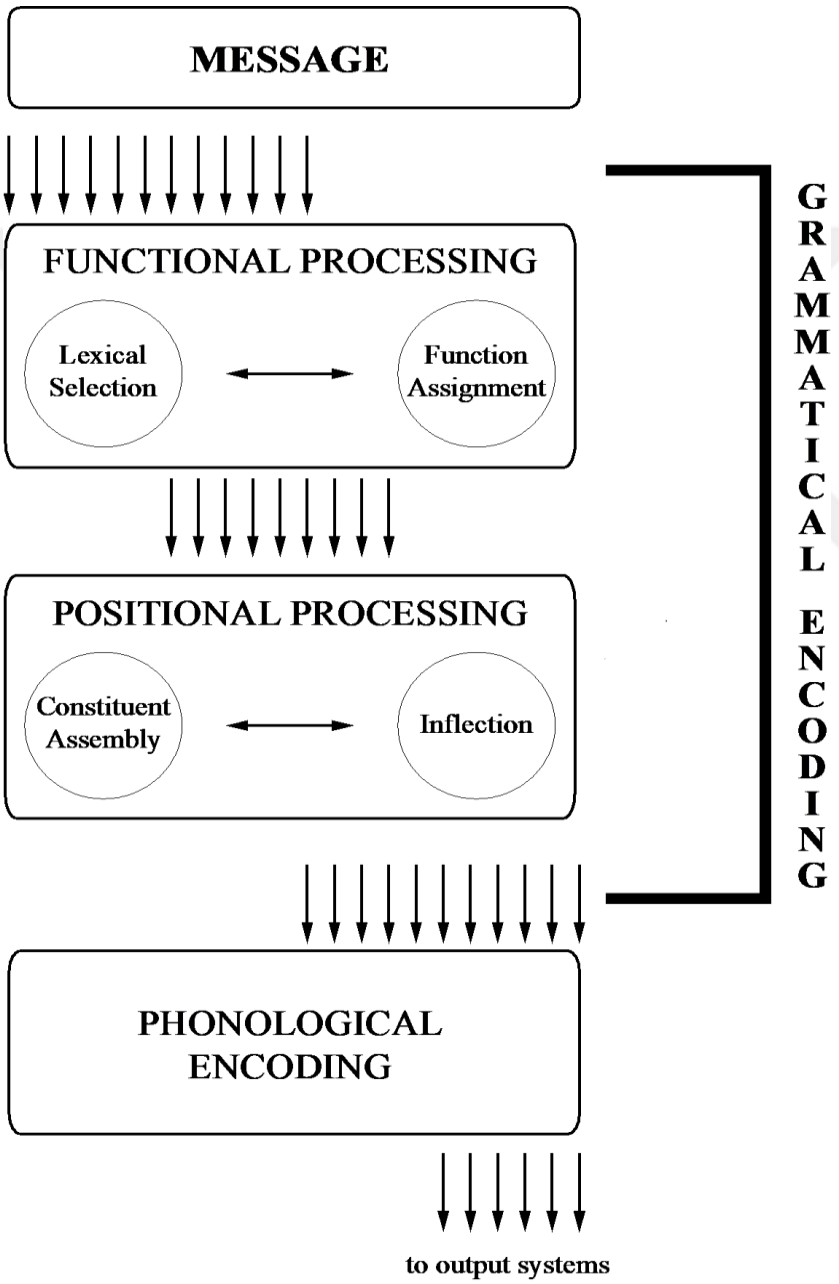


Figure 3. Bock and Levelt's model of sentence production (Adapted from Bock and Levelt (1994, p. 94))

Positional processing is the next level where the order and inflection of every morphological slot is settled. Positional processing also has two elements: constituent assembly and inflection. Constituent assembly includes hierarchical relationships among phrasal structures and word order. For the purposes of this study, the most relevant level is the inflection level. At the inflection level, number, gender, tense and aspect inflection and corresponding information are stored and they are connected to the nodes of a phrase structure (Bock & Levelt, 1994). As Bock and Levelt stated:

> [t]he only factor that reliably created attraction errors was grammatical plurality (i.e., subcategorized plurality) of the attracting noun. Because grammatical plurality is a property of lemmas rather than of nonlinguistic concepts or messages, lemmas may be the principal source of number agreement features in English utterances. The obvious place to state this dependency in the general architecture we have set out is within functional processing. […] the creation of the dependency requires that the finite (tense and number carrying) verb and the noun lemma linked to the nominative function have the same number. For this to happen, the verb must inherit the subject's number feature.
>
> (Bock & Levelt, 1994, p. 975)

In the final level of the model, phonological encoding, sound units and phonemes are assembled which are carried to the articulatory or output system. In Bock and Levelt's (1994) production model, it is proposed that sentence production is incremental because the speaker starts with linguistic planning and chooses the first few words of the sentence and then prepares the rest of speech (Bock & Levelt, 1994).

Unlike the top-down serial models, the interactive parallel models predict that all cognitive levels of sentence production (e.g., semantic level, lexical selection level, and phonological level) operate in parallel at the same time (Dell, 1986; Dell, Schwartz, Martin, Saffran, & Gagnon, 1997; McClelland & Rumelhart, 1981;

Rumelhart & McClelland, 1982). In these models, any level can interact with one another in a parallel way. Among interactive parallel models, the only model which makes predictions for inflectional processes is Spreading Activation Theory (i.e., the Dell Model) by Dell (1986). In Dell's model, speech is produced by a number of connected nodes which represent different units of speech (e.g., phonemes, morphemes, syllables, and concepts) that interact with each other in all directions, from the semantic level to the syntactic, morphological and phonological levels. These levels work in parallel with activation in each level. When a word is chosen, the nodes which represent that word's constituent morphemes, phonemes, semantics and syntax are activated and this activation spreads to the adjacent nodes up until the node that has the highest activation and the node which has the highest actıvation is chosen for the output string. Dell (1986) described the activation process as: "The defining components of spreading activation are spreading, summation, and decay. When a node has an activation level greater than zero, it sends some proportion of its activation level to all nodes connected to it (spreading)." (p. 287). However; while these levels are activated, interference or inactivation can occur in any stage. The likelihood of selecting a word (or other units) is linked to its level of activation; therefore, if an unintended unit is activated too much, this unit will be erroneously selected. For example, if a speaker wants to use the word *cat*, he/she starts with the conceptualization of a four-legged, furry animal and the conceptual set tried to retrieve the corresponding word *cat*. This chosen word selects the morpheme {cat} and then the phonemes /k/ /æ/ and /t/. However an interference in the phonological level for example may end up in activation of another word with similar sounds (e.g., mat, rat) as those words are active because of feedback from common phonemes or

an interference in semantic level may end up in activating the word *dog* (as there is a semantic relation - both cat and dog are four-legged animals that are usually pets).

Although not explaining S-V agreement specifically, Dell (1986) stated that all inflectional processes are computed within the syntactic node and any error of inflection is a result of an inactivation of this node or interference by another inflection marker. Information from semantic representation and input from the activated word nodes facilitates the activation of the syntactic node. Dell (1986, p. 316) explains this process as: "… the activation levels of word nodes will have to be taken into account by the syntax. For example, if an intransitive verb is very highly activated, it will have to assure the creation of a frame without a direct object." Although it is not proposed by Dell (1986), this can account for number agreement. For instance, if a plural head noun is highly activated, it will require the activation of a plural verb in the syntactic node or in the case of errors of attraction, a highly activated plural local noun might cause interference in selecting the correct inflection for the verb in syntactic level, although the head noun is singular.

In serial models of speech production (Fromkin, 1973; Garrett, 1975; Bock & Levelt, 1994) production is presented as a series of sequential stages, with earlier stages made of large units (i.e., sentences and phrases), and later stages including smaller unit constituents (i.e., phonemes, morphemes, syllables). In these models, production stages are independent and there is a unidirectional flow of information. However, in interactive parallel models, information can flow in any direction and hence the semantic level can get feedback from other levels (e.g., the syntactic, morphological and phonological levels) and vice versa. Information at any level can be concurrent with different levels and because of that, the levels of these models have interacting activity. Under these two umbrella terms, the two models which are

the most relevant to inflectional processes and S-V agreement is Bock and Levelt's model (1994) and the Dell Model (1986) which have different explanations for inflection processes. While Bock and Levelt explain sentence production as an incremental process starting with the message and ending in articulation with a specific step for inflection assignment, Dell explains it with activation of nodes and spreading of this activation to other nodes and although there is not a specific prediction for S-V agreement, Dell proposes that inflectional processes are computed by activation in the syntactic node.

We now turn to processing of S-V agreement.

3.2. Sentence processing and S-V agreement

In sentence processing the ultimate aim of the human sentence processing mechanism (henceforth, the parser) is to reach at the meaning of the sentence and to do so as quickly as possible (Frazier, 1987). The parser uses both linguistic and non-linguistic information in sentence processing. There is not a consensus in the psycholinguistic literature whether linguistic and non-linguistic information are used separately or interactively (Taylor, 1990). Depending on how sentence processing is viewed with respect to the parser's use of these sources of information, sentence processing models take either an autonomous parser approach (models that assume independent use of linguistic information) or an interactive approach (models that assume interactive use of linguistic and non-linguistic information).

In autonomous/modular models, the processing system contains lexical, structural and interpretive processes. Linguistic information is used to get words from the mental lexicon by the lexical processor and syntactic information is utilized by the syntactic processor. Finally, world knowledge is used by the interpretive

processor to form the meaning and to give the output of the structural processor (Forster, 1979; Garrett, 1980). The autonomous models assume that all these three processes are computed separately and in the order given: lexical, structural and interpretive.

One of the most prominent autonomous (or modular) models of sentence processing is the garden-path model proposed by Frazier (1987). The garden path model assumes that although semantic and pragmatic information are used for interpretation of meaning, they are not part of the syntactic processor; syntactic information is the primary source of information (see Frazier 1987 for a detailed discussion).

Unlike the autonomous models, the interactive parallel models predict for pragmatic, syntactic and semantic components to interact and operate together to achieve sentence comprehension (Gibson & Pearlmutter, 1998; Koda, 2005; Taraban & McClelland, 1988; Wingfield & Titone, 1998). As such, these models assume that the parser utilizes all possible sources of information involving syntax at the same time. Syntactic interpretations of a sentence are developed constantly and preserved until the parser decides on a final interpretation (Koda, 2005). In interactive parallel processing, all sources of information such as syntax, semantics and pragmatics are assumed to be active in the initial stages of processing but in the end, the parser reaches one analysis from many possible interpretations in light of the most suitable interpretation (See Gibson & Pearlmutter, 1998; Wingfield & Titone, 1998 for a detailed discussion.)

Although, for languages that have a strict word order (e.g., English) computing S-V agreement does not appear to be necessary for comprehension (due

to their stable positions in the sentence, subjects and verbs can be identified without processing agreement) (Nicol, Forster & Veres, 1997; Pearlmutter, Garnsey & Bock, 1999) and although in some languages such as English, S-V agreement is also not always overtly marked (except for specific instances such as the copula *be*), reading studies showed (even for English L1 speakers) that comprehenders are sensitive to ungrammaticalities triggered by S-V agreement violations (Dillon et al., 2013; Pearlmutter et al., 1999; Wagers, Lau & Philips, 2009). That is, L1 speakers have been reported to pay attention to S-V agreement information and to experience difficulty in processing in sentences violating S-V agreement even when the illicit S-V agreement did not crucially alter meaning (Dillon et al., 2013; Pearlmutter et al., 1999; Wagers et al., 2009). It is not clear under either the autonomous serial processing models or interactive parallel processing models when and how S-V agreement is performed in language processing (Nicol et al., 1997).

A relatively more recent model, namely the *cue-based memory retrieval* model by Lewis and Vasisth (2005), proposes that processing all dependencies including S-V agreement occurs at the retrieval stage of previously encountered items where a set of cues that are defined by the verb are checked against all representations in the working memory and the most suitable controller candidate is retrieved. The cue-based memory retrieval model is a syntactic production/ processing model which stems from a broader cognitive model named Adaptive Control of Thought-Rationale (ACT-R) (Anderson & Lebiere, 1998) and it combines sentence processing mechanisms with general cognitive theory principles to accommodate for both structural factors and semantic/planning effects in sentence processing (Lewis & Vasishth, 2005). The main assumption of the cue-based

memory retrieval model is that language processing does not involve a specific module but it rather draws on general constraints on cognition.

In cue-based memory retrieval processing cycle, there are two important notions: chunks and buffers. Chunks are feature bundles (e.g., case, number, argument structure, word category) of each lexical entry. Buffers are temporary memory areas where data is kept while it is being processed or transferred. There are four buffers in the model and each of them holds a single chunk, available for processing. Any information outside of the buffers has to be retrieved. Figure (4) shows a typical processing cycle of the model: first, a word is attended and a lexical entry is retrieved from declarative memory (1) (including syntactic information and argument structure) and held in the lexical buffer (2). Then, based on the syntactic expectation created by the lexical entry, retrieval cues are set (3). Some time is spent on working memory access (4) and eventually a single chunk which is held in the retrieval buffer is yielded (5). Depending on the retrieved constituent, a new syntactic structure is created and it is attached to the retrieved constituent (6). Also, the control buffer is updated based on the new syntactic prediction (7). In the end, attention is guided to the next word.

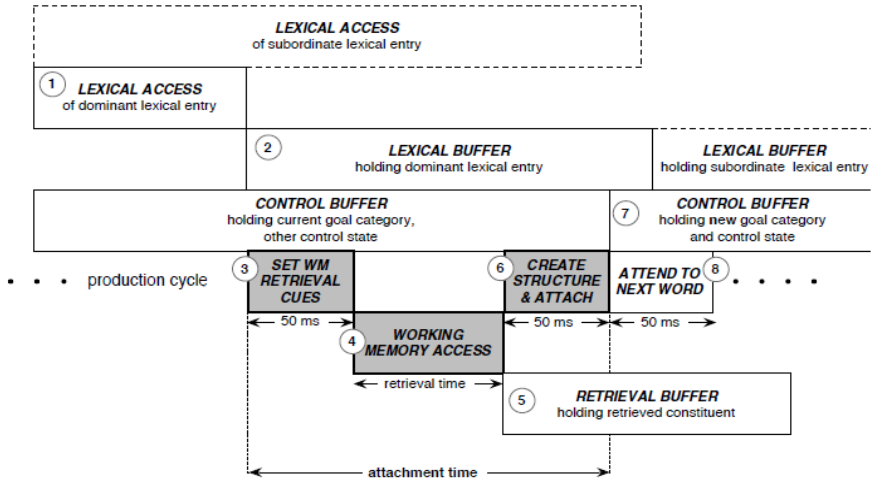


Figure 4. Processing cycle in cue-based memory retrieval model (Taken from Lewis & Vasishth (2005, p. 383))

In the case of S-V agreement, the cue-based memory retrieval account predicts that when the subject NP is processed it creates, in the working memory, an encoding of a representation of the NP itself and a prediction for the verb that the NP is the subject of. This prediction stays in the working memory – but outside the focus of attention (Levis & Vasisth, 2005) as the focus of attention is limited (Lewis, Vasisth & Van Dyke 2006). When the verb is encountered in the sentence, a search process is commenced by the verb to check the feature of a controller. The search starts with a set of cues (representational elements which denote subjecthood such as nominative case, to occur before the verb, specifier position in the verb phrase, number, person) that are checked against all representations in the working memory and the most suitable controller candidate (i.e., the previously encountered NP with the most suitable representational elements) gets to be retrieved as the controller (Lewis et al., 2006). Figure (5) shows S-V agreement according to cue-based memory retrieval in an example sentence.

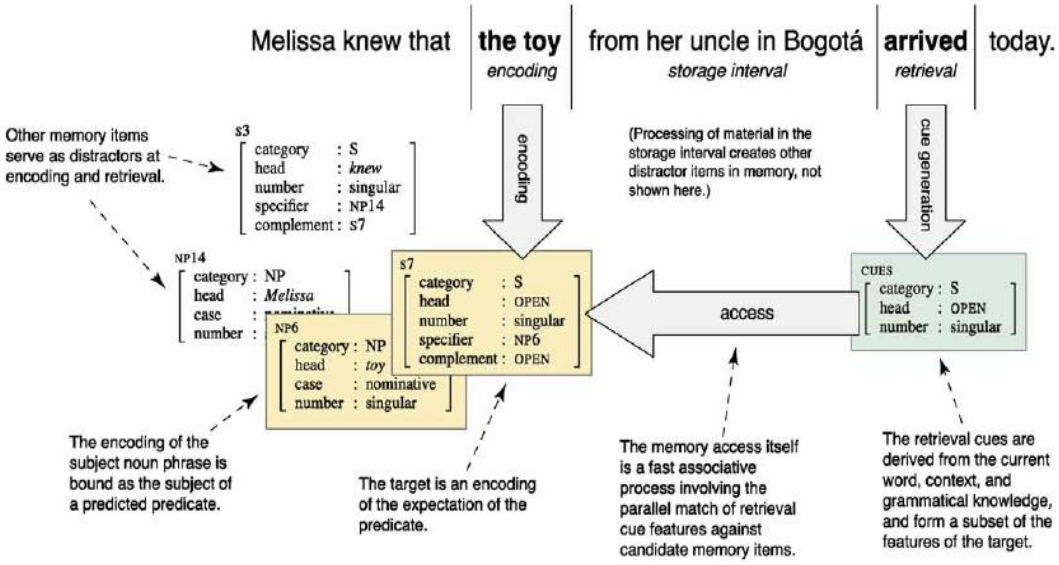


Figure 5. Processing cycle for S-V agreement in cue-based memory retrieval model (Taken from (Lewis et al., 2006, p. 448))

There are two important factors that affect the retrieval process: activation-based decay and similarity-based interference (Lewis & Vasishth, 2005). An item's (previously encountered lexical entries with their syntactic information, including argument structure) activation level decays immediately after it is first encountered and as other items are encountered. Therefore, activation-based decay assumes that linear distance affects dependency resolutions. That is, more recent items will be more easily retrieved (Lewis & Vasishth, 2005). However, Lewis and Vasishth (2005) and Lewis et al. (2006) also state that previously encountered items can be reactivated by additional retrieval, for example retrieving a relative pronoun may re-increase the activation levels of the referent noun.

Similarity-based interference has to do with cue-matching during retrieval of an item from the working memory. When retrieving an item from the working memory, the available cues are checked, in parallel, for all the previously encountered items in the working memory. The item which provides the best match to the given set of cues becomes highly activated and is retrieved. But occasionally, an item whose features partially match the retrieval cues can be retrieved. Therefore, similarity-based interference assumes that successful retrieval is negatively influenced by the number of items in memory which matches the cues during retrieval (Lewis & Vasishth, 2005).

The studies for S-V agreement and cue-based memory retrieval model will be explained in detail in section 3.3.

3. 3. Production and processing of S-V number agreement

S-V number agreement errors occur when the subject and the verb fail to agree in their number marking. S-V agreement errors have been reported to occur more

frequently when the subject of a sentence is complex and there are other NPs intervening between the head noun in the subject NP and the verb of the sentence. See example in (1) below:

(1) *The key to the cabinets were lost.

(Bock & Miller, 1991, p. 56)

In (1) the copula *be* must agree with the singular head NP in the subject, *the key*, but it erroneously agrees with the intervening plural NP, *the cabinets*, and is marked for plural morphology. The frequency of S-V agreement errors in such constructions has led researchers to investigate them in experimental contexts because systematic errors of a specific type can be windows to how cognitive mechanisms operate. Bock (1995) notes that:

> [a]greement errors promise to reveal something about the potential interactions between conceptual and grammatical constraints because speech errors in general often arise when conflicting linguistic forces are at work. At the same time, because speech errors are tightly restricted by properties of normal language production, the characteristics of errors should be interpretable in terms of the mechanisms that are available for error-free language use.
>
> (Bock, 1995, p. 57)

Investigating S-V agreement errors in experimental paradigms has resulted in different views on the causes of these errors. Some views attribute the problems to the restraints that the working memory limitations place on the cognitive mechanisms (e.g., the linear distance hypothesis, Jespersen, 1924; Quirk, Greenbaum, Leech & Startvik, 1972). Others argue that the operations of the linguistic system and the syntactic proximity (e.g., the clause-packaging hypothesis, Bock & Cutting, 1992; syntactic distance hypothesis, e.g., Franck et al., 2002; Kempen & Hoenkamp, 1987; Levelt, 1989; Pearlmutter, 2000; Pollard & Sag, 1994; Vigliocco & Nicol, 1998), the morphological markedness of the intervening NPs

(e.g., the markedness account, Eberhard, 1997; the head-overwriting account, Pearlmutter, Garnsey & Bock, 1999) or interference in cue-based retrieval from memory (e.g., Lewis et al., 2006; Lewis & Vasishth, 2005; Tanner & Bulkes, 2015; Wagers et al., 2009) can account for the pattern of S-V agreement errors.

The linear distance hypothesis (Bock & Miller, 1991; Jespersen, 1924; Quirk et al., 1972) states that the verb erroneously agrees with the closely preceding local noun instead of the head noun because, due to memory limitations, speakers have difficulty in tracking the correct number feature from the head noun the verb.

The clause-packaging hypothesis (Bock & Cutting, 1992) maintains that S-V agreement is computed within clause boundaries and S-V agreement errors occur more within the same clause than across different clauses.

The syntactic distance hypothesis (Levelt, 1989; Franck et al. 2002; Pearlmutter, 2000; Vigliocco & Nicol, 1998) claims that agreement attraction occurs due to the syntactic distance (not linear distance) between the intervening noun and the head noun. The intervening noun which is closer to the head noun syntactically causes more interference in agreement assignment as the syntactically closer noun's number feature is more likely to percolate up to the head noun.

The markedness account (Eberhard, 1997) predicts more S-V errors when the local noun is plural and the head noun is singular than when the local noun is singular and the head noun is plural because plural nouns are considered to have a marked number feature, making them more attractive for the verb to agree with. Singular nouns can only be marked when they are modified by a numeral modifier.

Similar to the markedness account, the head-overwriting account (Pearlmutter et al., 1999) also predicts more agreement attraction when the local noun is plural

and the head noun is singular but it also accounts for this asymmetry. The argument under the head-overwriting account is that the marked number feature of plural local nouns overwrites the number feature of singular head nouns so errors of agreement attraction occur.

Finally, the cue-based memory retrieval account (Lewis & Vasishth, 2005; Lewis et al., 2006) maintains that agreement attraction occurs due to interference in working memory during retrieval stage where a set of cues that are generated by the verb are checked against all representations in memory and the partially matching NPs might be retrieved instead of the subject. Details on these accounts and the studies that tested them are explained in the following sections.

3.3.1. The working memory and the linear distance hypothesis

The *linear distance hypothesis* (also called *the proximity concord*), proposed by Quirk et al. (1972), maintains that S-V agreement errors occur in sentences with subjects in the form of complex NPs, mostly due to working memory limitations. The parser faces difficulty in assigning the number feature to the verb when there is a noun that intervenes between the head noun and the verb because keeping track of the number feature of the head noun is a challenge for the working memory and in most cases the verb erroneously agrees with the local noun instead of the head noun (Jespersen, 1924; Quirk et al., 1972). This view predicts increased difficulty in S-V agreement with more intervening words between the subject head noun and the verb because the parser's cognitive resources would have been consumed to remember the number feature of the subject by the time it encountered the verb in the sentence (Jespersen, 1924).

The linear distance hypothesis has been tested in several studies (Bock & Cutting, 1992; Bock & Miller, 1991; Eberhard, 1997; Vigliocco & Nicol, 1998)[3]. Bock and Miller (1991) were the first to experimentally investigate subject-verb agreement errors. Their experiments tested whether agreement attraction errors (such as **The key to the cabinets were rusty*) which occurred spontaneously in English during production could be observed in laboratory setting. Recall that in agreement attraction the verb agrees with a noun other than the subject. In the example **The key to the cabinets were rusty*, the verb agrees with the attractor or the local noun *the cabinets* instead of the subject *the key*. The effect is caused by the mismatch between the head of the subject NP and the intervening NPs in their number feature. In addition to the mismatch asymmetry that is caused by a plural local noun intervening between the singular head noun and the verb, they also tested whether or not the animacy of the local noun affected the number agreement assignment on verbs. Their study included three sentence preamble completion experiments in English.

In their first experiment, the participants were auditorily presented with some preambles where the number feature of the head and local noun was manipulated in that either the head noun was singular and the local noun was plural as in (2) or the head noun was plural and the local noun was singular as in (3). The post-modifying NPs (i.e., the local/attractor NPs) occurred in either prepositional phrases (PPs) as in (2a, 3a) or relative clauses (RCs) as in (2b, 3b). The length of the preamble was also manipulated in that both the PPs and RCs were either short as in (2, 4) or long as in (3, 5). The PP/RC modification was included to test the effect of clause boundaries in S-V agreement assignment. The length of the PPs and RCs were modified to test the

[3] Although all these studies examined linear distance in at least one of the experiments, they also examined other accounts as well; therefore, they will be discussed in more detail under following accounts (syntactic distance, clause packaging hypothesis, markedness account, head-overwriting account) regarding S-V agreement.

role of working memory in producing S-V agreement. The specific question was whether or not longer post-modifiers would result in more errors (as would be predicted by the linear distance hypothesis) since there would be more material between the head of the subject NP and the verb. The participants' task was to repeat the preambles back and complete each preamble to full sentences.

(2) Singular head, plural local noun, short preambles:

a. PP: The key to the cabinets

b. RC: The boy that liked the snakes

(3) Singular head, plural local noun, long preambles:

a. PP: The key to the ornate Victorian cabinets

b. RC: The boy that liked the colorful garter snakes

(4) Plural head, singular local noun, short preambles:

a. PP: The keys to the cabinet

b. RC: The boys that liked the snake

(5) Plural head, singular local noun, long preambles:

a. PP: The keys to the ornate Victorian cabinets

b. RC: The boys that liked the colorful garter snakes

(Bock & Miller, 1991, p. 56)

In addition to these experimental preambles in which the local noun and the head noun mismatched in their number feature, the experiment included baseline (control) conditions in which the head noun and the local noun matched in their number feature. The results of Bock and Miller's Experiment 1 showed that in the singular head, plural local noun condition (2a, 2b, 3a, 3b) participants made significantly more agreement errors but there was no reliable difference in the number of errors made in the longer local noun conditions (3, 5) compared to the

shorter local noun conditions (2, 4). Participants also produced more errors following preambles with PPs compared to preambles with RCs. The first experiment proved that the mismatch errors that were detected in spontaneous production before could actually be tested and observed in the laboratory setting.

Having proven the occurrence of attraction errors in experimental settings, in their Experiment 2, Bock and Miller tested whether animacy and concreteness had an effect on number mismatch. Since sentential subjects are more likely to be animate than inanimate (Clark, 1965), it was predicted that there would be fewer S-V agreement errors following preambles which included an animate head noun. The number feature, concreteness and animacy of the head and local NP were manipulated as in (6-9).

(6) High Concrete Subject, Inanimate Local Noun

a. SP: The author of the speeches

b. PS: The authors of the speech

(7) High Concrete Subject, Animate Local Noun

a. SP: The mountain of the nomads

b. PS: The mountains of the nomad

(8) Low Concrete Subject, Inanimate Local Noun

a. SP: The nomad of the mountains

b. PS: The nomads of the mountain

(9) Low Concrete Subject, Animate Local Noun

a. SP: The speech of the authors

b. PS: The speeches of the author

(Bock & Miller, 1991, p. 67)

As in Experiment 1, Experiment 2 also included baseline preambles in which the head noun and the local noun matched in their number feature. The results were

similar to Experiment 1 in that in mismatch conditions, there were more errors when the local noun was plural as in (6a, 7a, 8a, 9a) than when the local noun was singular (6b, 7b, 8b, 9b). Animacy of the local noun did not have any effect on the number of subject verb agreement errors. That is, only plural local nouns (but not singular local nouns) elicited agreement errors regardless of their animacy (Bock & Miller, 1991, p. 71). While concreteness did not create an effect for the head noun position, it created a significant effect for the local noun; concrete local nouns in mismatch conditions with plural distractors resulted in more errors. But since the effect of concreteness did not interact with animacy, Bock and Miller re-ran the experiment (using the same experimental preambles) with a different group of participants. In the replication experiment, high concrete local nouns did not significantly cause more agreement errors than low concrete local nouns. Bock and Miller concluded that "… the concreteness effects in Experiment 2 were probably artifacts of the unbalanced distribution of concreteness variations over participants." (Bock & Miller, 1991, p. 72). In addition, concreteness cannot be accepted as a factor to affect S-V agreement assignment alone because singular local nouns did not lead to S-V agreement errors whether they were high concrete or low concrete.

In their Experiment 3, Bock and Miller investigated the role of animacy in S-V agreement without other manipulations. For the brevity of discussion, the third experiment will not be discussed here in detail, interested readers are referred to Bock and Miller (1991). But importantly, in that experiment they found that animacy did not affect S-V agreement assignment "Plural local nouns elicited errors, both when they were animate and when they were inanimate; singular local nouns did not, regardless of whether they were animate or inanimate. Local animacy did not affect agreement, local plurality did." (Bock & Miller, p. 71, 1991)

In their three experiments, Bock and Miller (1991) confirmed that the S-V agreement errors that occur in natural language production (spoken or written) also emerge in experimental settings. As predicted, when the head noun and the local noun mismatched in their number feature (compared to when the two match), speakers were more likely to produce S-V agreement errors. Their results further show that the linear distance between the subject and the verb cannot account for the S-V agreement errors and hence these errors cannot be attributed to the shortcomings of working memory since long preambles did not cause more errors than short preambles. Bock and Miller (1991), also showed, for the first time that a plural local noun following a singular subject head causes more S-V agreement errors than a singular local noun following a plural subject head. This is a phenomenon which is now referred to as *mismatch asymmetry*: S-V errors occur more frequently when the local noun is plural than it is singular.

3.3.2. Clause-packaging hypothesis

The clause-packaging hypothesis, proposed by Bock and Cutting (1992) maintains that agreement is computed within clause boundaries and "that information from one clause should be unlikely to interfere with the specification of agreement in another clause." (p. 104). This predicts for S-V agreement errors to occur more frequently within the same clause compared to across different clauses.

Bock and Cutting (1992) also examined the effects of linear distance in S-V agreement errors. They further tested the effects of working memory and hierarchical distance in marking S-V agreement. The participants were not given a working memory test, but in Bock and Cutting's (1992) predictions, working memory capacity would be challenged by a clausal boundary, in that, tracking the number

feature from the head noun to the verb would be a challenge for the working memory when there is a clausal boundary (p. 104). Similar to Bock and Miller (1991) the preambles consisted of post-modifiers either in the form of phrases (PPs) or clauses (RCs or complement clauses). There were three experiments in total. As in Bock and Miller (1991), the experiments employed a preamble completion task. That is, the participants would read the preambles out loud and complete them to full sentences.

Similar to Bock and Miller (1991), the preambles in Experiment 1 included PP or RCs but unlike Bock and Miller (1991) the phrasal (PP) and clausal preambles (RC) were equal in syllable number. That is, preamble length was not manipulated. The RCs are preceded by a clause boundary whereas the PPs are not. It was predicted that when the preamble includes a clause boundary as in the RCs, it would be challenging for the memory because it is difficult to track the number feature from the head noun to the verb through a clause boundary. This challenge on the memory was predicted to lead to more S-V errors. Keeping preamble length equal across phrasal and clausal modifiers would ensure that any significant difference in the results is due to the manipulation of the subject type (phrasal unit or clausal unit). Hence, the findings could only be attributed to the effect of clausal boundary.

The sentence preambles in Experiment 1 included a head NP followed by post-modifiers in the form of PP as in (10a-10d) or RC as in (11a-11d). As different from Bock and Miller's (1991) study, in this study the phrasal and clausal preambles were equal in syllable number. Example preambles can be seen below in (10-11):

(10) Prepositional Phrase Preambles

a. Mismatch, Singular Local Noun: The editors of the history book

b. Mismatch, Plural Local Noun: The editor of the history books

c. Match, Singular Local Noun: The editor of the history book

d. Match, Plural Local Noun: The editors of the history books

(11) Relative Clause Preambles

a. Mismatch, Singular Local Noun: The editors who rejected the book

b. Mismatch, Plural Local Noun: The editor who rejected the books

c. Match, Singular Local Noun: The editor who rejected the book

d. Mismatch, Plural Local Noun: The editors who rejected the books

(Bock & Cutting, 1992, p. 106)

As in Bock and Miller (1991), the participants were presented with the preambles auditorily and their task was to repeat the preambles out loud and complete the sentences. The results of Experiment 1 were similar to Bock and Miller (1991) in that there were an increase in agreement errors when the head noun was singular and the local noun was plural compared to the conditions when the head noun was plural and the local noun was singular. This confirms the plural attraction or mismatch asymmetry observed in Bock and Miller (1991). Also, participants produced more S-V agreement errors following the preambles with PP compared to preambles containing relative clause RC. These results are also in line with the results of the first experiment of Bock and Miller (1991) study.

In Experiment 1, the clausal structure in the preamble was always an RC. To ensure that the increased S-V agreement errors observed with RCs are attributable to clausal boundaries but not to any other feature specific to relative clauses, Experiment 2 employed preambles with complement clauses (CC) as in (13) and compared them to preambles with PPs as in (12). The researchers aimed to investigate if other types of clauses would cause fewer S-V agreement errors

compared to phrasal units, as well. As in Experiment 1, length of the post-modifiers was not manipulated.

(12) Prepositional Phrase

a. Match, Singular Local Noun: The report of the destructive fire

b. Mismatch, Plural Local Noun: The report of the destructive fires

(13) Complement Clause

a. Match, Singular Local Noun: The report that they controlled the fire

b. Mismatch, Plural Local Noun: The report that they controlled the fires

(Bock & Cutting, 1992, p. 111)

The results were similar to those in Experiment 1: there were more agreement errors after the phrasal preambles with plural local noun (12b) than clausal preambles with plural local nouns (13b). Together with the results of the Experiment 1, the results of Experiment 2 showed that S-V agreement errors occur more frequently when the local attractor is within the same clause as the subject head than when it is in a different clause.

Experiment 3 employed the same sentence preamble structures as in Experiment 1 but in Experiment 3 the length of the post-modifying structure was manipulated. Longer preambles (10c, 10d and 11c, 11d) included an NP compound (*forest fires*) in the local NP as opposed to a single noun (*fires*). The specific question was whether or not the increased length between the head noun and the local noun would result in an increase in S-V agreement errors. Although Bock and Miller (1991) also tested the length effect, their length manipulation was not consistent

across experimental items. They used either adjectives or articles or quantifiers and did not ensure a standard measure of length modification such as number of syllables. In Experiment 3 of Bock and Cutting (1992), length was consistently manipulated by adding an NP compound (*forest fires*) in the local NP as opposed to a single noun (*fires*). Example preambles for Experiment 3 are presented in (14).

(14) Prepositional Phrase Preambles

a. Short, Match, Singular Local Noun: The report of the destructive fire

b. Short, Mismatch, Plural Local Noun: The report of the destructive fires

c. Long, Match, Singular Local Noun: The report of the destructive forest fire

d. Long, Mismatch, Plural Local Noun: The report of the destructive forest fires

(15) Complement Clause Preambles

a. Short, Match, Singular Local Noun: The report that they controlled the fire

b. Short, Mismatch, Plural Local Noun: The report that they controlled the fires

c. Long, Match, Singular Local Noun: The report that they controlled the forest fire

d. Long, Mismatch, Plural Local Noun: The report that they controlled the forest fires

(Bock & Cutting, 1992, p. 115)

The results of Experiment 3 showed an increase in S-V agreement errors after long mismatch PP preambles such as (14d) compared to short mismatch PP preambles such as (14b) but not after long mismatch CC preambles (15d) compared to short

mismatch CC preambles such as (15b). Bock and Miller (1991) had observed in their Experiment 1 a similar trend to the results of Bock and Cutting's (1992) Experiment 3 in that the number of S-V agreement errors slightly increased after longer PP preambles, however; Bock and Miller's (1991) results had not reached statistical significance. After re-inspecting the data in PP mismatch conditions of Bock and Miller (1991), Bock and Cutting (1992, p. 118) concluded to rule out the length effect due to the opposing results after PP and RC preambles: "In fact, the number of errors after longer clauses decreased slightly as the number of errors after longer phrases increased slightly, nullifying the length effect".

Bock and Cutting's (1992) results show that S-V agreement errors occur more often when a local (i.e., attractor) NP occurs within the same clause as the subject head than when the local NP occurs in a different clause. This suggests that agreement is computed within clause boundaries. The linear distance between the subject and the verb also matters only when the distance is manipulated within clause boundaries. Hence, the linear distance hypothesis was ruled out by Bock and Cutting (1992). Given the findings in their three experiments, Bock and Cutting (1992) proposed the clause-packaging hypothesis.

The clause-packaging hypothesis was also tested in comparison to the linear distance hypothesis and syntactic distance hypothesis (see below) by Franck, Vigliocco and Nicol (2002). Franck et al. (2002) provide counter-evidence to the clause-packaging hypothesis; the details of their study will be presented under the discussion of the syntactic distance hypothesis.

3.3.3. Syntactic distance hypothesis

The syntactic distance hypothesis maintains that agreement attraction occurs not due to the linear proximity of the intervening noun to the verb but due to the syntactic (i.e. hierarchical) proximity between the head and the local noun (Levelt, 1989; Franck et al. 2002; Pearlmutter, 2000; Vigliocco & Nicol, 1998). In this view, it is assumed that the number feature of a syntactically closer intervening NP is more likely to percolate up to the head noun. In other words, an intervening NP that is more deeply embedded in the syntactic structure will attract the verb in number agreement less than an NP that is not deeply embedded.

Vigliocco and Nicol (1998) tested the syntactic distance hypothesis in comparison to the linear distance hypothesis in two production experiments. Although both experiments were sentence preamble completion experiments, participants produced declarative sentences in Experiment 1 and they produced questions in Experiment 2. Unlike the sentence preamble completion experiments in the previous studies (e.g., Bock & Cutting, 1992; Bock & Miller, 1991), in Vigliocco and Nicol's study participants were presented with an adjective followed by a preamble on a computer screen. Their task was to use both the adjective and the preamble and utter declarative sentences in Experiment 1 and questions in Experiment 2. The number feature of the head noun and the local noun were modified. The aim of this presentation was to set the stage for the second experiment in which participants would be asked to produce questions with the same materials.

Examples in (16a-d) illustrate the conditions in both Experiment 1 and Experiment 2. The head noun was either singular as in *the helicopter for the flight* or

plural as in *the helicopters for the flight* The number feature of the local noun either matched the head noun as in (16a, 16d) or mismatched it as in (16b, 16c):

(16) a. Match, SS: safe/ the helicopter for the flight

b. Mismatch, SP: safe/ the helicopter for the flights

c. Mismatch, PS: safe/ the helicopters for the flight

d. Match, PP: safe/ the helicopters for the flights

(Vigliocco & Nicol, 1998, p. 14)

As mentioned above, the participants' task was to use the adjective and the preamble and utter a declarative sentence in Experiment 1 (as in (17a)) and utter a question in Experiment 2 (as in (17b)).

(17) a. The helicopter(s) for the flight(s) is/are safe.

b. Is the flight for the helicopters safe?

In declarative sentences the verb linearly follows the attractor (i.e., local) noun (*the flight(s)*) but in questions, although the verb is linearly distant from the attractor noun, the syntactic distance between the head and local noun is the same as in declarative sentences. (In (17b) upon checking its agreement feature with the subject, the copula *be* would need to move high up in the hierarchical structure to form a question). Based on the assumptions of the linear distance, if participants made fewer errors in questions which contain conditions where there is a number mismatch between the head and the local noun (16b) (16c), compared to the declarative sentences, that would support the Linear distance hypothesis as the proximity between the verb and the head noun in questions would hinder the occurrence of attraction errors. On the other hand; if there were not significant differences between the same mismatch conditions of two experiments or if participants produced more

attraction errors with questions, that would rule out linear distance hypothesis and prove that not the linear distance between the local noun and the verb but the syntactic position of the head noun and the local noun are important in S-V assignment, supporting the syntactic distance hypothesis.

The results showed no difference in the frequency and distribution of error rates between the two experiments (although there was the usual plural attraction - more S-V agreement errors in SP condition than in PS conditions in both experiments) suggesting that agreement errors occur due to the syntactic distance between the head and the local attractor noun in a sentence because the linear distance between the verb and the local noun was manipulated across the two experiments but this did not influence the S-V agreement error rates. Vigliocco and Nicol concluded that:

> [a]greement would be computed when a hierarchical frame for the to-be-uttered sentence is generated, prior to the serial ordering of the words. Therefore, these results suggest an architecture in which assigning grammatical roles and building hierarchical structures are separate from assigning word order.
>
> (Vigliocco & Nicol, 1998, p. 24)

Pearlmutter (2000) investigated whether linear distance or syntactic distance has a greater effect on processing number agreement. The experimental sentences in Pearlmutter (2000) included complex subjects with three NPs such as *The pond near the trail(s) for the horse(s).* Pearlmutter (2000) included subject NPs consisting of three phrases because in three phrase subjects there are two intervening nouns between the head noun and the verb. The intermediate noun (N2) (*the trail(s)*) is syntactically closer to the head noun whereas the local noun (N3) (*the horse(s)*) is linearly closer to the verb. This manipulation provides a condition to test whether it

is the linear proximity or the syntactic proximity of the attractor noun that causes agreement attracion. The linear distance account would predict that the third noun (N3), *the horse(s)* in the example, would cause more processing difficulty than the second noun (N2), *the trail(s)*. The syntactic distance account would predict that the N2 would cause greater processing difficulty than N3 as it is closer to the head noun in the structural hierarchy. He conducted two experiments to test these predictions.

The first experiment was non-cumulative self-paced reading. Sixty native speakers of English took part in Experiment 1. All conditions contained a singular head noun, the number feature of N2 and N3 were manipulated as follows: Singular head noun, singular N2, singular N3 (SSS) (control condition) as in (18a); singular head noun, singular N2, plural N3 (SSP) as in (18b); singular head noun, plural N2, singular N3 (SPS) as in (18c); singular head noun, plural N2 and plural N3 (SPP) as in (18d). All experimental sentences were grammatical. Twenty sets of four sentences were prepared as in the examples below:

(18) a. SSS: The lamp near the painting of the house was damaged in the flood.
b. SSP: The lamp near the painting of the houses was damaged in the flood.
c. SPS: The lamp near the paintings of the house was damaged in the flood.
d. SPP: The lamp near the paintings of the houses was damaged in the flood.

(Pearlmutter, 2000, p. 92)

The RTs in the verb region (the verb and the word following the verb) were analyzed in each sentence. The shortest RTs were measured in the SSS condition. There was no reliable difference between the RTs in the other three conditions. The results did

not provide any evidence that N2 mismatches are any more or less difficult than N3 mismatches (Pearlmutter, 2000). Pearlmutter argued that the results could be attributed to the singular heads' being unmarked (Bock & Eberhard, 1993; Eberhard, 1997; see below for a detailed discussion). That is, "…the singular noun heads in this experiment may have been so weak that either N2 or N3 was able to interfere […] so that the effects of N2 and N3 were not additive." (Pearlmutter, 2000, p. 94).

Thus, Experiment 2 included subjects in which the head nouns were plural and the N2 and the N3 were either singular or plural. See (19a-d) for examples.

(19) a. PSS: The lamps near the painting of the house were damaged in the flood.
b. PSP: The lamps near the painting of the houses were damaged in the flood.
c. PPS: The lamps near the paintings of the house were damaged in the flood.
d. PPP: The lamps near the paintings of the houses were damaged in the flood.

(Pearlmutter, 2000, p. 95)

Twenty-four sets of four sentences as in (19) were created. The procedure was the same as in Experiment 1. The RT results showed that, PSP condition caused a significant processing difficulty compared to the control condition PPP. However, neither PSS nor PPS caused significantly longer RTs compared to PPP, suggesting that the middle noun (N2) which is closer to the head noun syntactically, caused more processing difficulty than the local noun (N3) which is closer to the verb linearly.

Pearlmutter (2000) was the first in the literature to test whether it is the linear distance between the local noun and the verb or the syntactic distance between the

local noun and the head noun that causes difficulty in tracking S-V agreement in sentence processing. Although this study pioneers the studies with complex subjects of three NPs in L1 and L2 (Franck et al., 2002; Lago & Felser, 2018, and also the present study), it still cannot sufficiently explain why the plural distractors in Experiment 1 did not create a significant mismatch effect given the markedness account (Eberhard, 1997). Also, in accordance with the markedness account, Pearlmutter (2000) should have predicted processing difficulty when distractors were plural as in Experiment 1 (not singular as in Experiment 2).

Franck et al. (2002) also tested the syntactic and linear distance between the attractor NP and the verb in S-V agreement. But unlike Vigliocco and Nicol (1998) who used declarative sentences versus questions to manipulate the linear distance between the local noun and the verb, Franck and colleagues used complex subjects which consisted of three NPs such as *the inscription on the door of the toilet* just like Pearlmutter (2000). As in Pearlmutter (2000), using three NP structures would introduce two attractor NPs, one of which would be linearly close to the verb (the local noun) and the other would be syntactically close to the head noun (the intermediate noun). This would allow for a "direct comparison with data reported in the literature, which were all declarative sentences" (Franck et al., 2002, p. 380).

Franck et al. (2002) employed two parallel experiments, one in French (Experiment 1) and the other in English (Experiment 2). Fifty-six native speakers of French participated in Experiment 1 and forty native speakers of English participated in Experiment 2. There were 32 experimental items. An example set of preambles and conditions are shown below (S stands for singular and P stands for plural.).

(20) a. SSS: L'inscription sur la porte de la toilette

The inscription on the door of the toilet

b. SSP: L'inscription sur la porte des toilettes

The inscription on the door of the toilets

c. SPS: L'inscription sur les portes de la toilette

The inscription on the doors of the toilet

d. SPP: L'inscription sur les portes des toilettes

The inscription on the doors of the toilets

e. PPP: Les inscriptions sur les portes des toilettes

The inscriptions on the doors of the toilets

f. PPS: Les inscriptions sur les portes de la toilette

The inscriptions on the doors of the toilet

g. PSP: Les inscriptions sur la porte des toilettes

The inscriptions on the door of the toilets

h. PSS: Les inscriptions sur la porte de la toilette

The inscriptions on the door of the toilet

(Franck et al., 2002, p. 383)

Participants read the sentence preambles aloud and they completed the sentences. They were instructed to use the verb *être* in French and the copula *be* in English. Their utterances were recorded. Figure (6), taken from Franck et al. (2002, p. 382) provides a visual representation of the predictions of these three accounts for S-V agreement errors for sentences with complex subjects which consist three NPs.

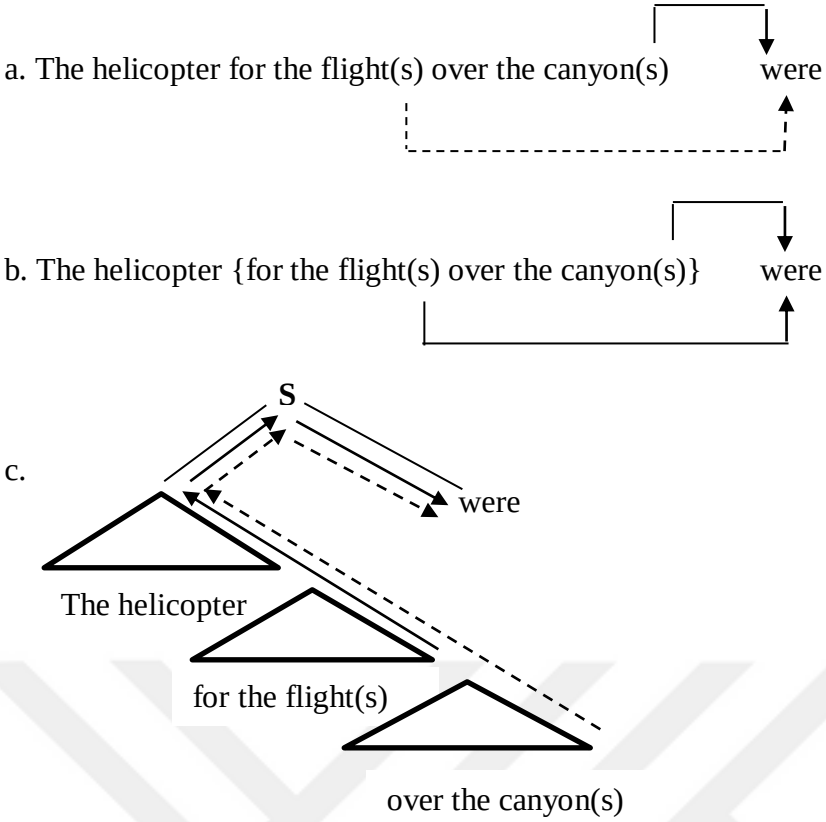


Figure 6. Linear processing account, clause-packaging hypothesis and syntactic processing account (Taken from Franck et al. (2002, p. 382)). While the plain arrows mean high interference, dashed arrows mean low interference. (a) represents the linear processing account, where the local noun immediately preceding the verb gives its agreement feature to the verb. In (b) we can see clause-packaging hypothesis, since N2 and N3 are in the same clause, they have equal chance of interfering with the verb agreement. Finally, in (c) we can see syntactic processing account, since N2 is higher in the tree structure and closer to the head noun and the verb syntactically, it has a higher chance to percolate its agreement features to the verb erroneously

The results for both French and English showed that there were more agreement errors when the N2 mismatched the N1 in its number feature than when the N3 mismatched the N1. That is, SPS and PSP conditions generated more errors than SSP and PPS respectively. Also there were more errors in SPS and PSP than their baseline conditions SSS and PPP. That shows that, for French speakers, syntactic distance causes the number agreement attraction errors. The same results were obtained for English. Agreement errors occurred more when there was a

mismatch between the N1 and the N2 than when there was a mismatch between the N1 and the N3. Franck and colleagues, hence, argue that the attraction errors occur due to the syntactic distance between the intervening noun and the head noun rather than due to the linear distance between the local noun and the verb. This is attributable to the syntactic distance hypothesis. In the process of organizing syntactic units to a hierarchical structure, since the intermediate noun is higher in the syntactic tree, the syntactic distance between the intermediate noun and the head noun is shorter and the intermediate noun has a higher chance to percolate its number feature to the head noun. While supporting the syntactic distance hypothesis, the results refute the linear distance hypothesis.

Effects of syntactic distance vs linear distance in declarative sentences were examined first by Pearlmutter (2000) in English and then by Franck et al. (2002) in French and English with complex subject NPs consisting of three nouns. Both Pearlmutter (in comprehension) and Franck et al. (in production) showed that when the subject NP included three NPs the intermediate noun (N2) caused more attraction errors than the local noun (N3) (Pearlmutter, 2000; Franck et al., 2002). These findings suggest that when there is a mismatch between the head noun and the intervening noun in their agreement features, the structural distance between the intervening noun and the head noun is more important than the linear distance between the local noun and the verb in causing agreement attraction. Both Pearlmutter (2000) and Franck et al. (2002) attribute their findings to the syntactic distance hypothesis which proposes that agreement assignment is erroneously taken from the intermediate noun due to its proximity to the head noun in the syntactic tree.

3.3.4. The mismatch asymmetry, the markedness and head-overwriting accounts

It has been reported for native speakers of English (and was briefly mentioned in Chapter 1 and 2) that the S-V number agreement errors were higher when the head noun was singular and the local noun was plural as in (21a) than when the head noun was plural and the local noun was singular as in (21b) (Bock & Miller, 1991; Bock & Cutting, 1992; Bock& Eberhard, 1993; Bock, 1995).

(21) a. The key to the cabinets ….

b. The keys to the cabinet ….

This asymmetry in subject verb agreement errors has been referred to as *mismatch asymmetry* or *plural attraction* (Bock, 1995; Bock & Cutting, 1992; Bock & Eberhard, 1993; Bock & Miller, 1991).

Mismatch asymmetry in S-V agreement errors has been attributed to the *markedness* of plural nouns (Eberhard, 1997). In this view, the default form for a noun is singular. When a noun is plural, it is marked. Linguistic elements which have a property (e.g., +plural) are considered marked, while their counterparts which do not have this property would be unmarked. This can be attributable to the fact that the marked element being usually derived by inflection from the unmarked element (e.g., *dog* vs. *dog-s*) (Nicol et al. 1997; Eberhard, 1997). When there is a plural local noun after a singular head noun, this creates plural attraction errors because plural nouns are more marked, hence they are more salient. Thus, a plural local noun that mismatches with the head noun in its number features as in (21a) would cause more attraction errors than a singular local noun that mismatches with the head noun in its number features as in (21b). The singular local noun would not be as strong a distractor as the plural local NP.

Eberhard (1997) tested the subject preambles which include one head noun and one local noun to investigate markedness introduced by plural inflection. In addition, she also tested whether or not singular nouns modified by singular quantifiers such as *one, each, every* would be perceived as marked and would cause the same type of errors in subject-verb agreement. She conducted three experiments in English with sentence preamble completion methodology.

In Experiment 1, each experimental preamble was made up of a complex subject phrase which included a prepositional phrase. There were four conditions in Experiment 1 manipulating the markedness of the singular head noun (unmarked vs. marked singular) and the number feature of the local noun (matching or mismatching with the head noun). Unmarked singulars were modified by the determiner *the* whereas marked singulars were modified by numeral modifiers such as *one, each* and *every.* Preambles in (22) and (23) illustrate the experimental conditions.

(22) Unmarked Singular Head Noun

a. Match (SS): The key to the cabinet

b. Mismatch (SP): The key to the cabinets

(23) Marked Singular Head Noun

a. Match (SS): One key to the cabinet

b. Mismatch (SP): One key to the cabinets

(Eberhard, 1997, p. 152)

Thirty-two native English speakers participated in the experiment. The participants were asked to listen to the preamble and repeat it and then complete it to a full sentence. Their utterances were recorded. The results showed more agreement errors in the mismatch (SP) conditions (22b, 23b) compared to the match (SS) control conditions (22a, 23a). In the mismatch conditions (22b, 23b); it was observed that

participants made fewer errors when the singular subject was modified by a quantifier as in (23b) compared to when it was modified by the definite article *the* as in (22b). This showed that the determiner *the* was less effective in signaling the number feature than the quantifiers. This finding shows that when singularity is marked by a numeral quantifier, plural local nouns are less likely to cause erroneous plural agreement on the verb. That is, singular marking on the head noun cancels out the markedness introduced by the plural suffix on the local noun.

Experiment 2 tested the singular markedness with a different preamble design. If singular nouns were indeed marked when they were modified with a numeral quantifier, they would also cause more S-V errors in the local noun position when the head noun is plural. See (24) for example preambles in Experiment 2. In Experiment 2, the head noun of the subject NP was plural and the local noun was either plural as in (24a) or singular as in (24b, 24c). The singular local noun was modified by either the definite article *the* as in (24b) or a numeral modifier (e.g., *one)* as in (24c).

(24) a. Match (PP): The keys to the cabinets
b. Mismatch (PS), unmarked: The keys to the cabinet
c. Mismatch (PS), marked: The keys to one cabinet

(Eberhard, 1997, p. 152)

The procedure was the same as in Experiment 1. Native English speakers participated in the experiment. The results showed that number agreement errors were significantly higher after mismatching preambles with marked singular local nouns as in (24c) compared to the preambles with unmarked singular local nouns as in (24b). This finding further supports the results of Experiment 1 in that countable singular nouns are not salient without overt number marking. The results, together

with the results from Experiment 1 suggest that the asymmetry in attraction errors (i.e., plural local nouns resulting in more attraction errors than singular local nouns) disappear when the singular head noun is modified via a modifier and an asymmetry in attraction errors can be created with a singular local distractor which is modified by a numeral.

The third experiment in Eberhard (1997) was conducted to test the effects of quantifiers on plural nouns. The first two experiments showed that singular quantifiers make the otherwise unmarked singular nouns marked. However, another interpretation of these results can be that, singular nouns have a specified number feature but without a numeral modifier, their number feature is not as strong as the number feature that plural nouns have. The impact of singular quantifiers in the first two experiments could be increasing the strength of the singular number feature by double marking it. Experiment 3 examined whether the role played by quantifiers in Experiments 1 and 2 were to mark the singular nouns which are otherwise unmarked in their number feature or to strengthen their already existing number feature. Thus, in Experiment 3, plural local nouns, which are considered to be already marked, (that mismatched with the head noun) were modified by quantifiers such as *many*, *several* and *a few*. The prediction was that if quantifiers enhance the markedness effect, plural attraction errors would increase due to double marking by both a plural noun and a plural quantifier. The sentence preambles in Experiment 3 were derived from the first two experiments. There were three conditions in Experiment 3: a match (control) condition with a singular head noun and a singular local noun (SS) as in (25a), and two mismatch conditions, one with a singular head noun and a plural local noun (SP) (25b) and the other with a singular local noun plural local noun (SP) which was modified with a plural quantifier as in (25c).

(25) a. Match (SS): The key to the cabinet

b. Mismatch (SP): The key to the cabinets

c. Mismatch (SP), double plural marking: The key to a few cabinets

(Eberhard, 1997, p. 158)

Participants produced significantly more errors in both the SP (25b) and the SP with plural quantifier (25c) conditions compared to the control (SS) condition (25a). But, the number of mismatch errors in the SP condition with double marking (plural quantifier and plural inflection) (25c) was not significantly higher than the SP condition with no quantifier (25b). The results of Experiment 3 showed that quantifiers do not increase the strength of the number feature but they indeed add a markedness feature and singular nouns are truly unmarked. Eberhard concludes that "the additional feature or property of the marked noun (plurality) results in increased activity in the processing system, and that increased activity interferes with processing the unmarked information" (1997, p. 163). This suggests that the quantifiers make singular nouns marked.

In conclusion, Eberhard (1997) proposed markedness account, in which an intervening marked element stimulates the number feature in agreement computation system and interferes with computation of the unmarked information.

In mismatch conditions the increased likelihood of a plural local noun (compared to a singular local noun) to cause an S-V error is also attributed to the head-overwriting effect (Pearlmutter et al., 1999). Thus, the markedness of the plural local noun, explained in the above section, is considered to over-write the singular feature of the head noun.

Pearlmutter et al. (1999) implemented three experiments to understand the processing of S-V agreement in English and to understand the head-overwriting effect. Their first experiment was a self-paced reading experiment and investigated whether or not native speakers were sensitive to S-V agreement violations during the course of reading and whether or not the number mismatch effect reported in the previous production studies (e.g., Bock & Cutting, 1992; Bock & Miller, 1991) would also be observed in comprehension. The subject phrase in Experiment 1 consisted of two NPs: a singular head NP and a plural or singular local NP embedded in a PP. The verb, copula *be* was in past tense form. The head noun and the local noun either matched in their number feature as in (26a, 26c) or mismatched as in (26b, 26d) and the copula either agreed with the head noun in its number feature, resulting in grammatical sentences as in (26a, 26b) or did not, resulting in ungrammatical sentences as in (26c, 26d). Ungrammaticality is also indicated via an asterisk before the example sentence.

(26) a. Match, Grammatical: The key to the cabinet was rusty from many years of disuse.

b. Mismatch, Grammatical: The key to the cabinets was rusty from many years of disuse.

c. Match, Ungrammatical: *The key to the cabinet were rusty from many years of disuse.

d. Mismatch, Ungrammatical: *The key to the cabinets were rusty from many years of disuse.

(Pearlmutter et al., 1999, p. 432)

Participants' reading time (RT) for each word was recorded. The RTs for the copula in the ungrammatical match condition as in (26c) was the longest which was

followed by the RTs for the copula in the ungrammatical mismatch (26d) and those in the grammatical mismatch as in (26b) conditions. This pattern of results showed that English native speakers are sensitive to S-V agreement violations and their reading behavior is affected by the number mismatch between the head noun and the local noun. The number mismatch between the head noun and the local noun had a mirror effect for grammatical and ungrammatical sentences: while it created processing difficulty and slow-down in grammatical sentences such as (26b) compared to (26a), it resulted in processing ease and faster reading in ungrammatical sentences such as (26d) compared to (26c).

Experiment 2 used the same materials as in Experiment 1 but the method was eye-tracking. Eye-tracking methodology reflects natural reading behavior more closely than self-paced reading, where RTs can be measured more precisely and difficulties in processing can be investigated in more detail. It also allows for inspecting movements back to earlier parts of the sentence (regressions) (Pearlmutter et al., 1999, p. 436). Two eye-tracking measures, namely first-pass reading time and total reading time[4] for the verb region were analyzed. Since very short and high frequency words (such as the copula) are not always fixated for long enough durations, the copula and the following word were examined together as the critical region. Both Experiment 1 and Experiment 2 showed the same pattern of results. That is, the critical regions in the grammatical match condition (26a) were read the fastest followed by the ungrammatical match condition (26c), ungrammatical

[4] Detailed information on first-pass reading and total duration will be provided in Chapter 5, Section 5.2.5. For brevity of the discussion here, first-pass reading time is "the sum of the time spent fixating an area from when it is fixated first until another area is fixated" and it is considered to reflect earlier stages of processing, while total duration is the sum of all fixations in an area and it is considered to reflect later stages of processing (Pearlmutter et al., 1990, p. 437).

mismatch condition (26d) and the grammatical mismatch condition (26b), respectively.

Previous studies (Bock & Cutting, 1992; Bock & Eberhard, 1993; Bock & Miller, 1991; Eberhard, 1997) had reported a mismatch asymmetry in the occurrence of S-V agreement errors. That is, in conditions where the head noun and the local noun mismatched in their number feature, a plural attractor resulted in more S-V errors than a singular attractor. Experiment 3 was designed to test this mismatch asymmetry in comprehension by employing sentential items where the head of the subject phrase was plural. There were four conditions in total manipulating the number feature of the head noun (singular or plural) and the match between the head noun and the local noun (match, mismatch). Thus there was a singular head noun and singular local noun (SS) condition as in (27a), singular head noun and plural local noun (SP) condition as in (27b), a plural head noun and plural local noun (PP) condition as in (27c) and plural head noun and singular local noun (PS) as in (27d). Experiments 1 and 2 showed that native English speakers were sensitive to agreement violations and ungrammatical mismatch conditions and grammatical mismatch conditions showed a complementary pattern (i.e., while the mismatch condition created an ease of processing in ungrammatical sentences, it created a difficulty of processing in grammatical sentences). Thus, in Experiment 3, all the conditions were grammatical.

(27) a. SS: The key to the cabinet was rusty from many years of disuse.

b. SP: The key to the cabinets was rusty from many years of disuse.

c. PP: The keys to the cabinets were rusty from many years of disuse.

d. PS: The keys to the cabinet were rusty from many years of disuse.

(Pearlmutter et al., 1999, p. 445)

As in Experiment 1, Experiment 3 employed self-paced reading paradigm. The results showed that for singular head conditions, (27a) and (27b), RTs were slower for the verb region in the SP condition (27b) compared to the SS condition (27a) confirming the mismatch effect observed in Experiments 1 and 2. But, there was no reliable difference in RTs for PP (27c) and PS conditions (27d), suggesting that the mismatch effect was eliminated when the head noun was plural. This finding confirms in comprehension the mismatch asymmetry (or plural attraction) reported in previous production studies (Bock & Cutting, 1992; Bock & Eberhard, 1993; Bock & Miller, 1991; Eberhard, 1997). That is, the mismatch effect does not occur with plural heads and the number feature of the plural heads does not get over-written by the number feature of singular local nouns. Only the number feature of singular head is overwritten in SP condition compared to SS condition.

In following two studies, although researchers do not state that they tested the head-overwriting hypothesis, based on their results, they can be examined under the head-overwriting account.

Nicol and colleagues' (1997) study can be examined under the head-overwriting hypothesis based on its results. The study included five reading experiments to investigate L1 speakers' sensitivity to S-V agreement in processing. As the last three experiments are not directly related to the present study (notional number, effects of animacy and concreteness) only the first two experiments are reported here. The first experiment in the study investigated whether or not English speakers would be sensitive to the S-V agreement errors in comprehension.

Experiment 1 employed the *Maze Technique*. In the maze technique, the participants are presented with some word pairs on the computer screen for a limited

amount of time (500 ms). The pairs disappear after 500 ms. Participants' task is to read the pairs and decide which of the two words (i.e. *hesitates* and *announcement* in (28)) continued the sentence better. Only one of the two words would provide a grammatical continuation. An example trial for the sentence *The announcement by the director was disturbing to everyone* is presented below in (28):

(28)

The	…
hesitates	announcement
pillow	by
the	doctor
instead	director
was	ink
disturbing	elephant
to	egg
under	everyone

(Nicol et al., 1997, p. 574)

The participants' reading times (RTs) for the verb and overall error rates were measured. The number feature on the head noun and the local noun were manipulated in the experimental items resulting in the following four conditions: singular head singular local noun (SS), as in (29a), singular head, plural local noun (SP) as in (29b), plural head plural local noun (PP) as in (29c), plural head plural local noun (PS) as in (29d). Below are the examples of experimental conditions as full sentences:

(29) a. SS: The author of the speech is here now.

b. SP: The author of the speeches is here now.

c. PP: The authors of the speeches are here now.

d. PS: The authors of the speech are here now.

(Nicol et al., 1997, p. 574)

The highest reading time and the highest amount of error were observed in the SP condition (29b) confirming the mismatch asymmetry in the production studies.

The second experiment was also a reading experiment but it employed a sentence classification task (word order accuracy judgement) in which the participants were asked to read a sentence that appeared on a computer screen. Participants judged the accuracy of word order of the sentence after they read each sentence. The experimental sentences always had accurate word order and they were the same as in Experiment 1. The fillers included ill-formed sentences.

(30) a. SS: The author of the speech was subsequently well rewarded.

b. SP: The author of the speeches was subsequently well rewarded.

c. PP: The authors of the speeches were subsequently well rewarded.

d. PS: The authors of the speech were subsequently well rewarded.

(Nicol et al., 1997, p. 577)

The results of Experiment 2 were similar to those in Experiment 1. Participants showed longer RTs while classifying (judging the word order accuracy) the sentences in SP condition than the sentences in SS condition. No difference in RTs was observed between PP and PS conditions. These findings show that the participants are sensitive to correct word order as well as the mismatch effect created by the number mismatch between the head (singular) and the local (plural) noun.

Dillon et al. (2013) conducted a study to understand mechanisms behind S-V agreement and anaphora binding. They conducted two experiments but only the first

experiment tested S-V agreement number mismatch effects. Thus, for its relevance to this thesis, I will report their first experiment only. Dillon et al. (2013) employed relative clauses (RCs) instead of prepositional phrases (PPs). The experiment employed eye-tracking methodology and English native speakers participated in the study. Four conditions were created by manipulating the grammaticality of the sentence and the number match between the head noun and the local noun. Note that Dillon et al. use the term "interference" for mismatch and "no interference" for match in the number features of the head noun and the local noun. For consistency, I will use the term 'match' to refer to "no interference" and 'mismatch' to refer to "interference". The underlined words in the following examples illustrate the critical regions (31):

(31) a. Grammatical, [Match]: The new executive/ who oversaw/ the middle manager/ apparently/ was dishonest/ about the company's profits

b. Grammatical, [Mismatch]: The new executive/who oversaw/ the middle managers/ apparently/ was dishonest/ about the company's profits

c. Ungrammatical, [Match]: The new executive/ who oversaw/ the middle manager/ apparently/ were dishonest/ about the company's profits

d. Ungrammatical, [Mismatch]: The new executive/ who oversaw/ the middle managers/ apparently/ were dishonest/ about the company's profits

(Dillon et al., 2013, p. 89)

First fixation duration, probability of regression out and total duration measurements for the critical regions were examined. There was a reliable difference between the grammatical match condition (31a) and the other conditions (31b, 31c, 31d). Grammatical match condition (31a) was read faster than all the other three conditions. The ungrammatical match condition, (31c), had the longest duration; it was followed by the ungrammatical mismatch condition, (31d), and the grammatical mismatch condition, (31b).

The findings confirm the mismatch effect observed in previous S-V agreement production and comprehension studies (Bock & Cutting, 1992; Bock & Eberhard, 1993; Bock & Miller, 1991, Eberhard, 1997). The results of the experiment also confirm the facilitation of processing effect in ungrammatical sentences with mismatch condition previously observed in Pearlmutter et al. (1999). That is, in both studies the grammatical match condition was read the fastest, followed by ungrammatical mismatch, grammatical mismatch and ungrammatical match conditions respectively. Dillon et al. (2013) conclude that the mismatch effect facilitates S-V agreement processing in ungrammatical sentences.

Studies consistently showed that S-V agreement errors were observed more when the local noun was plural than when it was singular. These errors were also called attraction errors. The findings appear to confirm the markedness account (Eberhard, 1997) or head-overwriting effect (Pearlmutter et al., 1999). The markedness account maintains that plural nouns have the plural feature in terms of number which singular nouns lack; therefore when the head noun is singular and the local noun is plural, more attraction errors occur in production or more difficulty is observed in processing. Based on the markedness account, the head-overwriting

effect states that the number feature of singular heads can be over-written by the number feature of plural local nouns.

3.3.5 Cue-based memory retrieval

As was mentioned in Section 3.2, the cue-based memory retrieval model is a syntactic production/processing model which integrates structural features into a cognitive model (Cunnings, 2017a, 2017b; Lewis & Vasishth, 2005; Wagers et al., 2009). The model maintains that language processing does not involve a specific module but it rather draws on general constraints on cognition. Regarding S-V agreement, as the subject NP is processed, both the representation of the NP itself and a representation of the prediction of the verb that the NP is a subject of are encoded in the working memory. Once the verb is encountered, the retrieval mechanism searches for its controller whose features would indicate subject-hood and match with those of the verb's. The most suitable candidate for a controller is then retrieved (Lewis et al., 2006). However, the retrieval process is subject to interference due to activation-based decay and similarity-based interference. Recall that activation-based decay predicts that immediately after an item is first encountered, its activation levels decay while other items are encountered; therefore, more recent items will be more easily retrieved. Similarity-based interference states that retrieval cues generated by the verb are checked against all items in memory in parallel. The item which provides the best match to this set of cues becomes highly activated and is retrieved. But occasionally, an item which partially matches the retrieval cues may be retrieved.

In English, the subject and the verb are usually adjacent to each other. In such cases, assigning a subject to a verb is usually effortless. However, when there is a complex subject (e.g., the key to the cabinets), by the time the parser reaches the

verb, the activation level of the head NP decreases due to the interference from the local noun. And since there are two NPs which provides similar retrieval cues (e.g., nominative case and preverbal position) the local noun instead of the head noun may be retrieved due to the similarity-based interference.

Two types of similarity-based interference may occur in S-V agreement, namely facilitatory interference and inhibitory interference, both of which concern the cases where there is a mismatch between the head noun and the local noun(s).

A subject NP marked with certain features (e.g., number, gender, animate, specific) will prime the processing system to expect a verb to have matching features. When the parser reaches the verb, if the verb matches this prediction, the subject is retrieved and no further action is necessary. However, if there is a mismatch between the verb and the subject, a re-analysis is commenced and that causes a slow-down on the verb in ungrammatical sentences (self-paced reading and eye-tracking data, Dillon et al., 2013; Pearlmutter et al., 1999; Wagers et al., 2009).

Facilitatory interference occurs when there is a complex NP subject such as (e.g., the key to the cabinets) and the verb erroneously agrees with the local noun instead of the head noun, resulting in an ungrammatical sentence. But compared to an ungrammatical sentence with a simple NP (e.g., the key), for ungrammatical sentences with complex NPs (e.g., the key to the cabinets) in which the number features of the head noun and the verb mismatch but the local noun and the verb match, a reduced slow-down (i.e., facilitation) is observed (Cunnings, 2017a) because the local NP instead of the head NP is considered to be retrieved as a controller for the verb, reducing the effect of the mismatch between the head noun and the verb.

But in grammatical sentences with complex subjects where the head NP and the local NP of the subject mismatch in their number feature (e.g., the key to the cabinets), the local NP might be retrieved instead of the head NP as its features partially match with the cues generated by the verb and the number mismatch effect can cause slow-down when the parser reaches the verb. This type of interference is called inhibitory interference (Cunnings, 2017a; Van Dyke & McElree, 2006).

Thus, similarity-based interference may cause inhibitory effects in grammatical sentences but facilitatory effects in ungrammatical sentences where multiple items (complex NPs) fully or partially match a set of retrieval cues and when there is a number mismatch between the head and the local noun in the subject.

Although several studies tested the cue-based memory retrieval theory in sentence processing (e.g., Badecker & Lewis, 2007; Badecker & Kuminiak, 2007; Van Dyke, 2011; Van Dyke & McElree, 2006), only those that tested S-V agreement processing (i.e., Wagers et al., 2009 and Tanner & Bulkes, 2015) will be reviewed in this section. In Chapter 4, a critical overview of the model for L2 processing by Cunnings (2017a) will be examined.

Wagers and colleagues (2009) oppose to the representation-based models of agreement attraction (e.g., syntactic distance hypothesis, feature percolation). Recall that according to feature percolation (Franck et al., 2002; Nicol et al., 1997; Vigliocco & Nicol, 1998), features of an NP may percolate upward through the syntactic structure and erroneously value a head NP which is higher in the structure. Feature percolation was previously mentioned in section 3.3.3 to explain syntactic distance but it is important to note here that Wagers et al. does not compare syntactic and linear distance but instead examines the predictions of feature percolation with RCs made of an RC head and a subject and PPs made of a head and a local noun.

Feature percolation model generates two predictions: (i) significant attraction effects should not be observed in structures where the local (or intervening) noun is not syntactically dominated by the head (ii) attraction effects would emerge regardless of the grammaticality of the structure. Wagers and colleagues (2009) investigated these predictions via six self-paced reading experiments. All experiments were conducted with native speakers of English.

The specific aim of Experiment 1 was to investigate how native speakers of English would respond to ungrammaticalities introduced by S-V agreement violations. The results of this experiment would serve as a baseline for other experiments. The experimental sentences included simple NP subjects. Number feature on the NP and the verb and sentence grammaticality were manipulated as illustrated in (32) below.

(32) a. Singular subject/ grammatical:

The old key unsurprisingly was rusty from many years of disuse.

b. Plural subject/ grammatical:

The old keys unsurprisingly were rusty from many years of disuse.

c. Singular subject/ ungrammatical:

The old key unsurprisingly were rusty from many years of disuse.

d. Plural subject/ ungrammatical:

The old keys unsurprisingly was rusty from many years of disuse.

(Wagers et al., 2009, p. 211)

Because singular and plural nouns are different in the number of characters and morphological complexity, an adverb before the verb was used to examine whether plurality by itself caused any slow-down in processing. If so, the response times to the adverb after plural nouns as in (32b, 32d) would be longer than those to the

adverb after singular nouns as in (32a, 32c). The results of Experiment 1 showed that L1 speakers were indeed sensitive to agreement violations and that their responses to the ungrammaticality were observed at the critical verb region. In addition, they found that reading times for adverbs which follow plural nouns were longer than reading times for adverbs following singular nouns. This was taken as evidence for a greater processing load associated with plurality, irrespective of S-V agreement.

Experiment 2 investigated the first prediction of feature percolation. Recall that feature percolation predicts that the noun which is syntactically local to the head noun interferes with the verb's agreement morphology through feature percolation to the head noun. To test this prediction, Wagner et al. employed sentences which included object relative clauses as in (33). In object relative clauses the relative clause head (the musician(s)) functions as the attractor but it does not interfere syntactically or linearly with the subject (the reviewer) and the verb (praise(s)). Since there is no linear or syntactic interference from the attractor (i.e., the musician) in these sentences, the number feature of the attractor (RC head) cannot percolate (up) to the subject (i.e., the reviewer). So, the prediction was that if a strong attraction effect is observed (i.e., a slow-down in mismatch grammatical sentences (33b) compared to match grammatical sentences (33a) and reduced slow-down in mismatch ungrammatical sentences (33d) compared to match ungrammatical sentences (33c)) feature percolation account for S-V agreement would be refuted.

(33) a. Match, grammatical: The musician who the reviewer praises so highly will probably win a Grammy.

b. Mismatch, grammatical: The musicians who the reviewer praises so highly will probably win a Grammy.

c. Match, ungrammatical: The musician who the reviewer praise so highly will probably win a Grammy.

d. Mismatch, ungrammatical: The musicians who the reviewer praise so highly will probably win a Grammy.

(Wagers et al., 2009, p. 213)

The results showed longer RTs for ungrammatical match condition (33c) than for the grammatical match conditions (33a) in the region following the critical verb (praise(s)). The RTs in match grammatical sentences (33a) were not significantly longer or shorter compared to mismatch grammatical (33b) condition and there was facilitation (i.e., reduced slow-down) in ungrammatical mismatch (33d) condition compared ungrammatical match (33c) condition. This was similar to the findings of Pearlmutter et al. (1999) and Dillon et al. (2013) for PPs.

Given these results, Wagers et al. (2009) argued that the attraction effects which were observed in previous studies cannot be due to number features' upward percolation, because in that case, the attraction effect in RCs should have been either weaker than in PPs or absent. However, the results showed the same attraction effects in RC structures as in PP structures. But in RCs, different from PPs, the attractor is not syntactically dominated by the head noun and hence cannot percolate its features up to the head noun.

Although Wagers et al.'s Experiment 2 showed that agreement attraction also occurs in RC structures; only singular subjects were used in Experiment 2. Previous research with PP constructions consistently showed a mismatch asymmetry (Bock, 1995; Pearlmutter et al., 1999) in agreement attraction. That is, studies consistently showed a strong attraction effect for subjects with singular heads and plural attractors but not for plural heads and singular attractors. The cause of mismatch asymmetry

had previously been attributed to the markedness of plural nouns and the head-overwriting account (Eberhard, 1997; Pearlmutter et al., 1999). Wagers et al. tested the mismatch asymmetry in RC structures which involved plural subjects and singular or plural attractors (RC heads). If it is also observed with subject NPs modified with RC structures, that would strengthen the case that the attraction observed in PP and RC structures stems from the same cause. Therefore, in Experiment 3, in addition to the experimental sentences in Experiment 2 (as in (33)), they included four more conditions as in (34). The conditions were arranged in a 2x2x2 design with attractor number (singular / plural), subject number (singular / plural) and grammaticality (grammatical / ungrammatical). In (34), S stands for singular, P stands for plural and A stands for attractor:

(34) a. Mismatch, SA, grammatical: The musician who the reviewers praise so highly will probably win a Grammy.

b. Mismatch, PA, grammatical: The musicians who the reviewers praise so highly will probably win a Grammy.

c. Mismatch, SA, ungrammatical: The musician who the reviewers praises so highly will probably win a Grammy.

d. Match, PA, ungrammatical: The musicians who the reviewers praises so highly will probably win a Grammy.

(Wagers et al., 2009, p. 213)

The usual mismatch asymmetry reported in the literature was also observed in this experiment. That is, in ungrammatical sentences, when the RC subject was singular but the RC head (attractor) was plural (33d), the slow-down was reduced compared to ungrammatical match (33c). But in ungrammatical mismatch sentences with plural RC subjects and singular attractors (e.g., 34c), there was no significant

decrease in RTs on the critical region (praises) compared to ungrammatical match sentences with plural RC subjects and plural heads (34d) (Pearlmutter et al., 1999). Wagers et al. (2009) conclude that the results of Experiment 3, together with the results of Experiment 2, refute the feature percolation account.

But, in Experiment 3, in conditions with grammatical sentences (e.g., 33a, 33b, 34a, 34b) no significant attraction effect was observed. Only in the mismatch condition in the ungrammatical sentences, the slow-down due to ungrammaticality on the verb was reduced (33d) when the attractor was plural and the subject was singular. But previous research had shown that attraction effect was also observed in grammatical sentences (Nicol et al., 1997; Pearlmutter et al., 1999) (i.e., participants showed slow-downs in sentences with grammatical mismatch conditions). Wagers et al. (2009) argue that one possibility for not observing attraction effect in grammatical sentences might be due to the differences between sentences with RCs and PPs. Another possibility could be that the agreement effect observed in grammatical sentences in previous studies might have been merely due to the processing cost of the plural attractor prior to the verb (e.g. the key to the *cabinets was* rusty); i.e., the time taken to process the plural feature on the local noun. In order to test those possibilities, Experiment 4 was conducted with PP constructions similar to Pearlmutter (1999) but with an adverb placed before the verb as in *The key(s) to the cell(s) unsurprisingly was/were rusty from many years of disuse.* Using an adverb would distinguish the effects caused by the processing cost of the plural attractor which was predicted to manifest itself on the adverb region; and the actual attraction effects would be evident at the verb region. Similar to the results of Experiments 2 and 3, and to those in Pearlmutter et al. (1999), slow-down was significantly reduced in the ungrammatical mismatch sentences compared to ungrammatical match

sentences at the spill-over region (one word following the verb). In grammatical sentences, although a slow-down was observed in grammatical mismatch sentences compared to grammatical match sentences in the verb region, Wagers et al. (2009) interpreted this effect to be due to the spill-over effect associated with the processing cost caused by plural attractor itself, since the same slow-down effect was also observed on the attractor noun and the adverb regions.

Since they observed agreement attraction only in ungrammatical sentences contrary to previous studies (Nicol et al., 1997; Pearlmutter et al., 1999), Wagers et al. (2009) conducted Experiment 5, because they wanted to test PP constructions more directly by eliminating the adverb similar to experimental sentences in previous studies (Nicol et al., 1997; Pearlmutter et al., 1999). They used experimental sentences which replicate previous studies (Pearlmutter et al., 1999): *The key(s) to the cell(s) was/ were rusty from many years of disuse* (Wagers et al., 2009, p. 221). Each word was a region for self-paced reading. The results of the ungrammatical sentences in Experiment 5 were the same as previous experiments in that the slow-down in match ungrammatical condition in the verb region was reduced in mismatch ungrammatical condition in the verb region. But as in previous studies, there were significant slow-downs in grammatical mismatch sentences compared to grammatical match in the verb region and the regions following the verb. But since this slow-down was also present on the attractor noun (e.g. cells), Wagers et al. (2009) stated that the slow-down which is considered to be due to agreement attraction could be merely due to processing difficulty introduced by the plural attractor noun. A further mixed-effect models analysis showed that in grammatical sentences, a reliable effect of number was detected at attractor region (cells) and this effect was only confined to that region. Wagers et al. (2009) concluded that the slow-

downs they observed in grammatical mismatch conditions in Experiments 4 and 5 were due to processing difficulty introduced by the plural attractor (cells) and not due to agreement attraction.

In Experiment 6, Wagers and colleagues (2009) wanted to further test whether agreement attraction can be observed in grammatical sentences or not; therefore, in this experiment, they only used grammatical conditions of Experiment 4 (Singular head PP constructions with an adverb preceding the verb). No significant differences in RTs were found between the match and mismatch grammatical sentences on the verb region or the spill-over region.

To sum up, Experiments 2 and 3 in Wagers et al. (2009) showed that agreement attraction is observed in RCs even when the attractor (RC head) is hierarchically superior to the subject (refuting the feature percolation account) and Experiments 4, 5 and 6 showed that agreement attraction occurs only with ungrammatical sentences.

Given these findings, Wagers et al. (2009) argue against feature percolation in number agreement and explain their results with cue-based memory retrieval account (Lewis & Vasishth, 2005). According to Wagers et al. (2009), cue-based memory retrieval in S-V agreement processing may operate in two ways: agreement processing can be realized by a cue-based retrieval process where the verb number is utilized as a cue to search for the subject in memory. The cues generated by the verb consist of agreement features (e.g. [Number:Pl]) and structural cues (e.g., [Case:Nominative]) or [Role:Subject])). Wagers et al. (2009) argue that cue-based memory retrieval account also explains the grammatical-ungrammatical asymmetry in agreement attraction they found in their experiments because they predict that a partially-matching NP to the cues generated by the verb will almost never be

retrieved if a fully-matching NP to the cues generated by the verb is present (as in grammatical sentences). In other words, Wagers et al. state that NPs which totally match with the cues generated by the verb (subjects in grammatical sentences) strongly out-compete the partial matches (attractors in RCs or local nouns in complex subjects with PPs) hence there is little possibility of retrieving a number mismatching NP. This would be a reason for no significant agreement attraction in grammatical mismatch sentences in Wagers et al. (2009). But, in the case of ungrammatical sentences, as neither of the NPs totally matches the cues generated by the verb, the attractor noun might be retrieved instead of the subject. Wagers et al. (2009) argue that another explanation for the agreement attraction according to cue-based memory retrieval account is that a mismatch between the verb number and the subject number can start a reanalysis process to retrieve the correct subject using cues generated by the verb. When a subject is encountered, a verb marked with the necessary agreement features is predicted. When the parser reaches the verb, the verb's number features are checked against the predicted features and if they match, the subject is retrieved and no further action is necessary. However, if they mismatch, a cue based-retrieval is started to check for the correct controller. In this reanalysis stage, attractor NPs, instead of subjects, might be retrieved. Wagers et al. (2009) propose that this might be another explanation of why they observed agreement attraction only in the ungrammatical sentences.

Although Wagers et al. (2009) is an innovative study in that it explains the results by cue-based memory retrieval as different from the previous studies which explain their results with linear distance (Bock & Miller, 1991; Bock & Cutting, 1992), syntactic distance (Franck et al., 2002; Pearlmutter, 2000; Vigliocco & Nicol, 1998), markedness (Eberhard, 1997) or head-overwriting and mismatch asymmetry

(Dillon et al., 2013; Nicol et al., 1997; Pearlmutter et al., 1999); it has some flaws in its analyses and interpretations. First of all, the discussion in Wagers et al. (2009) on finding an asymmetry in agreement attraction between grammatical and ungrammatical sentences supports cue-based memory retrieval is not solid because cue-based memory retrieval account has predictions for both grammatical and ungrammatical sentences. Also, while Wagers et al. (2009) did not find a significant attraction effect in grammatical sentences (attributed the slow-down effect in grammatical sentences to the difficulty of processing the plurality), there are many studies which did (Nicol, 1997; Lago & Felser, 2018; Pearlmutter, 1999; Pearlmutter, 2000) and cue-based memory retrieval account itself does not state that this account only holds true for ungrammatical sentences. Although Wagers et al. (2009) interpreted their results only as facilitatory interference in ungrammatical sentences; cue-based memory retrieval account predicts inhibitory interference in grammatical sentences as well.

Another study on processing L1 number agreement, supporting cue-based memory retrieval was conducted by Tanner and Bulkes (2015). They conducted an event-related brain potentials (ERP)[5] study with L1 speakers of English. Tanner and Bulkes (2015) examined plural markedness (Eberhard, 1997), more specifically the effect of lexical quantification cues in processing S-V agreement. In line with cue-based memory retrieval account, Tanner and Bulkes (2015) argue that strong cues to an NP's number feature assist the encoding of the number feature of the NP in the working memory and facilitate the prediction of upcoming verb's agreement features. If predictions fail, these cues may also provide the retrieval targets for the memory search of the verb's suitable controller. Tanner and Bulkes (2015) argue that

[5] ERP measures brain response as a direct result of specific stimulus, in this case, linguistic stimulus and positivities elicitied around 600 milliseconds (P600) are a sign of late syntactic processing.

encoding an NP with the plural feature multiple times (both by the plural morphology and using a quantifier before the noun) causes a bigger expectancy for a plural verb. In other words, they predict that while both quantified and unquantified ungrammatical sentences will create disturbances in processing, quantified ungrammatical sentences will create greater disturbances. They manipulated grammaticality and quantification in their sentences. Grammaticality was manipulated by changing the number agreement of the verb and quantification was manipulated by either using *some* or *many* (35b, 35d) or *the* (35a, 35c). While *some* and *many* provide quantification and cues for plurality (multiple amount of something), *the* does not provide any number information.

(35) a. Grammatical, unquantified:

The cookies taste the best when dipped in milk.

b. Grammatical, quantified:

Many cookies taste the best when dipped in milk.

c. Ungrammatical, unquantified:

The cookies tastes the best when dipped in milk.

d. Ungrammatical, quantified:

Many cookies tastes the best when dipped in milk.

(Tanner & Bulkes, 2015, p. 1756)

While both quantified and unquantified ungrammatical sentences (35c, d) elicited a P600 response (positive-going deflection around 600 milliseconds, indicating late syntactic processing or reanalysis), as was predicted by Tanner and Bulkes (2015), quantified ungrammatical sentences (35d) generated greater P600 effects compared to the unquantified grammatical sentences (35c). Tanner and Bulkes (2015) argue that their results are in line with the assumptions of cue-based memory retrieval in S-

V agreement. Because a plural quantifier would create a stronger prediction than an unquantified structure with determiner *the* for the representation of the upcoming verb's number. When the stronger predictions generated by the quantifiers fail upon encountering a verb which does not match in terms of number feature with the predictive representation in working memory, stronger processing difficulties occur. Also, the cues generated by the verb mismatch with the quantified NPs more strongly in number feature during retrieval, as determiner *the* can be used with both singular and plural nouns in English.

To conclude, although the studies summarized here provide different accounts for processing and production of S-V number agreement (i.e., the linear distance hypothesis (Bock & Miller, 1991; Bock & Cutting, 1992), the syntactic distance hypothesis (Franck et al., 2002; Pearlmutter, 2000; Vigliocco & Nicol, 1998), the markedness account (Eberhard, 1997), the head-overwriting and mismatch asymmetry accounts (Pearlmutter et al., 1999), and the cue-based memory retrieval model (Tanner & Bulkes, 2015; Wagers et al., 2009)) the common observation is that the number mismatch between the subject head and the local or intervening noun(s) results in errors in production and difficulty in processing in the L1.

Let us now turn to Chapter 4 to examine S-V agreement in the L2.

CHAPTER 4

THEORETICAL MODELS AND STUDIES OF SUBJECT-VERB AGREEMENT IN THE SECOND LANGUAGE

This chapter, after presenting the theoretical framework for second language processing in general, will report on studies investigating processing of subject-verb agreement in the second language.

4.1. Theoretical accounts for second language processing

There have been several approaches to the language processing behavior of L2 speakers. One group of researchers (Clahsen & Felser, 2006a, 2006b, 2006c; Jiang, 2004; Keating, 2009; Ullman, 2001, 2005) argue that L2 speakers' processing behaviors' deviation from that of L1 speakers is due to the qualitative differences between the processing systems of L1 and L2 speakers. While others attribute L2 speakers' non-native-like processing to their working-memory capacity limitations, less-automatized processing skills or L2 leaners' proficiency in the target L2 (Hopp, 2006, 2010). In his critical review, Cunnings (2017a, 2017b) on the other hand, suggests that the difference between the processing systems of L1 and L2 learners is caused by L2 learners' vulnerability to interference while accessing information from memory and their increased dependence on discourse-related cues.

4.1.1. Qualitative differences between L1 and L2

Declarative and procedural memory by Ullman (2001) and Shallow Structure Hypothesis by Clahsen and Felser (2006a, 2006b, 2006c) are the two accounts which can be examined under the title of qualitative differences between L1 and L2.

Although they present different information regarding L1 and L2, they have a common aspect in stating that L1 and L2 processing are fundamentally different.

4.1.1.1. Declarative and procedural memory

Ullman (2001) proposed a dichotomy for memory systems; a declarative memory for the information storage and a procedural memory for skill learning and computing. The declarative memory contains information that is at least partly explicit, open to conscious awareness. The mental lexicon which is a collection of lexical units (e.g., *devour, teach*) and word specific information (e.g., the verb *to devour* takes a direct object, *teach* becomes *taught* in simple past tense) are stored in the declarative memory. Any irregular word specific information such as argument structure (the verb *to devour* takes a direct object), irregular inflection (*teach* becomes *taught* in simple past tense) and idiomatic expressions such (e.g. *kick the bucket*) are considered to be parts of the mental lexicon (Ullman, 2001). The procedural memory system; on the other hand, plays a role in learning and controlling the motor and cognitive skills. It contains information and procedures which are largely implicit. The mental grammar which includes syntax, morphology, phonology and grammatical structure building (e.g. regular inflection such as *walk+ed* in simple past tense) depends on procedural memory.

Ullman (2005) proposes that L1 and L2 speakers operate these memory systems in different ways. For L1 speakers, the declarative memory contains the mental lexicon and the procedural memory contains mental grammar and all rule-based operations. But, although young L2 leaners can use procedural memory to compute grammatical structures similar to L1 speakers, adult L2 speakers cannot use procedural routines as well as native speakers do due to the maturational changes in

the brain during adolescence. While skill-learning linked to procedural memory is attenuated during the critical period for language acquisition, declarative memory enhances in childhood and peaks in adolescence (Ullman, 2005). Hence, L1 speakers and young L2 learners make use of procedural memory whereas adult L2 speakers rely on declarative memory to compute the same grammatical operations. Majority of evidence for the declarative/procedural model on L1 and L2 processing comes from ERP research.

Notably, a study by Hahne and Friederici (1999) provided evidence supporting Ullman's dichotomy of declarative/ procedural memory systems. Employing ERP methodology, Hahne and Friederici examined phrase structure violations such as *Die Gans wurde im gefüttert* '*The goose was in the fed'* (Hahne & Friederici, 1999, p. 201) with L1 German speakers and L1 Japanese L2 German speakers. In ERP research, while left anterior negativities (LANs) indicate early grammatical computations, positivities elicited around 600 milliseconds (P600) are a sign of late syntactic processing or reanalysis; and negativities observed around 400 milliseconds (N400) indicate lexical-conceptual processing. The results of Hahne and Friederici (1999) showed that although L1 Japanese-L2 German speakers showed only N400 and P600 response to phrase structure violations such as *Die Gans wurde im gefüttert* '*The goose was in the fed'* (Hahne & Friederici, 1999, p. 201), L1 German speakers yielded P600, N400 and LAN effects to the same violations, suggesting that native speakers used procedural memory for processing but L2 speakers utilized their declarative memory.

Hahne (2001) conducted a study on selectional restrictions and word category violations such as *Das Geschäft wurde am geschlossen 'The shop was being on closed'* (Hahne, 2001, p. 254). The participants were German native speakers and L1

Russian-L2 German speakers. While the native speakers showed P600, N400 and LAN responses to the word category violations, the L2 speakers showed only an N400 response, suggesting that while L1 speakers are sensitive to both syntactic and lexical cues, L2 speakers are only sensitive to lexical cues.

The Hahne and Friederici (1991) and Hahne (2001) studies, briefly reviewed above, provide supportive evidence for the separability of grammar and lexicon and for declarative/procedural model. The declarative/procedural model is informative in our understanding of first language processing. It showed that L1 speakers depend on declarative memory mainly for mental lexicon and procedural memory for rule-based grammatical computations. But it has also been informative in our understanding of the morphological and syntactic processing behavior of L2 learners. It specifically predicts an increased reliance on declarative memory by L2 learners because the studies mentioned above consistently showed that unlike L1 speakers, L2 speakers failed to demonstrate LAN responses which represent early grammatical computations. This reliance on declarative memory by L2 speakers, as opposed to native speakers who use both declarative and procedural memory depending on task at hand, is considered as the main reason for the difference between their processing behaviors. That is, while L2 speakers do not appear to make rule-based computations, L1 speakers can.

4.1.1.2. The Shallow Structure Hypothesis

Clahsen and Felser (2006a, 2006b, 2006c) consider that the L2 speakers' increased reliance on declarative memory results in shallow parsing and L1 and L2 speakers are fundamentally different in their language processing behavior. The Shallow Structure Hypothesis (SSH) of Clahsen and Felser (2006a, 2006b, 2006c) maintains

that native speakers and L2 speakers are different in the sense that second language speakers cannot process syntactically detailed computations and this behavior does not change through increased proficiency or enhanced exposition to the language. Clahsen and Felser argue that "the syntactic representations adult L2 learners compute for comprehension are shallower and less detailed than those of native speakers." (Clahsen & Felser, 2006a, p. 32). Since their grammatical computations are less detailed than those by native speakers, L2 speakers must compensate for it by relying more on lexical, semantic or pragmatic information.

The results of several studies led to the development of the SSH. Some of these investigated syntactic ambiguity resolution in the L2 (Dussias, 2003; Felser, Roberts, Marinis and Gross; 2003; Papadopoulou & Clahsen, 2003) while others examined processing of filler-gap dependencies (Marinis, Roberts, Felser & Clahsen, 2005) or absence of early negativities in ERP studies (Hahne, Mueller & Clahsen, 2006).

Felser and colleagues (2003) examined RC attachment ambiguity resolution preferences of L2 learners of English. The RC that they tested involved *of*-PP and *with*-PP constructions such as *The dean liked the secretary of/with the professor who was reading a letter*. They tested three questions in their study: (i) do adult L2 learners use the same sentence parsing mechanisms as native speakers do, (ii) to what extent are L2 learners able to use and combine phrase-structure and lexical-semantic information during processing and (iii) do L2 learners transfer parsing strategies from their L1. Felser et al. (2003) conducted four experiments; two offline questionnaires and two online self-paced reading experiments. The participants were L1 German L2 English, L1 Greek L2 English and L1 English speakers, each group taking part in one online and one offline task.

In the questionnaire, the participants were to indicate which NP (*the secretary*, NP1, or *the professor*, NP2) was reading a letter. Both groups of L2 English speakers overall preferred NP2 interpretation more than NP1 interpretation, just like native speakers but when the preposition (*of* vs. *with*) factor was examined; L2 participants chose more NP2 responses when the experimental sentence was joined by the preposition *with* rather than *of*.

In the self-paced reading experiment the experimental sentences were disambiguated via number marking on the auxiliary (*was* or *were*) which forced either an NP1 or NP2 interpretation: The dean liked *the secretary* of the *professors* who *was/were* reading a letter /The dean liked the *professors* with the *secretary* who *was/were* reading a letter. The participants' reading times at the auxiliary verb and the following region were measured. The difference between NP1 and NP2 attachment was statistically significant for the preposition *with* (a preference for NP2 attachment for all participant groups), but the L2 speakers did not show any preferences for constructions involving the preposition *of* although there was an NP2 attachment preference by the L1 speakers for this construction. The L2 learners' native-like behavior for *with*-PP constructions and non-native-like behavior for *of*-PP constructions shows that L2 learners are sensitive to the type of linking preposition the thematic information provided with the preposition *with*. That is, while processing sentences with complex genitive sentences, the L2 speakers can access and use lexical and semantic information during processing but they cannot use recency or predicate proximity strategies that L1 speakers were reported to use for these constructions. If they used purely syntactical parsing for RC ambiguity resolution, they would also have shown the same NP2 preference in sentences with complex genitive antecedents. As all the participants were rated as advanced in

language proficiency tests, their non-native performance was not due to low proficiency or insufficient interlanguage grammar. Furthermore; since two groups of L2 English learners from different L1 backgrounds were tested, the non-native performance cannot be attributable to L1 transfer, either.

Using a similar design to Felser and colleagues (2003), Papadopoulou and Clahsen (2003) also tested RC attachment ambiguity resolution but the participants were L2 Greek learners of three different groups of L1 learners (Spanish, German and Russian) and an L1 Greek control group. There was an offline acceptability judgement task and an online grammaticality judgement task. With participants from three different L1 backgrounds allowed them to also test L1 transfer in RC attachment ambiguity resolution. The experimental sentences were similar in both experiments. Each sentence had a subject-RC and two possible antecedents which were introduced with the complementizer *pu* (that). Gender agreement was used as a disambiguation cue in the on-line task, resulting in either high or low RC attachment. Two types of complex NPs (DP+DP_{GEN} or DP+PP) served as subjects to be modified by the RC. This would allow for examining the role of lexical bias because while PP condition *with* provides thematic information the genitive condition *of* creates a syntactically more complex structure. For both tests, the native speakers preferred high-attachment in sentences with DP+DP_{GEN} antecedents and low attachment in sentences with DP+PP antecedents. The L2 groups also favored low attachment for sentences with PP antecedents (relative clauses with thematic prepositions) but they did not show any significant attachment preferences for DP antecedents. These results show that although L2 learners can process the PP condition (*with*) which introduces thematic information in the same manner as L1 speakers, they process the

genitive condition (*of*), which provides a syntactically complex structure, differently from L1 speakers.

Marinis and colleagues (2005) examined processing of long distance *wh*-dependency in English with L2 learners of English from different L1 backgrounds (Greek, German – *wh*-movement background, Chinese, Japanese – *wh-in-situ* background). The goal of the study was to test whether these participants from different L1 backgrounds could process long distance *wh*- dependencies in the same manner as native speakers of English do. In their experiment, Marinis and colleagues (2005) investigated computing long-distance *wh*- dependencies by comparing sentences with an intermediate gap (*The nurse* ***who*$_i$** *the doctor argued* ***e*$_i$** *that the rude patient had angered* ***e*$_i$** *is refusing to work late.*) (Marinis et al., 2005, p. 61) to the sentences which do not require an intermediate gap (*The nurse* ***who*$_i$** *the doctor's argument about the rude patient had angered* ***e*$_i$** *is refusing to work late.*) (Marinis et al., 2005, p. 61). According to Marinis et al. (2005, p. 70) subjacency principle would predict that a filler should be retrieved from the working memory in each grammatically possible gap position, and not only on encountering the lexical categorizer. Participants were given a questionnaire and each sentence was followed by a question and the participants chose the answer they thought to be most appropriate: (*The captain who the officer decided that the young soldier had displeased will write a formal report next week. /Who made a decision? a. the captain b. the officer c. the soldier*) (Marinis et al., 2005, p. 60). The online test was a self-paced reading test. The sentences were divided into six parts as in (1). Part 3 and 5 were critical to understand whether the participants are sensitive to intermediate gaps:

(1) The nurse who /the doctor argued /that/ the rude patient /had angered / is refusing to work late.
1 2 3 4 5 6

(Marinis et al., 2005, p. 62)

The results of the offline test showed that the L2 speakers, just like native speakers, interpreted the sentences correctly and chose the correct answers (*the captain* in the example) showing that the L2 speakers showed sensitivity to intermediate gap effect and obeyed the subjacency principle. The results of online test on the other hand showed that the native speakers and the L2 speakers employed different mechanisms in processing long distance *wh*- dependencies. While L1 speakers of English showed sensitivity to intermediate gap effect and followed the subjacency principle, no group of L2 speakers showed sensitivity to intermediate gap or obeyed the subjacency principle. While processing long-distance *wh*- dependencies, L2 speakers tried to make a direct lexical association between the filler and its subcategorizer instead of following the subjacency principle by using structural cues.

The studies summarized here (Felser et al., 2003; Marinis et al., 2005, Papadopoulou & Clahsen, 2003) all come to the common conclusion that L2 learners are different from native speakers in their syntactic processing and support the SSH. Since L2 learners have difficulty in detailed syntactic computations they resort to lexical, semantic and pragmatic cues instead. This pattern in L2 processing does not appear to stem from L2 learners' incomplete acquisition though because in all the studies reviewed above, the L2 speakers behaved similar to the native speakers in offline measures. L1 transfer also does not contribute to shallow parsing in the L2 because participants from typologically different L1 backgrounds behaved in a similar manner. Even though SSH is supported by those studies and other L2 studies (e.g., Keating, 2009), which will be described in more detailed in L2 studies part, not

all research in L2 processing support the predictions of SSH (Lago & Felser, 2018; Foote, 2011; Song, 2015). Hopp (2006, 2010), observed that L2 speakers' non-native-like processing could be attributed to L2 proficiency and L1 background rather than shallow parsing in the L2, concluding that the differences between language processing of L1 and L2 speakers are not qualitative but quantitative and are attributable to L2 speakers' language skills in the L2.

4.1.2. Quantitative differences between L1 and L2

Hopp (2006, 2010) maintains that language processing by native and L2 speakers are not fundamentally different; they are similar but processing in the L2 is cognitively more demanding compared to processing in the L1.

Hopp (2006) investigated L2 processing of subject-object ambiguities in German in a self-paced reading study. Half of the experimental sentences were disambiguated via case marking on the determiner as in (2) and the other half was disambiguated via number marking on the verb as in (3). The sentences had either subject-object (SO) order as in (2a, 3a) or object-subject (OS) order as in (2b, 3b).

(2) a. SO: Er denkt/ dass/ **der** Physiker/ am Freitag/ **den** Chemiker/ gegrüsst/ hat.
He thinks that the-NOM physicist on Friday the-ACC chemist greeted has

b. OS: Er denkt, dass **den** Physiker am Freitag **der** Chemiker gegrüsst hat.[6]

(3) a.SO: Sie sagt, dass **die** Baronin am Freitag **die** Bankiers eingeladen **hat**.
She says that the baroness-SG on Friday the bankers-PL invited has

[6] A gloss was not provided for condition (2b) in Hopp (2006, p. 378).

b. OS: Sie sagt, dass **die** Baronin am Freitag **die** Bankiers eingeladen **haben**.

She says that the baroness-SG on Friday the bankers-PL invited have

(Hopp, 2006, p. 378)

The experimental sentences were divided into seven segments, indicated via slashes in (2a) in presentation of self-paced reading. The participants were L1 English and Dutch speakers of L2 German and native speakers of German. The L2 groups were divided into advanced and near-native groups according to their proficiency in German. Their proficiency was measured via a C-test[7]. Native speakers of German and near native German speakers (with English and Dutch as their L1) showed slow-downs in sentences with OS word order (2b, 3b) compared to SO word order (2a, 3a). The slow-down was on segments three and four in sentences disambiguated by case (2) and on segment 7 in sentences disambiguated by verbal agreement (3). But advanced L2 German speakers did not show any significant slow-down in OS sentences (2b, 3b) compared to SO sentences (2a, 3a) in any segments. Based on these results, Hopp (2006) concluded that as the proficiency increases in the target language (near native vs. advanced), L2 speakers' processing behavior becomes more native like.

In another study similar to Hopp (2006), Hopp (2010) tested whether or not the problems L2 speakers experience with L2 inflection (e.g., case and subject-verb agreement) are due to age-related grammatical impairment (i.e., inability to reach native-like language skills after the critical period). He conducted three experiments on processing case marking and S-V agreement in German. Two employed grammaticality judgment tasks (one speeded, the other without time pressure)

[7] A C-test is a proficiency test in a target language. Similar to the cloze tests, multiple parts of words are deleted in a continuous text and participants are asked to fill in the blanks.

(GJTs[8]) and one online self-paced reading test. The participants were L2 speakers of German.

German has rich morphology where nominative, accusative, dative and genitive case is morphologically marked and agreement is marked for number and gender. The participants were from three different first language backgrounds: English, Dutch and Russian. Each of these languages differs with respect to its morphology. Russian, just like German, has a very rich morphological system. It morphologically marks six cases (nominative, accusative, dative, genitive, instrumental and locative). These case markings overlap with number and gender agreement. Although Dutch also has a rich inflectional system, it has case marking (nominative, accusative) only for personal pronouns. Similar to German, it has number and gender agreement. Among these three languages as L1s, English is the poorest in its morphology. It marks case or gender inflection only with pronominals but not with full nouns; and the definiteness feature is realized via determiners, not through morphology.

In each L2 group, there were two proficiency levels: near-native and advanced based on the participants' scores on a C-test in German. Experimental sentences were similar to Hopp (2006) in which the subject and object word order varied as SO and OS, and the word order was disambiguated by either case marking as in (4) or S-V agreement marking as in (5):

(4) a. SO: Er denkt, dass der Hotelier im August den Gastwirt angezeigt hat.
He thinks that the-NOM hotel owner in August the-ACC landlord sued has

[8] A GJT with time pressure means the presentation of a stimulus is restricted to a certain duration. In Hopp's (2010) experiment, the presentation duration of each word was limited to 250 ms.

b. OS: Er denkt, dass den Hotelier im August der Gastwirt angezeigt hat.[9]

(5) a. SO: Sie saggt, das die Radlerin am Freitag die Anwohner behindert hat.
She says that the cyclist-SG on Friday the residents-PL obstructed has

b. OS: Sie saggt, dass die Radlerin am Freitag die Anwohner behindert haben.
She says that the cyclist-SG on Friday the residents-PL obstructed have.

(Hopp, 2010, p. 914)

Both language background and proficiency affected the results. The Russian L1 group showed better performance in all three tests compared to the other two groups. In the speeded GJT and in the GJT without time pressure, near-native groups had high accuracy rates like native speakers but the advanced groups did not. In the self-paced reading task native speaker and near-native speaker groups showed significant slow-downs in OS (4b, 5b) sentences compared to SO (4a, 5a) sentences but advanced groups showed no significant slow-downs. Hopp (2010) concluded that native-like processing is possible for late L2 learners in the area of L2 inflection as their proficiency increases; and L1 transfer also has a role in L2 processing.

4.1.3. Cue-based memory retrieval in the L2

In his critical review, Cunnings (2017a) proposes that the primary reasons for the differences between processing in the L1 and the L2 are mainly due to interference in retrieval operations outlined under the cue-based memory retrieval account (Lewis & Vasishth, 2005).

Recall that in the cue-based memory retrieval account, the most important factors which affect retrieval are activation-based decay and similarity-based

[9] A gloss was not provided for condition (4b) in Hopp (2010, p. 914).

interference (Lewis & Vasishth, 2005). Immediately after an item is first encountered, its activation levels decay as other items are encountered because the focus of attention in working memory is very limited and the features of previously encountered items cannot be kept in working memory. This predicts a role for distance in dependency resolutions where more recent items will be more easily retrieved. Similarity-based interference on the other hand states that in memory retrieval, cues derived from the current context are matched against all previously encoded items in memory. The item which provides the best match to the set of cues generated by the verb becomes highly activated and gets to be retrieved. But since retrieval cues are checked against all items in working memory in parallel in cases where there is an item which partially matches the retrieval cues, this item may sometimes be retrieved. Therefore, similarity-based interference assumes that successful retrieval of an item from the working memory is influenced by the number of previously encountered items which matches the cues during retrieval.

According to Cunnings (2017a), L2 learners are more prone to similarity-based interference during retrieval from memory compared to L1 speakers. He suggests that rather than a fundamental difference in processing from L1 speakers, L2 learners' processing behavior can be attributed to their increased dependence on discourse-related and lexicosemantic cues in their retrieval of information from memory. This is attributed to two causes: (i) L2 speakers' focus of attention is very limited in the target language and (ii) the cues drawn from the syntactic structure are more abstract than the cues drawn from the lexical constituents and discourse (Cunnings, 2017b), hence making the lexical and discourse-related cues more prominent.

Cunnings' (2017a) arguments rely on data from previous studies which reported discrepancies in language processing by L1 and L2 speakers. Recall that in their RC attachment study, Felser et al. (2003) reported RC attachment preference similar to native speakers by L2 speakers when lexicosemantic cues (e.g., *with* PP) were present but such preference was not evident when lexicosemantic cues were absent (e.g., *of* PP). Clahsen and Felser (2006a) interpreted L2 speakers' lack of attachment preferences in Felser et al. (2003) as a proof for SSH (i.e., L2 speakers' inability to compute complex structures -- the *of* PP structures in their study). But Cunnings (2017a) argues that L2 speakers' reliance on lexicosemantic and discourse level cues can account better for their findings. He claims that L2 speakers have clear attachment preferences and can compute complex syntax, similar to native speakers when lexicosemantic cues are present.

In an RC attachment study, Pan, Schimke and Felser (2015) found that when L2 speakers were presented with discourse contexts which biased for non-local attachment for RC, the L2 speakers showed a non-local attachment preference. But when they were presented with discourse which biased local attachment, they showed a local attachment preference. Although Pan et al. (2015) interpreted their findings as supporting evidence for the SSH, i.e., that L2 speakers can do only shallow parses, Cunnings (2017a) argues that the results do not necessarily indicate L2 speakers' inability to compute syntactically detailed parses but they rather indicate L2 speakers' increased sensitivity to the discourse-related cues.

Cunnings' review (2017a) also includes studies examining reanalysis strategies used for garden-path sentences. One example is Jacob and Felser's (2016) study on the disambiguation of garden-path effects as in (6) with native English and L1 German L2 English speakers.

(6) While the gentleman was eating (,) the burgers were still being reheated in the microwave.

The sentence in (6) is ambiguous between a direct object reading and the subject reading of *the burgers,* and is disambiguated with a comma after *eating* which would force for a subject preference for *the burgers.* Jacob and Felser (2016) presented experimental sentences similar to (6) either with a comma or without a comma, with each sentence followed by a comprehension question such as *Was the gentleman eating burgers?*.

For both their L1 and L2 groups, there was a slow-down on the verb in the temporarily ambiguous sentences compared to unambiguous sentences with a comma showing that both groups were garden-pathed and had to reanalyze the temporarily ambiguous sentence. But the L2 learners gave significantly more inaccurate answers to the comprehension questions than L1 speakers. Jacob and Felser (2016) argue that the results support SSH in that L2 speakers do not form a fully specified parse following disambiguation. But Cunnings (2017a) maintains that these findings suggest persistence for the initial analysis for L2 speakers, even after the reanalysis of the sentence. Since L2 speakers are more prone to interference, their initial false interpretation of ambiguous sentences interferes with the reanalysis.

Another study reviewed in Cunnings (2017a) is a study on pronoun resolution conducted by Roberts, Gullberg and Indefrey (2008) with Dutch native speakers and L1 Turkish and L1 German speakers of Dutch. The self-paced reading study included sentences in Dutch as in (7):

(7) a. De werknemers zitten in het kantoor. Terwijl Peter aan het werk is, eet hij een boterham.

The workers are in the office. While Peter is working, he is eating a sandwich.

b. Peter en Hans zitten in het kantoor. Terwijl Peter aan het werk is, eet hij een boterham.

Peter and Hans are in the office. While Peter is working, he is eating a sandwich.

Both L2 groups in the study showed slow-downs in reading when there were two potential antecedents (*Peter* and *Hans*) for the pronoun (*hij* – he) as in (7b) compared to when there was only one antecedent (*Peter*) as in (7a). But Dutch speakers considered only *Peter* as the antecedent for the pronoun in (7b), but not *Hans*, suggesting that the other antecedent (*Hans*) did not cause interference in pronoun retrieval for Dutch speakers as the discourse bias strongly favors the sentence internal local referent, *Peter*. For L2 speakers, the two NPs (*Peter* and *Hans*) apparently competed to be antecedents for the pronoun as they both match with the pronoun in their gender feature. Thus, Cunnings (2017a) argues for Roberts et al.'s (2008) data that the partially matching NP *Hans* would cause interference in retrieval and the L2 speakers would be more prone to this interference resulting in their slower processing of pronoun compared to the native speakers.

Cunnings (2017a) argues that the L2 findings of agreement studies such as those in Keating (2009) can also be attributed to cue-based memory retrieval. In an eye-tracking study with L1 Spanish and L1 English L2 Spanish speakers, Keating (2009) investigated the processing of gender agreement in sentences such as **[$_{DP}$ Un trabajo $_{masc.}$ aburrida $_{fem.}$] es ideal para alguien que no tolera el estr´es.* (A work

boring is ideal for someone who not tolerates the stress.), **[$_{DP}$ Una casa $_{fem}$.] [$_{VP}$ es bastante peque˜no $_{masc}$. cuando tiene solo una habitacion]. (*A house is quite small when has only one room.)/ **[$_{IP}$ Un refresco $_{masc.}$ [$_{VP}$ tiene muy buen sabor [$_{CP}$ cuando [$_{VP}$ est´a fr´ıa $_{fem.}$ y no caliente]]]], and (A soft-drink has very good taste when is cold and not hot.) (Keating, 2009, p. 534) (more details in Section 4.2.). In these sentences the adjective (e.g., *aburrida, peque˜no, fr´ıa*) and the subject noun (e.g., *trabajo, casa, refresco*) that it modifies must agree in gender. Adjective-noun gender agreement dependencies were either short or long. That is the subject noun was either linearly distant from the modifying adjective or close to it.

For both long and short dependencies the native speakers of Spanish showed longer reading times on the critical adjective (*aburrida*, *peque˜no*, *fr´ıa* respectively in the example sentences) when it mismatched with the subject noun in terms of gender. But the L2 speakers' reading time slowed down only for short dependencies. Keating (2009) interpreted these findings as a support for SSH since they would indicate some deficit in L2 speakers' processing of gender agreement.

Cunnings (2017a), however, states that the difference between the gender agreement processing of L1 and L2 speakers does not necessarily reflect a deficit in L2 speakers' language processing but it rather indicates interference in memory retrieval. Recall that activation-based decay in cue-based memory retrieval account predicts that increased dependency length will cause the activation levels of the previously encountered item to decrease resulting in enhanced possibility of retrieval interference. The L2 speakers in Keating (2009) were sensitive to the ungrammaticalities introduced by the gender mismatch when the subject and the modifying adjective were adjacent, which, according to Cunnings (2017a) rules out any sort of a deficit-in-processing hypothesis. The observation that this sensitivity

disappeared when the noun and its modifying adjective were linearly distant from each other would suggest decayed activation of the subject NP. And if L2 learners are more prone to such decay than L1 speakers due to their limited focus of attention, then the findings in Keating (2009) study can be attributed to L2 speakers being more prone to interference in processing gender agreement compared to L1 speakers. Note that Lago and Felser (2018) also argued that Keating's (2009) results could indeed be attributed to the cue-based memory retrieval account and the L2 learners' increased susceptibility to retrieval interference but not to SSH because otherwise "…shallow parsing [would be] understood as the prioritization of linear information over linguistic structure" (Lago & Felser, 2018, p. 640) and the experimental items in the Keating (2009) study did not contrast for linear distance and syntactic distance.

Given the findings in Felser et al. (2003), Jacob and Felser (2016), Keating (2009), Pan et al. (2015), and Roberts et al. (2008) from different kinds of dependencies, Cunnings (2017a) concludes that, the differences between processing in the L1 and the L2 are attributable to an increased reliance on lexicosemantic and discourse-level information in L2 speakers' processing and to L2 speakers' vulnerability to interference in real-time sentence processing.

4.2. The processing of S-V number agreement in the second language

Although L2 acquisition of S-V agreement has been studied in great detail in the generative second language acquisition (SLA) literature, L2 agreement processing studies are very scarce. There is an ongoing debate in L2 processing literature as to whether L1 and L2 speakers are similar or different in their processing of S-V agreement. While some researchers argue that second language speakers' language processing differs from that of first language speakers based on the results of several

online studies (Jiang, 2004; Keating, 2009) others have found that processing in L1 and L2 are similar (Foote, 2011; Lago & Felser, 2018; Öztürk, 2007; Song, 2015).

Among the very limited number of studies in L2 S-V agreement processing, Jiang (2004) was the first to investigate whether L2 learners are sensitive to English S-V agreement violations while processing in their L2. His specific goal was to identify processing difficulties that Chinese L2 learners experience with inflectional bound morphemes and whether or not Chinese L2 learners are sensitive to morphology in the target language. Chinese L2 learners of English and native English speakers took part in a self-paced reading study. The experimental sentences included either a mismatch between the head noun and the distractor noun as in (8a) or not as in (8b). The reading time was measured for three regions: the head noun (*the key*), verb (*was*) and the word following the verb (*rusty*). In the following examples, S means singular, P plural, G grammatical. Match and mismatch refers to the matching of the number feature between the head and the local noun.

(8) a. SS, Match, G: *The key* to the cabinet *was rusty* from many years of disuse.

b. SP, Mismatch, G: *The key* to the cabinets *was rusty* from many years of disuse.

(Jiang, 2004, p. 611)

While native speakers exhibited longer RTs in the SP condition (8b) than the SS condition (8a) on the critical region (the verb) and the spill-over region (the word following the verb), the results did not show a significant increase in RTs in mismatch situations (8b) compared to match situations (8a) for L2 learners in any regions. Hence, the results of Experiment 1 suggest that L1 Chinese L2 English speakers are not sensitive to the mismatch effect between the head and the local noun

in grammatical sentences. Although Experiment 1 provided introductory insights to the issues with morphological sensitivity of L1 Chinese L2 English speakers, Jiang (2004) conducted a second experiment in a wider scope. Previous research had shown that when the head noun was singular and the local noun was plural, the number feature of the local noun could erroneously percolate to the head noun which causes perceived number disagreement between the head noun and the verb (i.e., plural attraction) (Nicol et al., 1997; Pearlmutter et al., 1999). As discussed in Chapter 3, mismatch asymmetry states that plural attraction occurs only when the local noun is plural and the head noun is singular and not vice versa (Bock & Cutting, 1992; Bock & Miller, 1991; Pearlmutter et. al., 1999; Vigliocco & Nicol, 1998). As Experiment 1 only included grammatical sentences and singular heads, Jiang (2004) argues that the lack of agreement attraction in Experiment 1 may not have correctly reflected L2 speakers' lack of sensitivity to agreement morphology in the target language. In order to test mismatch asymmetry and L2 speakers' sensitivity to S-V agreement violations in addition to agreement attraction, two new conditions were added in Experiment 2 to the conditions in Experiment 1: PS, mismatch, grammatical (G) (9a) and SS, match, ungrammatical (UG) (9b) conditions.

(9) a. PS, Mismatch, G: The bridges to the *island were about* ten miles away.

b. SS, Match, UG: ∗The bridge to the *island were about* ten miles away.

(Jiang, 2004, p. 617)

The native speakers exhibited slow-downs on the critical region (the verb) in SP, Mismatch, G condition (8b) compared to SS, Match, G condition (8a). Also, they showed slow-downs in SS, Match, UG (9b) condition on the critical and spill-over regions compared to SS, Match, G (8a) condition. They did not show any slow-

downs in RTs in PS, Mismatch, G (9a) condition compared to SS, Match, G (8a) condition. But the L2 speakers did not show significant differences in RTs for any conditions compared to SS, Match, G (8a) condition. Jiang (2004) proposed that the number morpheme and S-V agreement is not internalized and automatized in L2 processing. He concluded his results showed that Chinese L2 speakers of English are insensitive to number agreement in L2 even when number morphology induced ungrammaticality.

Although not directly a test of S-V agreement, a study by Keating (2009), briefly reviewed above in Section 4.1.3, is also relevant to the present study as it investigated linear distance effects and processing load in L2 sentence processing. Keating examined sensitivity to gender agreement with advanced, intermediate and beginning level English-speaking learners of Spanish. He tested whether or not English learners of L2 Spanish are sensitive to gender agreement errors and specifically if L2 learners can detect these errors in a native-like manner when the linear distance between the noun and the adjective is manipulated. The L2 learners were divided into three groups according to their L2 proficiency: beginner, intermediate and advanced. The experimental sentences included a noun modified by a postnominal adjective located in three syntactic domains: in a determiner phrase (DP) (10a), in a verb phrase (VP) (10b) or in a subordinate clause (10c). In the first condition the modifying adjective (*aburrida*) was in the DP immediately following the noun; therefore, agreement was local (attributive adjective agreement) (10a), in the second condition the modifying adjective (*peque˜no*) was in the verb phrase (VP) of the matrix clause (10b) and in the third condition modifying adjective (*refresco*) was in a subordinating clause (10c). Hence, in the second (10b) and the third (10c) conditions the agreement required a long-distance dependency as the adjectives

occurred outside of DP (predicative adjective agreement). The reason for this manipulation was to increase the linear distance between the noun and the post modifying adjective. In all conditions, the adjectives and (10a- *aburrida*, 10b- *peque˜no*, 10c- *fr´ıa*) modified the subjects (10a- *trabajo*, 10b- *casa*, 10c- *refresco*) were used. Half of the experimental sentences were grammatical and the other half were ungrammatical. Ungrammaticality was introduced by gender mismatch between the subject and the modifying adjective. An example set of items (DP, VP and subordinating clause) can be seen below:

(10) a. *[$_{DP}$ Un trabajo $_{masc.}$ aburrida $_{fem.}$] es ideal para alguien que no tolera el estr´es.
A work boring is ideal for someone who not tolerates the stress

b. *[$_{DP}$ Una casa $_{fem.}$] [$_{VP}$ es bastante peque˜no $_{masc.}$ cuando tiene solo una habitacion].
A house is quite small when has only one room

c. *[$_{IP}$ Un refresco $_{masc.}$ [$_{VP}$ tiene muy buen sabor [$_{CP}$ cuando [$_{VP}$ est´a fr´ıa $_{fem.}$ y no caliente]]]].
A soft-drink has very good taste when is cold and not hot

(Keating, 2009, p. 534)

The results showed that native speakers slowed down while reading adjectives in ungrammatical sentences compared to grammatical ones in all three conditions (10a, b, c). Similar to native speakers, advanced L2 learners showed increased RTs in adjectives when the noun and the modifying adjective were adjacent to each other as in (11a) but unlike native speakers, they did not show sensitivity to the ungrammaticalities introduced by gender mismatch when there was some distance and phrase (10b) and clause (10c) boundaries between the subject and the modifying adjective. Beginner and intermediate level L2 learners did not show any significant

slow-downs in ungrammatical sentences compared to grammatical ones in any condition.

Keating (2009) concluded that although L2 learners have the linguistic competence and are sensitive to gender agreement in the L2, their processing might deteriorate when processing limitations (e.g., comparatively poor working memory capacity of L2 learners) are present in cases that require longer-distance feature checking. When the head noun and the adjective are not adjacent, tracking the gender feature becomes difficult for L2 learners due to L2 learners' poor working memory capacity. Keating attributes his results to SSH (Clahsen & Felser, 2006) and concludes that:

> [t]he present findings support the SSH in that the advanced learners were only nativelike in their sensitivity to gender errors in local domains. Under the assumption that learners who display nativelike sensitivity to gender violations within the DP have abstract gender in their L2 grammars, this article attributes nonnative sensitivity to gender agreement anomalies outside the DP to a deficit in processing, where deficit means that L2 learners may not have the processing resources necessary to hold information about gender in working memory while processing material that intervenes between nouns and adjectives.
>
> (Keating, 2009, p 527)

As was discussed in Section 4.1.3 above, Keating's results were later attributed to L2 learners' vulnerability to interference during retrieval from memory by Cunnings (2017a) (and also by Lago and Felser (2018)). Unlike the results of Keating's gender agreement study, in their study on S-V number agreement, Lago and Felser (2018) found both L1 and L2 speakers to be sensitive to syntactic distance (see below for further details).

Foote (2011) examined S-V number agreement and noun-adjective gender agreement sensitivity of early and late L1 English L2 Spanish speakers. The learners had near-native proficiency of Spanish. Moving windows self-paced reading

paradigm was used in the experiment. There were 128 sentences and half of the sentences measured the sensitivity to number agreement errors (11a, b, 12a, b). In 32 of those sentences the head noun and the verb were next to each other as in (11a, b). In the other 32, there were intervening elements between them as in (12a, b). Sentences were either grammatical as in (11a, 12a) or ungrammatical as in (11b, 12b).

(11) a. Veo que tu padre (3 SG) es (3 SG) de Texas

See (1 SG) that your father is from Texas

I see that your father is from Texas.

b. ∗Veo que tu padre (3 SG) son (3 SG) de Texas

See (1 SG) that your father are from Texas

(12) a. El reloj (3 SG) del hombre es (3 SG) de Suiza

The watch of the man is from Switzerland

The man's watch is from Switzerland.

b. ∗El reloj (3 SG) del hombre son (3 SG) de Suiza

The watch of the man are from Switzerland

(Foote, 2011, pp. 201-202)

The rest of the items aimed to test the sensitivity to noun-adjective gender agreement, in 32 of the sentences the head noun and the verb were next to each other (13a, b). In the other 32 sentences, there were some intervening components between these two (14a, b). Half of the conditions were grammatical (13a, 14a) and the other half were ungrammatical (13b, 14b).

(13) a. Dicen que el libro (MASC SG) blanco (MASC SG) est´a en esa mesa
Say (3 SG) that the book white is on that table

They say that the white book is on that table.

b. ∗Dicen que el libro (MASC SG) blanca (FEM SG) est´a en esa mesa
Say (3 SG) that the book white is on that table

(14) a. El pollo (MASC SG) del taco est´a rico (MASC SG) pero picante
The chicken of the taco is tasty but spicy

The chicken in the taco is tasty but spicy.

b. ∗El pollo (MASC SG) del taco est´a rica (FEM SG) pero picante
The chicken of the taco is tasty but spicy

(Foote, 2011, p. 202)

The results showed no significant differences for S-V number agreement among the L2 speakers and the native speakers. Both groups showed slow-downs in ungrammatical conditions compared to grammatical conditions, but slow-downs were significantly longer in ungrammatical sentences where the subject and verb was adjacent (11b) compared to where they were non-adjacent (12b). In other words, the sensitivity to ungrammaticality was reduced when there were intervening words between the head noun and the verb. Similarly for gender agreement, both the native and the L2 speaker groups showed slow-downs in ungrammatical sentences (13b, 14b) compared to grammatical sentences (13a, 14a). However, the slow-downs in the ungrammatical sentences where the subject and the verb were adjacent was

significantly longer (13b) compared to the sentences where they were not (14b). Based on these results, Foote (2011) argues that L2 learners are sensitive to S-V and gender agreement in the target language and processing of inflectional morphology in L1 and L2 are not fundamentally different. He concludes that based on this study, it is possible to become nativelike in the realm of L2 inflectional morphology.

Song (2015) tested the predictions of the SSH (Clahsen & Felser, 2006a, 2006b, 2006c) on sensitivity to plural errors with Korean learners of English. The L2 speakers had advanced proficiency in English. As reviewed above, the SSH maintains that L2 learners cannot compute detailed syntactic structures. Song (2015) tested this prediction by employing Determiner Phrases (DP) as in (15a) and Quantifier Phrases (QP) as in (15b) as experimental items. DP structures were considered simple structures while QP structures were considered complex structures because the local NP in quantifier phrase is embedded under three phrasal units as can be seen in example (15):

(15) a. Simple DP structure

$[_{DP}$ those$_{\{+plural\}}$ $[_{NP}$ long Latin words$_{\{+plural\}}]]$

b. Partitive QP structure

$[_{QP}$ many$_{\{+count\}}$ $[_{NP}$ (unit)$_{[+count]}$ $[_{PP}$ of $[_{DP}$ her $[_{NP}$ books$_{\{+plural\}}]]]]]$

(Song, 2015; p. 245)

An example set of sentences are presented below, in (16). G stands for grammatical and UG stands for ungrammatical. There were ten regions in each sentence from R1 to R10, each region corresponding to a word.

(16) a. Simple, G: Kevin memorized those long Latin words in just ten seconds.

b. Simple, UG: Kevin memorized those long Latin word in just ten seconds.

c. Partitive, GR: Mary donated many of her books to the public library.

d. Partitive, UG: Mary donated many of her book to the public library.

(Song, 2015, p. 247)

Two independent variables were tested; structure (simple (16a, 16b) vs. partitive (16c, 16d)) and grammaticality (grammatical (16a, 16c) vs. ungrammatical (16b, 16d)). 32 sets of items were used. Moving windows self-paced reading paradigm was used for data collection. For the analysis, the critical region was Region 6 (which corresponded to the head of DPs and QPs) and the spill-over regions were the following two regions. The results showed that, similar to the native speakers, the L2 learners slowed down in the ungrammatical sentences both with DP and QP structures. This suggested that similar to native speakers, L2 learners are sensitive to ungrammaticalities introduced by the number mismatches between the determiner and quantifier and the noun not only in simple but also in complex structures, contra the predictions of the SSH. Nevertheless, there were some differences in the slow-down patterns. While native speakers slowed down immediately at the critical region (Region 6) for both structures, L2 learners slowed down at the critical region for the DP sentences and at spill-over regions in QP sentences. This study showed that L2 learners are sensitive to plural errors but their sensitivity can be delayed compared to native speakers, they can compute plural inflection even when there is structural distance between the determiner/quantifier and the modified noun.

Öztürk (2007) tested processing of S-V agreement in English and sensitivity to the mismatch asymmetry (Pearlmutter et al., 1999, Vigliocco & Nicol, 1998) by end-state L1 Turkish speakers of L2 English. L1 Turkish L2 English speakers and

native English speakers participated in her study. Two sentence preamble completion tasks (combined as one experiment in Experiment 1) and one self-paced reading task were administered. The first experiment (a production task) consisted of completing subject preambles to declarative sentences or to questions, in a very similar format to the Bock and Miller's (1991) preamble completion experiment. The purpose was to find out whether the native speakers and end-state L2 learners show similar patterns in production of number agreement in questions and declarative sentences. In the first experiment, 20 sets of sentence preambles (e.g., *the toy(s) for the kid(s)*) were used both for declarative sentences and questions. Four conditions were formed for every preamble by manipulating the number feature of both NPs (i.e. SS, SP, PP and PS). Each preamble was shown with an adjective (e.g., *expensive/ the toy(s) for the kid(s)*) at a computer screen and participants were asked to produce a grammatical declarative sentence or a question by using the adjective and the preamble. All participants took part in all experiments. The order of two parts of the experiment (declarative sentence production and question formation) was randomized so that half of the participants were asked to produce declarative sentences first and the other half were asked to form questions first.

In Experiment 2, she tested if L1 and L2 speakers are similar in processing S-V agreement. In the self-paced reading task, the reaction time on the verb region was measured. The sentences were split into four sections and after each sentence participants answered a comprehension question as in (17) below.

(17) a. <u>The toy</u> / <u>for the kid</u> / <u>was</u> / <u>very expensive</u>.
1 2 3 4

Was the toy for the kid expensive?

(Öztürk, 2007, p. 79)

As in Experiment 1, Experiment 2 also had four conditions: SS (18a), SP (18b), PP (18c) and PS (18d).

(18) a. SS: The toy for the kid was very expensive.

b. SP: The toy for the kids was very expensive.

c. PP: The toys for the kids were very expensive.

d. PS: The toys for the kid were very expensive.

The results for the declarative sentence production test revealed that while forming declarative sentences both the L2 speaker group and the native speaker control group made significantly more errors following SP preambles compared to SS conditions. There was not a significant difference between PP and PS conditions. Confirming the mismatch asymmetry which was observed in previous research (Pearlmutter et. al., 1999; Vigliocco & Nicol, 1998), the results showed that L1 and L2 speakers were affected by agreement attraction similarly.

The results for question formations showed no significant difference between any condition for either the native speakers or the L2 speakers. Although the L2 group produced most errors in PS condition, this did not reach statistical significance. The question formation task had aimed to test the role of linear and syntactic distance in determining the attraction errors in L2 sentence processing. It had been predicted that if there had been agreement errors in declarative sentences but not in questions, that would have been evidence in favor of linear distance hypothesis. However; if there had been agreement errors also in the question formations, that would have supported the syntactic distance hypothesis. Since there were no significant differences between any conditions in the question formation experiment, Öztürk (2007) concluded that her results supported the linear distance

hypothesis. (But note that previous research had shown sensitivity to syntactic distance in S-V agreement processing not only for L1 speakers (Franck et al., 2002; Pearlmutter, 2000) but also for L2 speakers (Lago and Felser (2018)).

Similar to Experiment 1, the results of the comprehension experiment showed a significant slow-down in the verb area in the SP condition compared to SS condition for both participant groups but there was not a significant difference between PP and PS conditions, confirming the mismatch asymmetry (i.e., plural distractor nouns causing more agreement attraction than singular distractor nouns) in comprehension. Although native speakers and L2 speakers showed similar patterns in their RTs to plural mismatches overall, the L2 speakers were slower than the native speakers.

Although informative on Turkish speakers' processing of English S-V agreement, Öztürk's (2007) study had some limitations, such as a small number of participants (N = 21 for L2 speakers, N= 20 for L1 speakers), running the two production tasks one after another without no interval as one experiment, and not using any filler preambles in the production experiments, which could have increased the possibility for the participants to guess the purpose of the experiments. And most importantly, although linear and syntactic distance was tested in production experiments, they were not tested in processing; therefore, the conclusions regarding linear vs. syntactic distance of that study cannot be extended to L2 processing.

Lago and Felser (2018) conducted a study similar to the present one. By using complex noun phrases (embedded and coordinated), they tested whether native and nonnative speakers of German were sensitive to linear or syntactic distance in agreement attraction. They employed two experiments with German native speakers

and L1 Russian L2 German speakers. Both experiments were speeded forced-choice tasks. In Experiment 1, sentence preambles were shown to the participants in a phrase-by-phrase fashion in the center of a screen for 700 ms. Immediately after the last phrase was shown, two options to continue the preamble appeared on the screen for the participants to choose: *ist* (is) or *sind* (are). This type of task is similar to the classical sentence preamble completion tasks but it has some advantages. In spoken preamble completion tasks, researchers discard some trials due to participants' false starts. The forced-choice task would prevent discarding such trials. Also, with the forced-choice tasks not just verb choices but also the response times can be measured (Lago & Felser, 2018). In both experiments complex embedded preambles and coordinated preambles were used. The head noun was always singular and the number feature of the second and the third NP was manipulated.

(19) a. Embedded, SSS: Der Geruch / des Stalls$_{.gen.sg}$ / des Landwirts$_{.gen.sg}$

The smell of the stable of the farmer

b. Embedded, SPS: Der Geruch / der Ställe$_{.gen.pl}$ / des Landwirts$_{.gen.sg}$

The smell of the stables of the farmer

c. Embedded, SSP: Der Geruch / des Stalls$_{.gen.sg}$ / der Landwirte$_{.gen.pl}$

The smell of the stable of the farmers

d. Coordinated, SPS: Der Geruch / der Ställe$_{.gen.pl}$ / und des Landwirts$_{.gen.sg}$

The smell of the stables and the farmer

e. Coordinated, SSP: Der Geruch / des Stalls$_{.gen.sg}$ / und der Landwirte$_{.gen.pl}$

The smell of the stable and the farmers

(Lago & Felser, 2018, p. 626)

In the embedded preambles the second noun is syntactically closer to the head noun, whereas in the coordinated preambles the second and the third noun jointly modify the head noun so the second and the third noun have equal syntactic distance to the head. Hence, Lago and Felser (2018) predicted that if agreement was modulated by syntactic distance, participants would make more errors and/or show longer response times in SPS (19b) than in SSP (19c) condition in the embedded preamble condition but there would be smaller number of errors or no change in error rates or response times in SPS condition in the coordinated preamble condition (19d) compared to coordinated SSP condition (19e), because in the coordinated preambles the second and the third nouns have equal syntactic distance to the head.

Based on previous research, Lago and Felser (2018) hypothesized that while native speakers would be affected more by the syntactic distance (i.e., N2 manipulation) (Franck et al., 2002; Pearlmutter, 2000), L2 speakers would be affected by linear distance (i.e., N3 manipulation) (Keating, 2009). Also, native speakers should show stronger sensitivity to the mismatches in embedded preambles (19b) compared to the corresponding coordinated preamble version (19d) as N2 manipulation actually reflects syntactic distance in embedded preambles but in coordinated preambles N2 and N3 have the same syntactic distance to the head noun.

The results of Experiment 1 showed that, for both groups response times were longer and error rates were increased for SPS condition (19b) compared to SSP condition (19c) after embedded preambles. However, while L2 speakers showed significant error rates and slow-downs in response times only after embedded preambles, the mismatches in the N2 in embedded and coordinated preambles affected L1 speakers in a similar way. That is, the results showed that the L2 speakers weighed the syntactic distance more strongly than the native speakers did,

which was unpredicted considering the previous research (Franck et. al., 2002; Pearlmutter, 2000).

Lago and Felser (2018) state that the reason for not obtaining a stronger agreement attraction effect due to N2 mismatch in the embedded preambles compared to coordinated preambles could be due to the native speakers' very low error rates in the embedded preambles. In other words, a difference in the effect of N2 manipulation in embedded preambles vs. coordinated preambles was not observed because the error rates were not sufficiently high enough after embedded preambles to show any difference. They suggest that this is probably because the task was too easy for the native speakers and hence conducted Experiment 2 with the same items but with a more difficult speeded forced-choice task.

Experiment 2 aimed to replicate Experiment 1 in a way that the task would not be easy for either group of participants. This time, the sentence preambles were presented word-by-word and the presentation speed was 400 ms per word and the participants had to give a response in two seconds. A different group of German native speakers and Russian speakers of German participated in Experiment 2. The results showed that there were significantly more agreement errors in SPS (19b) conditions compared to SSP conditions (19c) after embedded preambles for both groups (although the effect was marginally significant for the L2 speakers). There was not a significant difference between the error rates made after SPS (19d) and SSP (19e) conditions after the coordinated preambles for either group. For both groups error rates were significantly higher in the SPS condition (19b) after embedded preambles compared to SPS condition (19d) after coordinated preambles. However, as different from Experiment 1, there were not significant differences in

response times between SPS (19b, 19d) and SSP (19c, 19e) conditions either in the embedded or in the coordinated preamble conditions.

Lago and Felser (2018) state that, the results of Experiment 2 show that L2 speakers, just like native speakers, are affected by syntactic distance but not by linear distance. If linear distance to the verb affected attraction, there would be more errors in SSP (19c, 19e) conditions. Also, the number of attraction errors would have been similar for embedded and coordinated NPs since they had identical linear order. But the SPS (19b) condition caused more errors than SSP (19c) condition for embedded NPs while there were no significant differences between SPS (19d) and SSP (19e) conditions in coordinated NPs. Lago and Felser (2018) conclude that their results show that L2 speakers are not more prone to agreement errors than native speakers and similar to native speakers they are affected by syntactic distance more than linear distance.

Although this study is informative in that it uses complex NPs with one head NP and two embedded (or coordinated) daughter NPs with a production task which is also informative about comprehension, it has some flaws. First of all, using coordinated NPs together with embedded NPs blurs the results. As the syntactic distance of the third noun to the head is different between two phrases, they cannot be compared. Furthermore, coordinated NPs appear to be unnecessary indeed since linear distance effect could already be tested with N3 manipulation, as in the SSP condition (19c). Lago and Felser (2018) also did not provide a baseline condition for coordinated NPs and that makes the interpretation of the results difficult. Also, it should be noted here although L2 speakers showed strong attraction effects due to N2 mismatch (19b) in Experiment 1, with a finer designed experiment, in Experiment 2 they only showed a marginal increase in error rates in SPS (19b)

condition compared to SSP (19c) condition in embedded preambles. And finally, although the researchers extend their results to comprehension, Experiment 2 did not show any significant differences in response times.

The studies reviewed in this section can only offer tentative conclusions about L2 learners' processing of S-V agreement. While Jiang (2004) and Keating (2009) showed processing of agreement in the L1 and L2 are different, Foote (2011), Lago and Felser (2018), Öztürk (2007) and Song (2015) showed that the processing of agreement in the L1 and L2 are similar. Although both Keating (2009) and Foote (2011) observed that participants' sensitivity to gender agreement was affected by the linear distance of the modifying adjective to the subject, Keating (2009) found this effect only for L2 speakers but Foote (2011) observed this with both L1 and L2 speakers. And finally, Lago and Felser (2018) found that both L1 and L2 speakers were sensitive to syntactic distance in S-V agreement production and processing.

The present study investigates S-V agreement in English with Turkish speakers of English, with an aim to shed further light onto the role of syntactic and lexical information in L2 processing. Similar to Öztürk (2007), the participants are Turkish speakers of English with advanced proficiency in their L2. But unlike Öztürk (2007), the present study employs complex subjects with a head NP and two post modifying PPs (e.g., *the daughter(s) of the author(s) of the book(s*)), similar to (Franck et al., 2002; Lago & Felser, 2018; Pearlmutter, 2000). Employing a complex NP subject with two intervening NPs has been an attested way to investigate the effects of linear and syntactic distance hypotheses in the L1 research. By extending the method to L2 processing, I hope to examine the roles of linear and syntactic distance in L2 processing. Employing an eye-tracking methodology (Experiments 1 and 2) will allow me to do so in an experimental setting that presents linguistic

stimuli in a way that is as natural as possible, unlike the relatively unnatural self-paced reading tasks. A further advantage of the eye-tracking methodology is that it informs on early and late stages of processing (Rayner, Sereno, Morris, Schmauder, & Clifton, 1989; Roberts & Siyanova-Chanturia, 2013). The present study also uses the lexical cue *one* to singularly mark the middle and the local nouns in Experiment 2. This manipulation will make it possible to examine the role of lexical information and additional cue encoding in processing S-V number agreement in the L2, testing the predictions of Cunnings (2017a, 2017b). A sentence completion task will follow the eye-tracking experiments to test the participants' offline sensitivity to S-V number agreement.

Chapter 5 will provide further details on the experiments.

CHAPTER 5

THE PRESENT STUDY

5.1. Introduction

This thesis investigates processing of S-V number agreement in English by Turkish L2 speakers of English. As was presented in Chapter 3, syntactic and linear distance of constituents and memory related factors such as activation-based decay and similarity-based interference can influence native speakers' processing of S-V agreement. And as was reviewed in Chapter 4, whether L2 speakers are affected by linear or syntactic distance or cue-based memory retrieval in their processing of S-V agreement is not clear. Thus, the specific questions tested in this thesis are whether or not Turkish L2 speakers of English are sensitive to linear and/or syntactic distance and whether or not this sensitivity changes when a lexical cue is present.

To test these questions, two eye-tracking experiments and a pen-and-paper sentence completion test are conducted. In Experiment 1, the first eye-tracking experiment, the effects of linear and syntactic distance on S-V agreement were tested. Experiment 2, the second eye-tracking experiment, also tested the effects of linear and syntactic distance but in addition, by employing a lexical numeral modifier (e.g., *one*) to modify the middle and/or local NPs in the subjects of the experimental sentences, the role of lexical information in L2 processing of S-V agreement was also examined. Finally, a pen-and-paper sentence completion test was conducted to ensure that the L2 speakers had the metalinguistic knowledge of S-V agreement in English and also to test whether or not their offline processing of S-V agreement will be similar to or different from their online processing of the structure.

5.2. Experiment 1

Experiment 1 investigated whether Turkish L2 speakers of English are sensitive to linear or syntactic distance in S-V agreement processing. Recall that the linear distance hypothesis (Bock & Miller, 1991; Jespersen, 1924; Quirk et al., 1972) states that the verb erroneously agrees with the local noun instead of the head noun, due to the linear distance between the head noun and the verb. Syntactic distance hypothesis (Franck et al., 2002; Kempen & Hoenkamp, 1987; Levelt, 1989; Pearlmutter, 2000; Vigliocco & Nicol, 1998) on the other hand states that the main reason of agreement attraction is the syntactic distance between the intervening noun and the head noun. The number feature of the intervening noun which is closer to the head noun syntactically percolates up to the head noun and this creates more interference in agreement assignment.

This experiment tests the effects of linear and syntactic distance on L2 learners' sensitivity to S-V agreement by employing declarative sentences which have complex subjects in which the head NP is followed by two daughter PPs. While the head NP is always singular in the experimental sentences, the number feature of the nouns in the middle and the local NPs are manipulated, creating conditions where the head noun and the intervening nouns either match or mismatch in number.

Experiment 1 (and also Experiment 2) employed eye-tracking methodology. There are several significant advantages of eye-tracking over traditional techniques such as metalinguistic judgment tasks or self-paced reading. The eye-tracking methodology enables us to obtain information about cognitive processes during reading (Frenck-Mestre, 2005; Rayner, 1998; Rayner et al., 1989). The amount of time spent fixating at an item reflects the cognitive effort required to process it,

meaning that longer durations and more fixations indicate greater processing effort and shorter fixations and similarly, skipping indicates less processing effort (Liversedge, Paterson & Pickering, 1998; Pickering, Frisson, McElree & Traxler, 2004). Unlike other experimental techniques such as self-paced reading, eye-tracking also allows us to observe reading in an experimental setting as natural as possible. And researchers can obtain information about both early and late stages of processing in eye-tracking experiments (Rayner et al., 1989; Roberts & Siyanova-Chanturia, 2013).

5.2.1. Participants

Forty-eight sophomore and junior students (females = 38) from Boğaziçi University whose ages ranged from 19 to 25 (M = 21.20) participated in Experiment 1. All of the participants reported their native language to be Turkish and their second language to be English. They were all advanced speakers of English, with a minimum BUEPT (Boğaziçi University English Proficiency Test) score of 60 (C). C in BUEPT corresponds to 6.5 in IELTS (International English Language Testing System), 550 in TOEFL PBT (Paper-based Test) and 79 in TOEFL IBT (Internet-based Test).

The participants' average age of exposition to English was 10. They had been attending Boğaziçi University, which offers English-medium instruction, for 2 or 3 years at the time of data collection. Seventeen participants had normal and thirty-one participants had corrected to normal (with glasses or contact-lenses) vision. All students received course credit for their participation.

Before each experiment, participants filled in a language background questionnaire, taken from Gürel (2002), eliciting information on demographics and language history (See Appendix A).

Note that the only participant group in Experiment 1 and in the other experiments were Turkish speakers of English. As was reviewed in Chapter 3, number agreement behavior of native speakers of English has been widely examined (Bock & Cutting, 1992; Bock & Eberhard, 1993; Bock & Miller, 1991; Dillon et al., 2013; Eberhard, 1997; Franck et al., 2002; Nicol et al., 1997; Pearlmutter et al., 1999; Pearlmutter, 2000). The experimental materials in this thesis employed complex subjects consisting of three NPs which are largely based on Franck et al. (2002) and Pearlmutter (2000). The intermediate and local NPs were all embedded in prepositional phrases. The number feature of the intermediate and the local noun were manipulated to create four conditions. As it was reviewed in detail in Chapter 3, both Franck et al. (2002), whose items the present study's materials were largely based on, Pearlmutter (2000) and Lago and Felser (2018) who also used complex subjects made of three NPs found that syntactic distance of the middle noun to the head noun affected L1 speakers' processing of S-V agreement. Thus, given the similarity of the present materials to those used in Franck et al. (2002), Lago and Felser (2018) (only the embedded clauses) and Pearlmutter (2000) and given the abundance of L1 studies on the subject, whose findings seem to converge on the role of syntactic distance in S-V agreement, the present study did not test native speakers of English as a control group. But the results will be compared to the findings in the previous studies.

5.2.2. Materials

Following Pearlmutter (2000) and Franck et al. (2002), the experimental sentences included complex subject NPs with three NPs such as *the article by the editor of the newspaper.* Complex subjects with three NPs allow for the ideal conditions to test the syntactic distance and the linear distance hypotheses because they allow for the use of declarative sentences which are used in online experiments in general. To test syntactic distance vs. linear distance hypotheses, some previous studies (e.g., Vigliocco & Nicol, 1998; Öztürk, 2007) employed tasks in which participants were required to form either questions or declarative sentences for complex subject preambles with two NPs. Franck et al. (2002) argues that questions "do not allow for a direct comparison with data reported in the literature, which were all declarative sentences" (p. 380) because most agreement attraction studies and some early studies regarding linear distance (Bock, 1995) were conducted with declarative sentences. Hence, Franck et al. (2002), Lago and Felser (2018) and Pearlmutter (2000) used complex subjects made of three NPs which would allow them to compare their results to the earlier studies testing the effects of linear distance. To my knowledge, Franck et al. (2002), Lago and Felser (2018) and Pearlmutter (2000) are the only studies which examined the production and processing of number agreement in relation to the syntactic or linear distance with complex noun phrase subjects made of three NPs.

As the studies reviewed in Chapters 3 and 4 showed, the number mismatch between the head and the local noun created difficulty in processing or led to S-V agreement errors in production. With two intervening NPs, it is possible to examine mismatch effects that can be caused by an NP linearly closer (NP3) to the verb or by an NP syntactically closer (NP2) to the head noun. This allows us to examine

whether the participants are sensitive to linear distance or syntactic distance in their processing of S-V agreement in English.

In Experiment 1, each sentence had a singular (S) head NP, *the article* in (1), and was followed by an intermediate NP, *the editor(s*) in (1), and a local NP, *the book(s)* in (1). The intermediate and local NPs were either singular (S) nouns as in (1a) or plural (P) nouns as in (1b, c, d). The intermediate and local NPs were embedded in prepositional phrases. The number feature of the intermediate and/or the local noun was manipulated to create four conditions as in (1). A past or present tense copula (*is* or *was*) was used. The copula was always the ninth word in the sentences and the total length of the sentences varied from twelve to fourteen words.

(1) *a. SSS, No Mismatch:* The article by the editor of the newspaper was so difficult to understand.

b. SPS, N2 Mismatch: The article by the editors of the newspaper was so difficult to understand.

c. SSP, N3 Mismatch: The article by the editor of the newspapers was so difficult to understand.

d. SPP, Total Mismatch: The article by the editors of the newspapers was so difficult to understand.

In Pearlmutter et al. (1999) in addition to grammatical sentences with match (SS) conditions where the verb agreed with the head noun in its number feature and mismatch conditions (SP) where there was a mismatch between the head and local noun's number feature; there were also ungrammatical sentences with (SS) and (SP) conditions. It was shown that ungrammatical sentences provided mirror image pattern to grammatical sentences. That is, in grammatical sentences, mismatch effect

caused longer RTs, while in ungrammatical sentences, the same mismatch effect caused shorter RTs (Pearlmutter et al.,1999, p. 434), suggesting that the number mismatch between the head noun and the local noun made the processing of grammatical sentences difficult whereas the same mismatch actually made the processing of ungrammatical sentences easy. Thus, instead of testing the number mismatch with ungrammatical as well as grammatical sentences, the two eye-tracking experiments employed only grammatical sentences to reduce the number of comparison conditions for statistically more robust results.

The experimental sentences were all written by the author of the thesis and they were inspected for their grammatical accuracy and semantic acceptability by an English native speaker. Sentences that were judged to be ungrammatical or semantically unacceptable were revised and re-inspected. Twenty-four experimental stimuli were allocated into four lists using a Latin-square design. Seventy-two filler sentences were added to the experimental stimuli and they were pseudo-randomized. The filler sentences were similar to the experimental sentences in their structure and complexity but there were some differences (e.g. different number features on the head noun, different verbs other than copula *be*). Hence, every list had one condition of each item and each item appeared the same number of times in each of the four lists (See Appendix B).

After each sentence, a comprehension question was presented to ensure comprehension. The comprehension questions asked if the sentence included a certain word (e.g., *interesting* in (2)). The correct answer would be *yes* for half of the sentences and *no* for the other half. The question appeared on the next window, after the sentence.

(2) Does the sentence include the word "interesting"?

Yes No

5.2.3. Predictions

Experiment 1 tests whether the linear distance between the intervening nouns and the verb or the syntactic distance between the intervening nouns and the head noun affect S-V agreement by Turkish learners of English. More specific predictions are outlined as below.

(i) The linear distance hypothesis (Quirk et al., 1972) proposes that the parser faces difficulty in assigning the number feature to the verb when there is a noun that intervenes between the head noun and the verb because keeping track of the number feature of the head noun is challenging for the working memory and in most cases the verb erroneously agrees with the local noun instead of the head noun (Jespersen, 1924; Quirk et al., 1972).

If the linear distance hypothesis is correct, and if it also correctly accounts for S-V number agreement in the L2, it is predicted that the Turkish speakers of English will face difficulty, reflected in measures such as longer fixations on the copula verb or the following words, in conditions where the local noun mismatches with the head noun (SSP) more so than in conditions where the middle noun mismatches with the head noun (SPS).

The predictions of the linear distance hypothesis in the L2 will also go hand in hand with the findings on use of WM in the L2 as the number feature of the head noun cannot be kept in the WM due to WM limitations because the WM in the L2 has been reported to be more limited compared to the WM in the L1 (Ellis, 2005; Jespersen, 1924; Quirk et al., 1972; Harrington & Sawyer, 1992). This would suggest

that the L2 speakers might me more inclined to be attracted to interference from a local noun than a non-local noun. (Ellis, 2005; Jespersen, 1924; Quirk et al., 1972; Harrington & Sawyer, 1992)

(ii) The syntactic distance hypothesis on the other hand maintains that agreement attraction occurs not due to the linear proximity of the intervening noun but due to the syntactic (i.e., hierarchical) proximity between the head and the intervening noun (Levelt, 1989; Franck et al. 2002; Pearlmutter, 2000; Vigliocco & Nicol, 1998). In this view, an intervening NP that is more deeply embedded in the syntactic structure will attract the verb in number agreement less than an NP that is not deeply embedded because the number feature of the syntactically closer noun can more easily percolate to the head noun.

For the conditions in Experiment 1, the syntactic distance hypothesis predicts processing difficulty at the verb (or the following few words) in conditions where the number feature of the middle noun mismatches to that of the head noun (SPS condition) than in conditions where the number feature of the local noun mismatches to that of the head noun (SSP condition).

(iii) But sensitivity to syntactic information has been challenged by the Shallow Structure Hypothesis for L2 speakers. The SSH (Clahsen & Felser, 2006a, 2006b, 2006c) maintains that L2 learners' grammatical computations are "shallower and are less detailed than those of native speakers" (Clahsen & Felser, 2006a, p. 32). And therefore, L2 speakers depend more on non-structural cues (lexical, pragmatic) than structural cues during sentence processing. This view assumes fundamental differences between L1 and L2 speakers in their sentence processing.

If the SSH is correct in its predictions, then the L2 speakers of the present study will not be sensitive to the number mismatches between the middle noun and the head noun (i.e., SPS condition, N2 mismatch). Although SSH does not specifically make any particular predictions with respect to linear distance, given Keating's (2009) finding on the role of linear distance in L2 Spanish gender agreement, it is reasonable to predict a role for linear distance in S-V number agreement as well. Note that Keating attributed his results (effect of linear distance) to SSH in L2 processing of gender agreement. But SSH has been challenged by the results of Foote (2011), Lago and Felser (2018) and Song (2015) for S-V agreement in the L2. Thus, if SSH is wrong and if L2 speakers use syntactic information in computing complex structures, then L2 speakers would show sensitivity to syntactic distance introduced by the intermediate noun (i.e. SPS condition, N2 mismatch).

(iv) Alternatively, the cue-based memory retrieval account (Lewis & Vasishth, 2005; Lewis et al., 2006) of sentence processing and its extension to L2 processing (Cunnings, 2017a, 2017b) predicts that L2 speakers will be more prone to the number mismatches in N3 compared to N2 due to activation-based decay. Recall that in activation-based decay, an item's activation levels decay immediately after it is first encountered and as other items are encountered. Based on this, as N3 will have a higher level of activation compared to N2 (and N1) and as L2 speakers are considered to be more vulnerable to interference during processing, N3 mismatch is predicted to cause a greater interference than N2 mismatch during S-V agreement processing.

The following are the specific research questions tested in Experiment 1:

1. Are Turkish learners of English similar to native speakers in their processing of S-V agreement (Franck et al. 2002; Lago & Felser, 2018; Pearlmutter, 2000; Vigliocco & Nicol, 1998) in that they are affected by the number mismatches associated with the structurally closer noun to the head noun more than the number mismatches associated with the linearly closer noun to the verb?
2. Or are they different from native speakers as suggested by the SSH (Clahsen & Felser, 2006a, 2006b, 2006c) and are insensitive to the structural information in their processing of S-V agreement in English?
3. And if so, do Turkish learners of English instead show sensitivity to number mismatches associated with the linearly closer noun to the verb in their processing of S-V agreement in English as would be predicted by the linear distance hypothesis, WM accounts in the L2 and interference during memory retrieval by Cunnings (2017a, 2017b)?

5.2.4. Procedure

Eyelink 1000 Plus (SR Research) was used to record eye movements. The participants were seated comfortably in front of the computer screen and rested their chins on the chin rest to stabilize head movement. Their eye-movements were calibrated and the calibration was validated before commencement of the experiment. During calibration, nine dots appeared on the screen and the participants were asked to follow them with their gaze. The same procedure was used for validation. The participants started the experiment only after successful of calibration and validation. For all the participants, movements of the right eye were recorded.

Following calibration, the experiment started with practice sentences. The author stayed with the participants during the practice session and answered any questions the participants might have had. The experiment began with participants' key press after the practice items. The sentences were left-aligned on the screen. The participants read the sentences at their own pace and moved to the comprehension question by left-clicking the mouse. The comprehension question was always a *yes/no* question to be answered by clicking the *yes* or *no* options on the screen. The sentence disappeared on the screen and the comprehension question appeared on the next screen. Upon answering the question the participants moved to the next sentence by left-clicking the mouse. No feedback was provided on their accuracy of answers to the comprehension questions. The participants were offered a break half-way through the experiment but no participant took a break. It took 30-40 minutes on average for each participant to finish the experiment.

5.2.5. Data Analysis

Six eye-tracking measures, namely first fixation duration, gaze duration (first pass reading time), total duration, regression path duration, re-reading duration and probability of regression out (Conklin, Pellicer-Sanchez, 2016; Clifton, Staub & Rayner, 2007; Liversedge, Paterson & Pickering, 1998; Rayner et al., 1989) were analyzed. First fixation duration is the time spent in first fixating a region. It is the earliest point to see the effects due to experimental manipulations "as this is the first time the reader has directly fixated the region in which disruption to processing is anticipated." (Liversedge et al., 1998, p. 58). Gaze duration (referred to as first pass reading time when the region includes more than one word (Conklin, Roberts & Siyanova-Chanturia, 2013; Clifton et al., 2007; Liversedge et al., 1998; Conklin, Pellicer-Sanchez, 2016; Rayner et al., 1989)) is "the sum of all the fixations made in

a region until the point of fixation leaves the region either to the left or to the right." (Liversedge et al., 1998, p. 58). Total duration is the sum of all fixations which are made within an area of the text, involving the fixations made while re-reading the area (Liversedge et al., 1998). Regression path duration is "the sum of all the fixations from the first fixation in a region up to but excluding the first fixation to the right of this region" (Liversedge et al., 1998, p. 63) and rereading duration is defined as "the regression path reading time for a region less the first pass reading time for a region" (Liversedge et al., 1998, p. 63). Probability of regression out is the number of saccades made by the reader from the critical region (Liversedge et. al., 1998).

While first fixation duration and gaze duration are considered to give information about early/initial stages of processing, regression path duration, rereading duration, total duration and probability of regression out are considered to reflect later stages of processing (Clifton et al., 2007; Liversedge et al., 1998; Rayner et. al., 1989; Roberts & Siyanova-Chanturia, 2013). Using such a combination of six measures reduces the possibility of not detecting a significant effect in reading time to minimum.

Before the analyses, the data were cleaned from extremely long or short fixations (Morrison, 1984; Rayner, 1978; Rayner et al., 1989). Fixations under 80 ms and over 800 ms were eliminated from the data (Rayner et al., 1989).

The data were analyzed using mixed effects linear or logistic regression (Bates, Maechler, Bolker & Walker, 2015). In mixed effects modeling both subjects and items can be included in the model in the same analysis (Baayen, 2008; Baayen, Davidson & Bates, 2008). R statistical computing software (R Core Team, 2017) was used for all statistical analyses. For the main analyses *lme4* (Bates et al., 2015) and

languageR packages (Baayen, 2013) were used. The verb region, the 9th word in each sentence (corresponding to the copula verb), was the critical region. The 10th and 11th words, the two words following the verb, were merged as one interest area and this area was analyzed as the spill-over region. The reason to merge two words in the spill-over region was because there were no fixations on the 10th word in some cases especially when it was a function word. Mismatch (No Mismatch, N2 Mismatch, N3 Mismatch, and Total Mismatch) was the fixed factor and items and participants were random factors. The dependent variable was the six eye-tracking measures (informing on fixation durations and probability of regressing out of a region) described above.

5.2.6. Results

Data from one participant (due to calibration failure) and six participants (due to low accuracy (<80% correct) on the comprehension questions) were excluded from the analyses. Hence, the analyses were run on data from forty-one participants.

5.2.6.1. The critical region

In all the analyses, No Mismatch condition was taken as the baseline and fixation durations and probability of regression out for the other three conditions (N2 Mismatch, N3 Mismatch and Total Mismatch) were compared to it. In the analyses for each eye-tracking measure, the model fit was examined via quantile – quantile (qq) plots. Data points with standardized residuals above or below 2.5 standard deviations were eliminated from the analyses (Baayen & Milin, 2010). Moreover, overly influential subjects and items were identified and excluded from the analyses via *influence.ME* function (Nieuwenhuis, Grotenhuis & Pelzer, 2012). 1 subject in total duration and rereading duration, 1 subject and 1 item in first fixation duration,

gaze duration and regression path duration deviated from group statistics. Such data were eliminated from the analyses and the model was re-fit. Table 2 below presents the data after these steps.

Table 2. Mean Values for Four Conditions in the Critical Region with Standard Errors in Parentheses

	First Fixation Duration	Gaze Duration	Regression Path Duration	Rereading Duration	Total Duration	Probability of Regression Out
No Mismatch	221(6.51)	224 (6.56)	274 (24.4)	56.8 (11.9)	274 (11.5)	.057 (.023)
N2 Mismatch	214 (6.62)	217 (6.83)	266 (17.5)	74.6 (14.4)	299 (13.9)	.113 (.030)
N3 Mismatch	227 (6.66)	239 (7.64)	316 (23.4)	105 (16.9)	312 (14)	.161 (.034)
Total Mismatch	207 (5.84)	212 (6.09)	252 (14.2)	66.8 (13.8)	264 (11.9)	.080 (.027)

A separate mixed effects linear regression model was built for each eye-tracking measure. None of the conditions reliably predicted first fixation duration, gaze duration or regression path duration measures. That is, the participants did not read any condition significantly faster or slower than the baseline condition (first fixation duration; N2 Mismatch vs. No Mismatch: β = -6.649, *SE* = 8.99, *t* = -0.74, *p* = 0.46, N3 Mismatch vs. No Mismatch: β = 6.46, *SE* = 8.91, *t* = 0.72, *p* = 0.469, Total Mismatch vs. No Mismatch: β = -13.493, *SE* = 9.15, *t* = -1.47, *p* = 0.141; gaze duration; N2 Mismatch vs. No Mismatch: β = -7.293, *SE* = 9.56, *t* = -0.76, *p* = 0.44, N3 Mismatch vs. No Mismatch: β = 14.971, *SE* = 9.45, *t* = 1.58, *p* = 0.11 and Total Mismatch vs. No Mismatch: β = -11.92, *SE* = 9.70, *t* = -1.22, *p* = 0.22; regression path duration: N2 Mismatch vs. No Mismatch: β = -6.52, *SE* = 28.04, *t* = -0.23, *p* = 0.81, N3 Mismatch vs. No Mismatch: β = 38.35, *SE* = 27.6, *t* = 1.38, *p* = 0.16, Total Mismatch vs. No Mismatch: β = -23.79, *SE* = 28.48, *t* = -0.83, *p* = 0.4).

For the total duration measure, the participants showed a marginally significant slow-down in reading the N3 Mismatch condition compared to the baseline, $\beta = 32.47$, $SE = 17.03$, $t = 1.91$, $p = 0.05$ but not for the Total Mismatch ($\beta = -14.91$, $SE = 17.26$, $t = -0.86$, $p = 0.38$) or the N2 Mismatch ($\beta = 20.02$, $SE = 17.22$, $t = 1.16$, $p = 0.24$) conditions.

For rereading duration, again only the N3 Mismatch condition was read more slowly compared to the No Mismatch condition, $\beta = 42.65$, $SE = 18.88$, $t = 2.25$, $p < .05$. Neither the N2 Mismatch condition ($\beta = 15.89$, $SE = 19.39$, $t = 0.81$, $p = 0.41$) nor the Total Mismatch condition ($\beta = 6.85$, $SE = 19.69$, $t = 0.34$, $p = 0.72$) created a statistically significant slow-down or fast reading behavior.

Similarly, the probability of regression out of the critical region was higher for the N3 Mismatch condition compared to the No Mismatch condition, $\beta = 1.27$, $SE = 0.51$, $z = 2.47$, $p < .05$; but other conditions did not reliably predict the participants' probability of regression out of the critical region: N2 Mismatch, $\beta = 0.85$, $SE = 0.53$, $z = 1.57$, $p = 0.11$, Total Mismatch, $\beta = 0.4$, $SE = 0.57$, $z = 0.7$, $p = 0.48$.

5.2.6.2. The spill-over region

As was mentioned above, the spill-over region consisted of the two words (10th and 11th words) following the copula verb. As it was the case in the critical region, in the spill-over region, the N2 Mismatch, N3 Mismatch and Total Mismatch conditions were compared to the No Mismatch condition which was taken as the baseline condition. Since the spill-over region included more than one word, instead of gaze duration, first pass reading time measurement will be reported. Similar to the critical area, a critical approach was adopted towards the model and data points with

standardized residuals above or below 2.5 standard deviations were eliminated from the analyses. Overly influential subjects and items were identified. 1 subject in total duration and first fixation duration, 3 subjects in first pass reading time, 2 subjects and 1 item in regression path duration, and 2 subjects in rereading duration deviated from the group trend. They were excluded from the analyses and the model was then re-fit. The data after these steps are presented in Table 3 below.

Table 3. Mean Values for Four Conditions in the Spill-Over Region with Standard Errors in Parentheses

	First Fixation Duration	First Pass Reading Time	Regression Path Duration	Rereading Duration	Total Duration	Probability of Regression Out
No Mismatch	230 (5.27)	278 (8.65)	348 (23.2)	156 (16.6)	443 (18.5)	.076 (.019)
N2 Mismatch	232 (5.51)	296 (9.92)	359 (22.5)	178 (20.7)	460(21.1)	.065 (.017)
N3 Mismatch	233 (6.19)	305 (10.1)	331 (13.4)	162 (20)	441 (17.9)	.088 (.020)
Total Mismatch	226 (4.82)	295 (9.15)	340 (17.3)	146 (16.1)	444 (19.3)	.095 (.020)

Only the N3 Mismatch condition reliably predicted the first pass reading time measurement in the spill-over area. Participants read the spill-over area significantly slower in the N3 Mismatch condition compared to the No Mismatch condition, β = 29.07, SE = 11.76, t = 2.47, $p < .05$. None of the other conditions made a reliable prediction: N2 Mismatch vs. No Mismatch: β = 15.47, SE = 11.75, t = 1.31, p = 0.18 and Total Mismatch vs. No Mismatch: β = 11.61, SE = 11.73, t = 0.98, p = 0.32. None of the conditions reliably predicted first fixation duration, regression path duration, rereading duration or total duration measures. That is, participants did not read any condition significantly faster or slower compared to baseline condition: first fixation duration; N2 Mismatch vs. No Mismatch: β = 2.20, SE = 7.33, t = 0.30, p = 0.76) N3 Mismatch vs. No Mismatch: β = 5.01, SE = 7.29, t = 0.68, p = 0.49, Total Mismatch vs. No Mismatch: β = -4.41, SE = 7.28, t = -0.60, p = 0.54; total

duration; N2 Mismatch vs. No Mismatch: β = 30.16, *SE* = 21.68, *t* = 1.39, *p* = 0.16, N3 Mismatch vs. No Mismatch: β = 19.003, *SE* = 21.67, *t* = 0.87, *p* = 0.38, Total Mismatch vs. No Mismatch: β = 1.19, *SE* = 21.71, *t* = 0.05, *p* = 0.95; regression path duration; N2 Mismatch vs. No Mismatch: β = 8.91, *SE* = 25.69, *t* = 0.34, *p* = 0.73, N3 Mismatch vs. No Mismatch: β = -16.90, *SE* = 25.56, *t* = -0.66, *p* = 0.50, and Total Mismatch vs. No Mismatch: β = -12.95, *SE* = 25.68, *t* = -0.50, *p* = 0.61; rereading duration; N2 Mismatch vs. No Mismatch: β = 20.13, *SE* = 22.53, *t* = 0.89, *p* = 0.37, N3 Mismatch vs. No Mismatch: β = 10.66, *SE* = 22.48, *t* = 0.47, *p* = 0.63, Total Mismatch vs. No Mismatch: β = -12.60, *SE* = 22.65, *t* = -0.55, *p* = 0.57.

For probability of regression out, only N3 Mismatch reliably predicted the probability of regression compared to the baseline, β = 0.89, *SE* = 0.44, *z* = 2.03, *p* < .05. Neither N2 Mismatch, β = 0.34, *SE* = 0.48, *z* = 0.71, *p* = 0.47 nor Total Mismatch, β = 0.43, *SE* = 0.46, *z* = 0.92, *p* = 0.35 reliably predicted the probability of regressing out of the spill-over region.

5.2.8. Discussion

The results of Experiment 1 showed a significant slow-down for the N3 Mismatch condition for the critical region (verb region, copula *be*) for total duration and rereading duration measurements. This suggests that Turkish L2 speakers of English were sensitive to the number mismatch of the NP linearly closer to the verb but not to the number mismatch associated with the NP that is syntactically closer to the head noun.

As was mentioned in the Data Analysis section above, total duration and rereading duration measures are considered to reflect later stages of processing (Liversedge et al., 1998; Clifton et al., 2007; Rayner et al., 1989; Roberts &

Siyanova-Chanturia, 2013); therefore, obtaining significant differences in those measurements shows that, participants' sensitivity to mismatch effect created by N3 Mismatch (i.e., linearly closer NP) emerges in later stages of processing.

The data showed a similar pattern for the spill-over region. The N3 Mismatch condition was read more slowly in first pass reading time measurement compared to No Mismatch condition. This effect was shown in an early measure, but at a late region. There was no reliable effect of the number mismatches associated with the NP syntactically closer to the head noun (i.e., N2 Mismatch) in the spill-over region, either.

The results of both regions show that, there is a pattern of significant slow-down in N3 Mismatch; which means that the number mismatches associated with N3 interferes with the processing of S-V agreement for Turkish learners of English. The participants, however, do not seem to be sensitive to the number mismatches associated with N2 which is syntactically closer to the head noun. Recall that the interference from the linearly close noun in S-V agreement was the main proposition of the linear distance hypothesis. The syntactic distance hypothesis would predict that number mismatch introduced with N2 which is closer to the head noun syntactically would create significant slow-down in reading times; however this was not observed in the results. Hence, the slow-down pattern in reading times in N3 Mismatch condition (SSP) proves that Turkish learners of English were sensitive to linear distance but not to syntactic distance.

As explained in Chapter 4 in detail, the SSH of Clahsen and Felser (2006a, 2006b, 2006c) states that L2 learners cannot compute detailed syntactic operations; the participants' insensitivity to the mismatches associated with NP2 could therefore

suggest that the L2 speakers in the present study were not distracted by the number mismatches in the syntactically closer NP. Note that although SSH predicts insensitivity to syntactic cues in complex structures, it does not specifically predict the N3 Mismatch condition to cause slow-down in processing S-V agreement. For that, one needs to refer to the linear distance and WM accounts.

Recall that it has been reported for L2 speakers to have relatively limited WM resources compared to L1 speakers (Ellis, 2005; Jespersen, 1924; Quirk, et al., 1972; Harrington & Sawyer, 1992). If that is the case, it may have been difficult for the L2 speakers in the present study to keep the number feature of the head noun in the WM due to WM limitations; but the number feature of the linearly closer NP could be kept in memory as it immediately precedes the verb and can create a significant interference in processing S-V agreement (Jespersen, 1924; Quirk et al., 1972). Although in this study WM was not tested, the results are in line with the predictions of the linear distance hypothesis and the parsimonious use of WM in the L2.

The participants' sensitivity to the mismatches associated with the N3 could alternatively be explained by the cue-based memory retrieval account (Lewis & Vasishth, 2005). Recall that in cue-based memory retrieval, due to similarity-based interference, successful retrieval is negatively influenced by the number of items in memory which matches the cues during retrieval. As the features of N2 and N3 also partially match with the cues generated by the verb (i.e., the NPs are marked with nominative case and occur in preverbal position), one of the intervening nouns might be retrieved and cause interruption in processing. That is, "[p]artial-cue matches, which constitute a kind of similarity-based interference, can give rise to the intrusion of ungrammatical retrieval candidates, leading to both processing slow-downs and even errors of judgment" (Vasisth, Brüssow, Lewis, Drenhaus, 2008, p. 687). And

due to activation-based decay, an item's activation level decays immediately after it is first encountered and as other items are encountered. Hence, there is an increased likelihood for the decay of the number feature of the N1 and N2 compared to the N3, which could have resulted in the sensitivity to the N3 mismatches. Note that for similar constructions in the L1, neither Franck et al. (2002) for French and English nor Pearlmutter (2000) for English observed sensitivity to N3 mismatches. Both studies reported N2 sensitivity for sentences which had complex subject NPs composed of three NPs. But Cunnings (2017a, 2017b) argues that L2 speakers' processing behavior might be more prone to similarity-based interference and activation-based decay (Lewis & Vasishth, 2005; Lewis et al., 2006). If so, that would explain the difference between the native speakers of English in Franck et al. (2002) and Pearlmutter (2000) and the L2 speakers in the present study.

It is also worth noting that any significant effect in the critical region emerged in measures which reflect the later stages of processing and in the spill-over area, they occurred in measures which reflect early stages of processing. Processing effects observed in the spill-over area are considered to reflect delayed reactions of participants (Wagers et al., 2009), so the effect observed in first pass measure in the spill-over region can still be considered as reflecting a delayed reaction.

To sum up, the results of Experiment 1 show that Turkish L2 speakers of English trace number agreement linearly, not syntactically, but it is not clear with the results of Experiment 1 whether this is due merely to the distance of constituents or due to cue-based memory retrieval processes and L2 speakers' vulnerability to interference while retrieving cues from memory. To disentangle the two alternatives, let us examine the data from Experiment 2.

5.3. Experiment 2

Experiment 2 investigated whether Turkish L2 speakers of English are sensitive to linear or syntactic distance in S-V agreement processing and if the magnitude of this sensitivity changes when the singular distractor nouns are marked with a singular numeral modifier *one* in line with the markedness account (Eberhard, 1997).The quantifier *one* is predicted to make the otherwise unmarked singular nouns marked and make the number mismatch between the head noun and the intervening nouns more salient (Tanner & Bulkes, 2015). In addition, use of a lexical item to mark singularity allows us to further test the predictions of the SSH (Clahsen & Felser, 2006a, 2006b, 2006c) which predicts L2 speakers to be more dependent on lexical information in their processing. It also allows testing the assumptions of Cunnings (2017a, 2017b) that L2 speakers weight lexical cues more heavily during online processing and when provided with multiple cues to encode features, L2 speakers can do complex syntactic processing, similar to native speakers. Experiment 1 and 2 together examine the role of lexical and morphosyntactic cues, computation of number agreement between the subject and the verb, and the role of syntactic and linear factors in L2 speakers' sentence processing.

5.3.1. Participants

Forty-seven participants, coming from the same subject pool as in Experiment 1, took part in Experiment 2 (36 females). The participants were again Boğaziçi University sophomore and junior students and they received course credit for participation. Participants' age ranged from 19 to 32 (M = 20.72). They had normal vision or corrected-to-normal (with glasses or contact lenses) vision. They were exposed to English at ages ranging from five to twelve years old (M = 10.4) and they

were all advanced learners of English according to BUEPT (Boğaziçi University English Proficiency Test) of which minimum pass score is 60 (C). Similar to the participants in Experiment 1, the participants in Experiment 2 had English medium instruction for two or three years.

5.3.2. Materials

The materials and sentences were similar to those used in Experiment 1 in that the subject was a complex NP made of one head and two daughter prepositional phrases (PPs) but unlike Experiment 1, in Experiment 2, all head nouns were plural and the intervening nouns were singular. Singular nouns were modified with the singular quantifier *one*. Following Eberhard (1997), the quantifier *one* was used to provide a lexical cue to make the singular nouns marked. Without any quantifier, singular nouns are reported to be unmarked and therefore they do not attract agreement. Eberhard (1997) found that the quantifier *one* makes the noun it modifies marked as in the example (3). The singular quantifier was chosen as *one* with the purpose of capturing the highest mismatch effect because although Eberhard (1997) used three quantifiers (*one, each* and *every*) in her experiment, *one* was found to create the most significant effect. Example (3) below illustrates the experimental conditions used in Experiment 2:

(3) a. *PPP, No Mismatch:* The boys with the posters of the actresses were happy in the movie premiere.

b. *PSP, N2 Mismatch:* The boys with one poster of the actresses were happy in the movie premiere.

c. *PPS, N3 Mismatch:* The boys with the posters of one actress were happy in the movie premiere.

d. *PSS, Total Mismatch:* The boys with one poster of one actress were happy in the movie premiere.

Twenty-four experimental stimuli were allocated into four lists using a Latin-square design. Seventy-two filler sentences were added to the experimental stimuli and they were pseudo-randomized. The filler sentences were similar to the experimental sentences in their structure and complexity but there were some differences (e.g. different number features on the head noun, different verbs other than copula *be*). Hence, every list had one condition of each item and each item appeared the same number of times in each of the four lists. Similar to Experiment 1, participants answered a comprehension question after reading each sentence (See Appendix C).

5.3.3. Predictions and Research Questions

The results of Experiment 1 showed that Turkish learners of English were sensitive to the number mismatches associated with the NP that is linearly closer to the verb. This provided support for the linear distance hypothesis and WM accounts and for cue-based memory retrieval accounts in computing S-V agreement in the L2 but did not allow us to attribute the findings to either account. The results of Experiment 1 also did not provide conclusive evidence on mismatch asymmetry (i.e., plural attraction). Recall that mismatch asymmetry means that number agreement errors are higher when the head noun is singular and the local noun is plural (Bock & Miller, 1991; Bock & Cutting, 1992; Bock& Eberhard, 1993; Bock, 1995; Öztürk, 2007; Pearlmutter et al., 1999; Vigliocco & Nicol, 1998; Wagers et al., 2009). However, Experiment 1 only tested complex NPs with singular heads and plural intervening nouns. Hence, in order to test mismatch asymmetry and whether or not additional lexical cues affect the sensitivity of L2 learners' processing S-V agreement,

Experiment 2 employed complex NPs with plural heads and singular intervening nouns which were marked with the singular quantifier *one*. The quantifier *one* would mark singularity and test whether marked singular intervening nouns can cause agreement attraction in L2 leaners' processing of S-V agreement. It would also test Cunnings' (2017a, 2017b) suggestions that when provided with lexical information L2 speakers can do complex syntactic processing, similar to native speakers. The following are the specific predictions:

(i) If the singular quantifier *one* makes an otherwise unmarked singular noun marked, the intervening singular nouns will create agreement attraction effect (similar to plural intervening nouns) for non-native speakers, as they did for native speakers (Eberhard, 1997).

(ii) The quantifier *one* serves one other purpose in Experiment 2 which is related to the role of lexical information in sentence processing in the L2. The SSH (Clahsen & Felser, 2006a, 2006b, 2006c) maintains that native speakers and L2 speakers are different in the sense that second language speakers cannot process syntactically detailed computations and this does not change through increased proficiency or enhanced exposition to the language. Since their grammatical computations are less detailed than those by native speakers, L2 speakers must compensate for it by relying more on lexical, semantic or pragmatic information. Therefore, according to SSH, it is predicted that the lexical cue *one* will increase the mismatch between the head noun and the intervening nouns. But since the L2 speakers will not attend to syntactic details, they will more likely be affected by the mismatches associated with the N3 (PPS), but not by those associated with the N2 (PSP).

(iii) The cue-based memory retrieval predicts that the lexical cue *one* will provide multiple encoding of the number feature (additional to the morphology of the NPs) for the intervening NPs. The number mismatch at the intervening NP is therefore predicted to be enhanced in the present experiment. This may result in the same N3 mismatch effect if linearity (induced by activation-based decay) is an equally strong force or if mere linear distance is responsible for the N3 mismatch sensitivities in Experiment 1. But if interference due to multiple encoding is stronger than activation-based decay, and if, as suggested by Cunnings (2017a, 2017b), L2 speakers can compute detailed syntactic structures when they are provided with lexical cues, then it is possible to observe sensitivity to N2 mismatches in this experiment.

The following are the specific research questions addressed in Experiment 2:

1. Will the singular quantifier *one* mark the intervening nouns as singular and cause agreement attraction for Turkish learners of English as it did for native speakers (Eberhard, 1997)?

2. Will the magnitude of sensitivity to linear distance by Turkish learners of English change when there is lexical information marking the number feature? Will Turkish learners of English still attend to linear distance when there is lexical information in the sentence in line with SSH (Clahsen & Felser, 2006a)?

3. Will Turkish learners of English attend to syntactic distance introduced by N2 mismatch when there is lexical information in the sentence, due to multiple encoding of the number feature and L2 speakers' weighting lexical cues more strongly during memory retrieval (Cunnings, 2017a, 2017b)?

5.3.5. Procedure

The procedure was the same as in Experiment 1.

5.3.6. Data Analysis

Data were analyzed following the same steps as in Experiment 1. As in Experiment 1, first fixation duration, gaze duration (first pass reading time in the spill-over region), total duration, rereading duration, regression path duration measures and probability of regression out were analyzed in the critical (ninth word) and the spill-over regions (the region that merges the 10th and 11th words).

5.3.7. Results

All the participants passed the comprehension accuracy threshold and had above 89% comprehension accuracy. Detailed results are reported below for the critical region and the spill-over region.

5.3.7.1. The critical region

As in Experiment 1, in the analyses, the model was examined and data points with standardized residuals above or below 2.5 standard deviations were eliminated from the data. Overly influential subjects and items were identified. 1 subject each in first fixation duration, gaze duration and regression path duration, 1 subject and 1 item in rereading duration deviated from the general group statistics; therefore, they were eliminated from the data and the model was re-fit. The remaining data are reported in Table 4 below.

Table 4. Mean Values for Four Conditions in the Critical Region with Standard Errors in Parentheses

	First Fixation Duration	Gaze Duration	Regression Path Duration	Rereading Duration	Total Duration	Probability of Regression Out
No Mismatch	217 (4.85)	226 (5.3)	266 (21.3)	87.9 (12.7)	307 (11.8)	.045 (.017)
N2 Mismatch	227 (5.86)	248 (8)	300 (25.1)	91.1 (14.1)	313 (12)	.077 (.021)
N3 Mismatch	232 (5.7)	253 (8.4)	303 (21.4)	79.1 (13.1)	320 (11.9)	.0802 (.021)
Total Mismatch	235 (5.9)	249 (6.93)	340 (32.6)	103 (13.2)	347 (13)	.103 (.022)

In Experiment 2, for the critical (verb) region, the Total Mismatch condition reliably predicted the total duration measure; that is, participants read this region significantly slower in Total Mismatch condition than the intercept: $\beta = 41.26$, $SE = 15.66$, $t = 2.63$, $p < .01$. Neither the N2 Mismatch nor the N3 Mismatch conditions reliably predicted the total duration in this region. There were no significant differences in reading times either in the N2 Mismatch condition vs. the No Mismatch condition: $\beta = 9.02$, $SE = 15.93$, $t = 0.56$, $p = 0.57$ or the N3 Mismatch condition vs. the No Mismatch condition: $\beta = 14.76$, $SE = 16.05$, $t = 0.92$, $p = 0.35$.

In the first fixation duration measurement, both N3 Mismatch: $\beta = 18.46$, $SE = 7.80$, $t = 2.36$, $p < .05$, and Total Mismatch: $\beta = 19.38$, $SE = 7.59$, $t = 2.55$, $p < .01$, reliably predicted this measure. That is, both conditions yielded significantly longer reading times compared to the No Mismatch condition. The N2 Mismatch condition did not reliably predict the first fixation duration measurement, N2 Mismatch vs. No Mismatch: $\beta = 9.64$, $SE = 7.77$, $t = 1.24$, $p = 0.21$, participants did not read the critical area significantly slower or faster than the baseline condition.

All conditions reliably predicted gaze duration. All conditions were read significantly more slowly compared to the No Mismatch condition: N2 Mismatch vs.

No Mismatch: β = 20.08, *SE* =10.05, *t* =1.99, $p < .05$, N3 Mismatch vs. No Mismatch: β = 28.50, *SE* = 10.13, *t* = 2.81, $p < .01$, and Total Mismatch vs. No Mismatch: β = 23.02, *SE* = 9.90, *t* = 2.32, $p < .05$.

The regression path duration was predicted by only the Total Mismatch condition. Only the reading time in Total Mismatch Condition: β = 74.29, *SE* = 36.66, *t* = 2.02, $p < .05$, was significantly longer than the intercept. N2 Mismatch: β = 32.07, *SE* = 37.50, *t* =0.85, *p* = 0.39, and N3 Mismatch: β = 40.04, *SE* = 37.74, *t* = 1.06, *p* = 0.28, did not yield significantly shorter or longer reading times than the No Mismatch condition.

None of the measurements reached statistical significance for the rereading duration condition; N2 Mismatch vs. No Mismatch: β = 2.57, *SE* = 17.78, *t* = 0.14, *p* = 0.88, N3 Mismatch vs. No Mismatch: β = -9.05, *SE* = 18.11, *t* = -0.50, *p* = 0.61, Total Mismatch vs. No Mismatch: β = 16.02, *SE* = 17.42, *t* = 0.92, *p* = 0.35.

Only the Total Mismatch condition reliably predicted the probability of regression out: β = 0.91, *SE* = 0.45, *t* = 1.98, $p < .05$. Neither the N2 Mismatch vs. No Mismatch: β = 0.57, *SE* = 0.48, *z* = 1.17, *p* = 0.23, nor the N3 Mismatch vs. No Mismatch: β = 0.61, *SE* = 0.48, *z* = 1.26, *p* = 0.2, yielded statistically significant results.

These results will be discussed in detail upon reporting on the results of the spill-over region.

5.3.7.2. The spill-over region

As in Experiment 1, the two words following the copula were merged in Experiment 2 as well. And as in Experiment 1, first pass reading time, but not gaze duration

measurement, will be reported for the spill-over area as there is more than one word in that region.

In the analyses, the model was examined for fit and data points with standardized residuals above or below 2.5 standard deviations were eliminated from the analyses. Overly influential subjects and items were identified. 1 subject each in total duration, first fixation duration and rereading duration, 1 subject and 1 item in regression path duration deviated from the general group trend so they were excluded from the analyses and the model was re-fit. Table 5 presents data for the remaining subjects and items.

Table 5. Mean Values for Four Conditions in the Spill-Over Region with Standard Errors in Parentheses

	First Fixation Duration	First Pass Reading Time	Regression Path Duration	Rereading Duration	Total Duration	Probability of Regression Out
No Mismatch	235 (4.71)	282 (7.54)	308 (14.6)	126 (14)	390 (13.7)	.0463 (.013)
N2 Mismatch	233 (4.44)	286 (8.3)	309 (21.8)	141 (15.9)	386 (12.6)	.0488 (.014)
N3 Mismatch	241 (5.38)	301 (9.42)	357 (21)	149 (16)	401 (13.9)	.0702 (.016)
Total Mismatch	231 (4.88)	285 (8.86)	321 (16.3)	137 (13.6)	407 (14.6)	.0751 (.017)

In the spill-over region, the only significant difference in reading time was in regression path duration measurement in the N3 Mismatch condition: $\beta = 44.72$, $SE = 20.80$, $t = 2.15$, $p < .05$, compared to the No Mismatch condition. In other words, only N3 Mismatch condition induced longer reading times than the baseline. N2 Mismatch vs. No Mismatch: $\beta = -4.30$, $SE = 20.57$, $t = -0.20$, $p = 0.83$, and Total Mismatch vs. No Mismatch: $\beta = 9.16$, $SE = 20.46$, $t = 0.44$, $p = 0.65$, did not reach statistical significance.

For first fixation duration, first pass reading time, rereading duration and total duration measures, none of the measurements yielded significant results. That means participants did not read any conditions significantly faster or slower compared to the baseline condition. First fixation duration: N2 Mismatch vs. No Mismatch: β = -2.67, *SE* = 6.44, *t* = -0.41, *p* = 0.67, N3 Mismatch vs. No Mismatch: β = 5.08, *SE* = 6.48, *t* = 0.78, *p* = 0.43, Total Mismatch vs. No Mismatch: β = -4.77, *SE* = 6.40, *t* = -0.74, *p* = 0.45; first pass reading time: N2 Mismatch vs. No Mismatch: β = -1.75, *SE* = 10.50, *t* = -0.16, *p* = 0.86, N3 Mismatch vs. No Mismatch: β = 14.57, *SE* = 10.49, *t* = 1.39, *p* = 0.16, and Total Mismatch vs. No Mismatch: β= 0.22, *SE* = 10.40, *t* = 0.02, *p* = 0.98; rereading duration: N2 Mismatch vs. No Mismatch: β = 10.47, *SE* = 18.85, *t* = 0.55, *p* = 0.57, N3 Mismatch vs. No Mismatch: β = 23.04, *SE* = 19.05, *t* = 1.20, *p* = 0.22, Total Mismatch vs. No Mismatch: β = 6.91, *SE* = 18.49, *t* = 0.36, *p* = 0.71; total duration: N2 Mismatch vs. No Mismatch: β = -8.21, *SE* = 17.19, *t* = -0.47, *p* = 0.63, N3 Mismatch vs. No Mismatch: β = 10.06, *SE* = 17.14, *t* = 0.58, *p* = 0.55, Total Mismatch vs. No Mismatch: β = 12.01, *SE* = 16.88, *t* = 0.71, *p* = 0.47. None of the conditions reliably predicted the probability of regression out: N2 Mismatch vs. No Mismatch: β = 0.63, *SE* = 0.45, *z* = 1.38, *p* = 0.16, N3 Mismatch vs. No Mismatch: β = 0.73, *SE* = 0.44, *z* = 1.66, *p* = 0.09, and Total Mismatch vs. No Mismatch: β = 0.76, *SE* = 0.45, *z* = 1.7, *p* = 0.08. That shows, for none of the conditions, proportions of fixations that are regressive were significant.

5.3.8. Discussion

Although Experiment 1 showed clear sensitivity to linear distance (a significant slow-down in N3 Mismatch), Experiment 2 did not replicate this pattern.

In the critical region, there was a consistent slow-down in reading and an increased probability of regressing out of the region for Total Mismatch conditions in

all measures, except for rereading duration. In first fixation duration, in addition to Total Mismatch, there was also a significant slow-down in N3 Mismatch compared to No Mismatch. In gaze duration, all conditions (N2 Mismatch, N3 Mismatch, and Total Mismatch) were read more slowly compared to No Mismatch condition.

Unlike Experiment 1, the results of Experiment 2 indicated that participants showed sensitivity to both the syntactic (N2 and Total Mismatch) and the linear distance (N3 and Total Mismatch) of the intervening nouns. And these sensitivities occurred in both early (first fixation duration, gaze duration, total duration) and late measures (regression path duration).

It was predicted that observing an N3 Mismatch would indicate sensitivity to linear distance. However, observing a significant difference in Total Mismatch conditions can be interpreted as both N2 Mismatch and N3 Mismatch contributing to the processing difficulty. Thus, the results of Experiment 2 show that Turkish L2 learners of English were sensitive to syntactic distance (especially in the early measures, first fixation duration and gaze duration) in addition to linear distance, contradicting the predictions of the SSH (Clahsen & Felser, 2006a, 2006b, 2006c). Under a shallow parse account, the L2 speakers are never expected to attend to syntactic details.

Note that two properties of the sentential items were different in Experiment 2 from Experiment 1: (i) the head NPs were plural and the distractor NPs were singular and (ii) singularity was marked with the lexical cue *one*. Regarding these, the markedness account (Eberhard, 1997) claims that singular nouns become marked when they are modified by a numeral and they attract agreement. This was supported here with L2 speakers in Experiment 2. That is, marking singular nouns with the

quantifier *one* resulted in making the number feature of the otherwise unmarked singular intervening nouns more salient and leading to greater interference in processing S-V agreement.

Also, remember that previous research showed that quantificational cues enhance sensitivity to S-V agreement violations (Tanner & Bulkes, 2015). And Cunnings (2017a, 2017b) further argue that when lexical cues are present, L2 speakers can also do detailed syntactic computations. The fact that the participants in the present study were affected by both syntactic distance (sensitivity to N2 and Total Mismatch) and linear distance (sensitivity to N3 and Total Mismatch) in Experiment 2 confirms Cunnings' (2017a, 2017b) arguments. That is, when the lexical cue *one* was present, Turkish L2 speakers of English attended to the number feature of both the N2 (syntactically closer to the head) and the N3 (linearly closer to the verb).

Furthermore, the results showed that the sensitivities in Experiment 2 occurred in earlier processing measures such as first fixation duration and gaze duration and mostly in the verb region. (In the spill-over region, there was an N3 Mismatch effect for regression path duration measurement.) This suggests that the lexical cues not only increased sensitivity to syntactic details but they also allowed for sensitivity to number mismatch to occur earlier.

Overall, these results are in line with Cunnings' (2017a, 2017b) proposition that when provided with lexical information (e.g., *one*), L2 learners show sensitivity to both linear and syntactic distance, suggesting that L2 speakers can do complex syntactic processing, similar to native speakers, when lexical cues are present (Cunnings, 2017a, 2017b). The premises of SSH (Clahsen & Felser, 2006a, 2006b,

2006c) alone cannot explain the results of Experiment 1 and 2 together but Cunnings' (2017a, 2017b) arguments based on cue-based memory retrieval (Lewis & Vasishth, 2005; Lewis et al., 2006) do.

5.4. Sentence completion task

Following Experiment 1 and Experiment 2, each participant took part in a pen-and-paper sentence completion test. Although the participants were all advanced learners of English, the offline test would serve to ensure that the L2 speaking participants of the study knew S-V agreement rules in English. The test would also provide data on the participants' offline decisions on S-V agreement in English.

The experimental sentences were the same as those in Experiment 1 and 2 except that the verb was missing and the participants were required to fill it in with the correct form of the copula *be*. The experimental sentences are presented in (4) and (5) below.

(4) Singular Heads

a. SSS, No Mismatch: The article by the editor of the newspaper _____ so difficult to understand.

b. SPS, N2 Mismatch: The article by the editors of the newspaper _____ so difficult to understand.

c. SSP, N3 Mismatch: The article by the editor of the newspapers _____ so difficult to understand.

d. SPP, Total Mismatch: The article by the editors of the newspapers _____ so difficult to understand.

(5) Plural Heads

a. PPP, No Mismatch: The boys with the posters of the actresses _____ happy in the movie premiere.

b. PSP, N2 Mismatch: The boys with one poster of the actresses _____ happy in the movie premiere.

c. PPS, N3 Mismatch: The boys with the posters of one actress _____ happy in the movie premiere.

d. PSS, Total Mismatch: The boys with one poster of one actress _____ happy in the movie premiere.

There were 48 experimental sentences, each in eight conditions, and they were distributed across four reading lists in a Latin-square design and intermingled with seventy-two filler sentences. The participants read every experimental sentence on paper and they were asked to fill in the blanks with the appropriate form of the copula *be* in present or past tense (See Appendix D).

All participants of Experiment 1 and Experiment 2 (N = 95, 74 females) took part in the sentence completion task. The participants' answers were analyzed. The participants were 98.6% correct in their answers overall. Table 6 shows their accuracy for each condition.

As can be seen in Table 6, the participants were highly accurate in their insertion of the missing verb. They made very few mistakes (N = 99.1 in the singular head condition, and N = 99.4 in the plural head condition) and those mistakes were all in the N3 Mismatch condition, but this was not statistically different from other conditions. The accuracy rate was slightly lower in PPS than in SSP, which was statistically not significant.

Table 6. The Accuracy Rate of the Participants in Sentence Completion Task for Eight Conditions

Conditions		Accuracy Rate (%)
Singular head	SSS, No Mismatch	100
	SPS, N2 Mismatch	100
	SSP, N3 Mismatch	99.1
	SPP, Total Mismatch	100
Plural head	PPP, No Mismatch	100
	PSP, N2 Mismatch	100
	PPS, N3 Mismatch	99.4
	PPP, Total Mismatch	100

As in Experiment 1, the participants appear to have been distracted (albeit not much) in assigning the correct number agreement to the verb when the noun that is linearly close to the verb mismatched the number feature of the head noun (SSP, PPS) though neither of these conditions was reliably different from their baseline conditions. Nevertheless, the participants still showed a very high rate of accuracy (98.6%). This suggests that the L2 learners correctly computed the subject-verb agreement in English and were able to disregard the mismatching number features of the intervening nouns. Their high accuracy rate also shows that they know subject-verb number agreement rules in English.

CHAPTER 6

GENERAL DISCUSSION AND CONCLUSION

6.1. Summary of the findings and discussion

This study investigated whether the processing of S-V agreement of Turkish learners of English is influenced by syntactic or linear distance and the effect of lexical information in processing S-V agreement. To answer these questions, two eye-tracking experiments and a pen-and-paper gap-fill sentence completion task were conducted. The experimental sentences included a complex subject with a head NP and two post-modifying PPs. In Experiment 1, the head NP was singular and the number feature was manipulated for the second and the third NPs as in *The daughter of the author(s) of the book(s) was pleased with the Nobel Prize*. In Experiment 2, the head NP was plural and the number feature of the second and the third NPs was manipulated and the number feature of the intervening NPs was marked with the singular quantifier *one* as in *The boys with (the) (one) poster(s) of (the)(one) actress(es) were happy in the movie premiere.* In online experiments, the fixation durations on and proportions of regressions out of the critical region (the verb) and the spill-over region (two-words following the verb) were measured. The accuracy rate of the answers was examined in the offline experiment.

The results of the eye-tracking experiments will be discussed, in relation to the specific assumptions of the linear distance hypothesis (Bock & Miller, 1991; Jespersen, 1924; Quirk et al., 1972), the syntactic distance hypothesis (Franck et al., 2002; Kempen & Hoenkamp, 1987; Levelt, 1989; Pearlmutter, 2000; Vigliocco & Nicol, 1998), the markedness account (Eberhard, 1997), the Shallow Structure

Hypothesis (Clahsen 2006a, 2006b, 2006c), and the cue-based memory retrieval account (Cunnings, 2017a, 2017b; Lewis & Vasishth, 2005). The findings will then be compared to the L1 studies of Pearlmutter (2000), Franck et al. (2002) and Wagers et al. (2009) as Pearlmutter (2000) and Franck et al. (2002) studies are the only L1 number agreement studies which used complex subjects with three NPs and Wagers et al. (2009) is a prominent L1 number agreement study which attributed its findings to the cue-based memory retrieval account (Lewis & Vasishth, 2005). The results of the current study will then be compared to the L2 studies of Lago and Felser (2018) and Öztürk (2007). Because Lago and Felser's (2018) study is the only L2 study in which number agreement was investigated using complex subject preambles with three NPs and in Öztürk's (2007) study, Turkish speakers of L2 English were examined in terms of their processing of number agreement.

The results of Experiment 1 showed a consistent slow-down in the N3 Mismatch condition (*SSP The daughter of the author of the books was pleased with the Nobel Prize*) compared to the No Mismatch condition. This was evident with eye-tracking measures reflecting later stages of processing (total duration and rereading duration) in the critical region and in measures reflecting early stages of processing (first pass reading time) in the spill-over region. The finding of a sensitivity to the number mismatches associated with the N3 (but not to those associated with the N2) shows that the linear distance between a distractor NP and the verb affects Turkish speakers' processing of S-V agreement in English.

Franck et al. (2002) and Pearlmutter (2000) studies tested S-V agreement in L1 English (Franck et al. (2002) also tested it in L1 French) using constructions similar to the present study that included complex subjects consisting of three NPs. As summarized in more detail in Chapter 3 (Section 3.2), Pearlmutter (2000)

conducted two self-paced reading experiments to test whether English native speakers use linear or syntactic distance in processing S-V agreement in English. The head nouns were singular in Experiment 1 and plural in Experiment 2 but no lexical information was used to mark the number feature in either of the experiments. The results of his Experiment 2 showed that N2 Mismatch created a significantly stronger interference than N3 Mismatch, suggesting that for English native speakers, number feature-tracking is affected by syntactic information. Franck et al.'s (2002) study consisted of two production experiments (one in English and the other one in French) on number agreement with L1 speakers to examine the role of linear and syntactic distance in S-V agreement attraction in production. Similar to Pearlmutter's (2000) study, their results showed for English (and also for French) that the participants produced more errors when N2 mismatched in number. These two L1 English studies, using constructions similar to those in the present study, consistently showed a clear mismatch effect for the N2 (albeit only for plural heads and singular distractors in Pearlmutter (2000) and for production in Franck et al. (2002)). Although neither study included an eye-tracking experiment, the sensitivity to syntactic distance in the L1 for three NP subject constructions was confirmed.

The sensitivity to N3 mismatch (but not to N2 mismatch) by Turkish learners of L2 English indicates a behavioral pattern for the L2 group different from that of the L1 speakers. This may be attributable to the limitations to WM resources in the L2 (Ellis, 2005; Harrington & Sawyer, 1992) which could lead to prominence of linear distance in L2 processing over syntactic information. It may also indicate insensitivity to syntactic information for complex structures in the L2, as suggested by the Shallow Structure Hypothesis (Clahsen & Felser, 2006a, 2006b, 2006c). But the findings of Experiment 2 (see below for a summary) indicate that neither

approach sufficiently explains the results in Experiment 1. To interpret the data from Experiment 1 and 2 together one needs to refer to the predictions of the cue-based memory retrieval account (Lewis & Vasishth, 2005).

Recall that the cue-based memory retrieval model assumes decay in the activation level of an item immediately after it is first encountered and as other items are encountered. This would result in more recent items to be more easily retrieved. Thus, activation-based decay predicts a role for linear distance in dependency resolutions. The N3 mismatch interference in Experiment 1 compared to the No Mismatch condition could therefore be also attributed to the predictions of activation-based decay in the cue-based memory retrieval account (Lewis & Vasishth, 2005). As the N3 is the NP which most closely precedes the verb, it has higher activation levels compared to the head noun and the N2; therefore, it is more likely to be retrieved and cause agreement attraction which manifests itself as a slow-down in RTs in the verb and the spill-over region.

Although Experiment 1 showed a mismatch effect (for N3), the constructions always included complex subjects with singular heads and plural distractors. It was not clear, without conducting Experiment 2, whether or not this observation would extend to complex NPs with plural heads and singular distractors. Recall that Eberhard (1997), under her markedness account, maintains that plural nouns are marked and singular nouns are unmarked; therefore, when the head noun is plural and the local noun is singular, the local noun does not attract agreement. But she also showed that it was possible to mark singularity on singular nouns using singular quantifiers (Eberhard, 1997). Thus, Experiment 2 used constructions similar to those in Experiment 1 but with plural heads and singular distractors. The singular distractor NPs were modified with the quantifier *one* to make singulars marked just like the

plural heads in Experiment 2 and the plural distractors in Experiment 1. But use of *one* would serve the purposes of the present study especially in testing whether the N3 mismatch effect observed in Experiment 1 can be attributable to linear distance *per se* (due to WM limitations or insensitivity to syntactic distance) or linear distance due to cue-based retrieval from memory. The L2 extension of cue-based memory retrieval account by Cunnings (2017a, 2017b) predicts that a lexical cue such as the quantifier *one* in addition to the morphosyntactic cues (singular or plural morphology of the NPs) would aid L2 speakers in their ability to compute complex syntax.

The results of Experiment 2 indicated sensitivity to both linear distance and syntactic distance. This is different from Experiment 1. The sensitivity to linear distance was apparent for the N3 and Total mismatch conditions in the verb region and for the N3 Mismatch condition in the spill-over region. Sensitivity to syntactic distance was observed in the N2 Mismatch and Total Mismatch conditions in the verb region. The sensitivities in the verb region occurred in both early measures (first fixation duration, gaze duration) and late measures (total duration, regression path duration) and the sensitivity in the spill-over region occurred in a late measure (regression path duration). These results show that when L2 learners are provided with lexical information, they can be sensitive to syntactic distance in addition to linear distance and they confirm both the cue-based memory retrieval account's predictions for S-V agreement in general and Cunnings' (2017a, 2017b) cue-based memory retrieval predictions for the L2 processing of S-V agreement dependency.

Regarding the cue-based memory retrieval account (Lewis & Vasishth, 2005), the numeral modifier *one* was predicted to further encode the number feature of the intervening nouns. As Tanner and Bulkes' (2015) study showed with plural quantifiers, quantifiers can increase the activation level of nouns by encoding them

multiple times in the working memory. Similarly, in Experiment 2 of the present study, presumably because the lexical encoding of singularity on the intervening NPs enhanced their number feature, the participants were distracted when there was a mismatch between the head NP and the intervening NPs regardless of the syntactic or linear distance of the distractor NPs.

Note that although there was sensitivity to linear distance alone (excluding sensitivities to total mismatch conditions) in three measures (first fixation duration, gaze duration, regression path duration) and in both regions, sensitivity to syntactic distance alone was present in a single measure (gaze duration) in the verb region only. This seems to suggest that sensitivity to linear distance was stronger than sensitivity to syntactic distance. Such an observation is also in line with the cue-based memory retrieval account because the cue-based memory retrieval account not only predicts enhanced cues due to lexical encoding but also sensitivity to linear distance due to activation-based decay.

Regarding the L2 processing of S-V agreement from a cue-based memory retrieval perspective, Cunnings (2017a, 2017b) proposed that L1 and L2 speakers weight syntactic and lexicosemantic or discourse level cues differently as the focus of attention of L2 learners is limited compared to L1 speakers in processing the target language: “L1/L2 differences may be related to how focal attention is allocated during parsing. In this case, L2ers’ increased susceptibility to interference may be a result of their need to retrieve information that L1 speakers maintain in focal attention.” (Cunnings, 2017b, p. 14) and to grammatical cues being more abstract than the cues derived from lexical items: “Although agreement cues

themselves (e.g., [+MASC]) should be easily derived from lexical items, the appropriate morphosyntactic licensing constraints on agreement are more abstract, and so may be more difficult for L2ers to implement in a nativelike way" (Cunnings, 2017b, p. 8). Cunnings (2017a, 2017b) also stated that L2 speakers can process different kinds of linguistic dependencies similar to native speakers when lexicosemantic or pragmatic cues are provided: "L2 learners construct fully-specified syntactic parses but implement memory retrieval cues differently to L1 speakers" (Cunnings, 2017a, p.19) and L1 and L2 processing is similar when lexicosemantic information is available (Cunnings, 2017a, p.13). In other words Cunnings (2017b) claims that "L2 learners behave similarly to L1 speakers with regards to applying constraints on when a linguistic dependency may be formed, but differently with regards to constraints on what information is accessed once retrieval is initiated." (p. 9).

The finding of sensitivity to syntactic distance in Experiment 2 (where a lexical cue was used to mark the number feature of the intervening NPs) supports this claim as the L1 speakers in Pearlmutter (2000) and Franck et al. (2002) were also sensitive to syntactic distance in their processing or production of similar constructions. But note that sensitivity to syntactic distance by native speakers was evident even when there were no lexical cues indicating the number feature.

In both Frack et al. (2002) and Pearlmutter (2000), there was a consistent effect for N2 mismatch but a cue-based retrieval account would also predict a role for linear distance (i.e., N3 mismatch) even for native speakers due to activation-based decay. Although neither Franck et al. (2002) nor Pearlmutter (2000) explain their results with cue-based memory retrieval (as those studies were conducted before cue-based memory retrieval account was proposed (Lewis & Vasishth,

2005)), it is possible that there is a difference in memory retrieval mechanisms of L1 and L2 speakers as suggested by Cunnings (2017a, 2017b). It may be that while pure syntactic information (i.e., syntactic dominance of N2 over N3) was sufficient to increase the activation levels of N2 for L1 speakers in Franck et al. (2002) and Pearlmutter (2000), the syntactic information alone could not produce the same re-activation for L2 speakers, leading to linear distance sensitivities in Experiment 1, and syntactic distance sensitivities when lexical cues were present in Experiment 2. Thus, the lexical information (*one*) in Experiment 2 might have led to higher activation of the intervening nouns in working memory by multiply encoding the number feature of the nouns and therefore creating sensitivities to both linear and syntactic distance. This possibility could be investigated in future research with L1 speakers using structures similar to those in the present study (i.e., complex subjects with three NPs (and with lexical cues marking number features)).

Wagers et al. (2009) is a prominent L1 English study on S-V agreement that attributed its findings to the cue-based memory retrieval account (Lewis & Vasisth, 2005). But unlike the present study which reported attraction effects (for L2 speakers) in grammatical sentences, Wagers et al. (2009) found agreement attraction only in ungrammatical sentences. Wagers et al. (2009) showed that the syntactic distance and feature percolation explanations for S-V agreement can indeed be attributed to cue-based memory retrieval account (Lewis & Vasishth, 2005). But note that Wagers et al.'s sentences included complex subjects with two NPs (unlike the three NP constructions in the present study). If in a three NP construction design with native speakers, which also manipulates other predictions of the cue-based memory retrieval account such as lexical cues, shows an N2 mismatch effect for native speakers, this may perhaps highlight the role of syntactic information even under the

cue-based memory retrieval in S-V agreement. With three NP constructions as subjects, it may also be possible to better examine the effects of activation-based decay and similarity-based interference.

The findings of Experiment 2 together with Experiment 1 also supported the markedness account of Eberhard (1997), as the singularly marked nouns (in Experiment 2) and the plural nouns (in Experiment 1) created a mismatch with the head noun and interfered with agreement. As Eberhard (1997) observed before, this study also proved that when singular nouns are modified with a numeral modifier they get marked and they even over-write plural heads. Even though Eberhard (1997) does not claim that quantifiers mark the number feature more strongly than plural morphemes, Tanner and Bulkes (2015) found that quantified plural NPs created stronger sensitivity to S-V agreement violations compared to unquantified plural NPs. Although an experiment with singular heads and plural intervening nouns marked with plural quantifiers was not conducted in this study, the stronger agreement attraction in Experiment 2 (with singular quantifiers) compared to that in Experiment 1 (where no quantifier was used) may provide support for Tanner and Bulkes' (2015) findings.

Finally, the answers provided in the pen-and-paper sentence completion task were highly accurate. This shows that Turkish learners of L2 English have the correct grammatical representations for English number agreement and the findings in the online experiments can only be attributed to their processing behavior but not to their representations of S-V number agreement in English.

The findings of the present study are both similar to and different from two previous L2 studies on S-V agreement, namely Lago and Felser (2018) and Öztürk

(2007). Lago and Felser reported that L2 speakers are sensitive to syntactic distance in S-V agreement, whereas Öztürk reported that L2 speakers are sensitive to linear distance in S-V agreement. The present study found a role for both syntactic and linear distance, providing partial support for either study, but use of syntactic information was modulated through lexical cues in addition to morphosyntactic information. This, I believe, is a novel contribution to the L2 literature on S-V agreement processing.

Employing constructions similar to the present study (*The smell of the stable(s) of/and the farmer(s)*), Lago and Felser (2018) found that both L1 and L2 German speakers are sensitive to syntactic distance (N2 mismatch) in production and processing of S-V number agreement. But the present study showed that Turkish L2 learners of English were sensitive to syntactic distance, only when lexical information was provided. The diverging results in the two studies could be due to the differences in the participant groups. Lago and Felser's participants were L2 German speakers residing in Germany but the participants in the present study were L2 English speakers residing in Turkey. This may suggest that sensitivity to syntactic or linear distance and reliance on lexical cues in processing or producing S-V agreement could perhaps depend on how immersed the L2 speakers are in the target language. Lago and Felser (2018) study and the present study also differed with respect to their experimental paradigms (speeded forced choice task in Lago and Felser (2018) and eye-tracking in the present study), and materials (coordinated (as well as embedded) NPs in Lago and Felser's (2018) study). It is not clear how these factors would contribute to the observed differences in the findings of the two studies but it is possible that speeded forced choice task and the eye-tracking paradigm may differ in their sensitivity in capturing aspects of language processing behavior.

Unlike Lago and Felser (2018) who reported L2 speakers to be sensitive to syntactic distance in S-V agreement, Öztürk (2007) reported, for production and processing, a role for linear distance in S-V agreement in L2 English. With participants whose L1 was the same as those in Öztürk (2007), the present study showed that Turkish speakers of L2 English can attend to both linear and syntactic distance in their processing of S-V agreement in English depending on whether or not lexical cues are present. When there is a lexical cue to mark the number feature of the distractor NP, L2 speakers are sensitive to syntactic distance in processing S-V agreement. Öztürk (2007) did not manipulate lexical information in her study.

Highlighting a role for lexical information in L2 sentence processing, the results of the present study partially support the arguments of Shallow Structure Hypothesis (Clahsen & Felser, 2006a, 2006b, 2006c), which predicts an increased reliance on lexical information by L2 speakers compared to L1 speakers. But the present study also showed that L2 speakers can compute complex syntax when provided with lexical cues. This contradicts the SSH as the SSH does not predict (with or without lexical cues) for L2 speakers to be able to compute complex syntax.

6.2. Conclusion

The two eye-tracking experiments in this study showed that Turkish speakers of L2 English were sensitive to linear distance in processing S-V agreement when there were only morphosyntactic cues in the sentence indicating a number mismatch between the head noun and the intervening nouns. However, when the number mismatch between the head and the intervening nouns was lexically marked; Turkish L2 speakers of English were sensitive to both the linear distance between the NPs and the verb and to the syntactic distance between the intervening NPs and the

subject head. The results of the pen-and-paper sentence completion test showed that Turkish L2 speakers of English knew S-V agreement rules in English.

The results provide some partial support to the Shallow Structure Hypothesis of Clahsen and Felser (2006a, 2006b, 2006c) in the sense that as was predicted by the SSH, the L2 speakers were sensitive to lexical cues. The findings provide counter-evidence for the SSH claim that L2 speakers cannot make syntactically detailed computations though because the Turkish speakers of English in the present study were sensitive to syntactic distance in their computation of S-V agreement in English.

The results align with the activation-based decay and similarity-based interference of cue-based memory retrieval (Lewis & Vasishth, 2005) and more specifically with Cunnings' (2017) argument that L2 speakers are able to process syntactically detailed computations when lexicosemantic information is available. Note that Cunnings (2017) also argues that L2 speakers weight lexicosemantic information more heavily than L1 speakers but the lack of a native speaker group in the present study does not allow me to firmly suggest that the findings support this argument. The lack of the sensitivity to syntactic distance when lexicosemantic information was missing (Experiment 1) compared to the sensitivity to syntactic distance in previous L1 studies (e.g., Franck et al., 2002; Pearlmutter, 2000), which also did not lexically mark the number feature of the NPs, can provide an indirect support to this argument.

The importance of lexicosemantic information in sensitivity to syntactic structure in Turkish speakers' processing of English S-V agreement is a finding that sheds light on the processing of S-V agreement by L2 learners and contributes to the

knowledge on the relationship between lexical and morphosyntactic information in S-V agreement processing.

6.3. Limitations and suggestions for further research

This is the first S-V agreement processing study conducted with three NP structures with Turkish L2 learners of English. And unlike many L1 and L2 studies, in addition to the sensitivity to linear and syntactic distance, the effect of lexical information was tested. The results showed that Turkish learners of L2 English showed sensitivities to mismatches attributable to the syntactic distance when lexical information was available in the sentence, as proposed by Cunnings (2017a, 2017b). Although the scope of the study was tried to be kept wide, there were things that could not be included in this study.

As was mentioned in Chapter 5 (Section 5.2.1) and in this chapter (Section 6.1), there were no L1 English speakers as a control group in this study. This is an unfortunate limitation that occurred due mostly to practicality reasons (e.g., difficulty finding English speaking participants in Istanbul who are also not speakers of Turkish, time pressure). But I tried to restrict its negative implications in the current design by using experimental items that closely matched to those used in previous L1 studies examining S-V agreement in English (i.e., Pearlmutter (2000) and Franck et al. (2002)). Pearlmutter (2000) and Franck et al. (2002) who also used complex subjects made of three NPs found that syntactic distance of the middle noun to the head noun affected L1 speakers' sensitivity to S-V agreement. Thus, given the similarity of the present materials to those used in Franck et al. (2002) and Pearlmutter (2000) whose findings agree on the prominence of the role of syntactic distance in S-V agreement, the present study did not include native speakers of

English as a control group. Still, including a native English speaker control group in the present study would have provided more direct comparisons for L1 and L2 processing of S-V agreement.

Secondly, although an intermediate experiment (between Experiment 1 and Experiment 2) with subject NPs consisting of plural head nouns and unmarked singular intervening nouns was considered, it was not conducted due to time pressures. Such an experiment and observation of no sensitivity to number mismatch in that experiment would have ensured that the lexical quantifier *one* marks an otherwise unmarked singular NP and markedness plays an important factor in agreement attraction. Furthermore, a follow-up experiment with singular head nouns and plural intervening nouns modified with plural quantifiers would enrich the results and contributions of this study on the role of lexical information in sensitivity to syntactic structure and in processing S-V agreement.

It is also possible that sensitivity to linear or syntactic distance may interact with individual WM capacity; but the present study did not test that.

Future research controlling for these potential limitations in the present study can further inform on processing of S-V number agreement in the L1 and the L2.

APPENDIX A

BACKGROUND QUESTIONNAIRE FOR PARTICIPANTS

I agree to participate in this study:

Signature: _____ Name (Please print):

_____

Date: _____

I. PERSONAL INFORMATION (Will Remain Confidential)

1. Sex: Female Male
2. Date of Birth: Place of Birth: City: Country:
3. Occupation:
4. Highest Level of Schooling: Secondary High school University
5. Do you have any visual problem?
   a. Yes
   b. No
6. If yes, how do you correct it?
   a. I use glasses
   b. I use contact lenses
   c. Other (Please specify):

      _____

II. LINGUISTIC INFORMATION

1. Mother Tongue:
2. Language of Education
   a. Primary

      School:_____
   b. Secondary School: _____
   c. High School: _____
   d. University: _____
3. Age & Place of first exposure to English:
4. How often do you use English?

5. Where do you generally use English?
   a. Home: _____ hours
   b. Work:_____ hours
   c. Social:_____ hours
6. Have you lived in an English-speaking country before?
   If so, how long did you stay there?
   Country (1) Age of arrival: Length of stay:
   Country (2) Age of arrival: Length of stay:

III. ENGLISH LANGUAGE PROFICIENCY

1. Have you ever taken any standardized English Proficiency Test (e.g., TOEFL, IELTS)?
   a. Yes
   b. No
2. If yes, what was your score?:
   _____
3. How would you rate your linguistic ability in English in the following areas?:

	Beginner	Intermediate	Advanced	Near-Native
Reading				
Writing				
Speaking				
Listening				
Overall Competence				

IV. SECOND LANGUAGE(S):

1. Do you speak any other foreign languages besides English?
   a. Yes
   b. No

2. If yes, please specify what languages you speak:_____
3. How would you rate your linguistic ability in those languages in the following areas?

Language 1: _____

	Beginner	Intermediate	Advanced	Near-Native
Reading				
Writing				
Speaking				
Listening				
Overall Competence				

Language 2: _____

	Beginner	Intermediate	Advanced	Near-Native
Reading				
Writing				
Speaking				
Listening				
Overall Competence				

APPENDIX B

ITEMS AND QUESTIONS USED IN EYE-TRACKING EXPERIMENT 1

1.

a. SSS, No Mismatch: The advertisement about the house of the estate-agent was interesting to look at.
b. SPS, N2 Mismatch: The advertisement about the houses of the estate-agent was interesting to look at.
c. SSP, N3 Mismatch: The advertisement about the house of the estate-agents was interesting to a look at.
d. SPP, Total Mismatch: The advertisement about the houses of the estate-agents was interesting to look at.

Does the sentence include the word "interesting"?
a. yes b. no

2.

a. SSS, No Mismatch: The announcement from the founder of the club was tragic and made everyone anxious.
b. SPS, N2 Mismatch: The announcement from the founders of the club was tragic and made everyone anxious.
c. SSP, N3 Mismatch: The announcement from the founder of the clubs was tragic and made everyone anxious.
d. SPP, Total Mismatch: The announcement from the founders of the clubs was tragic and made everyone anxious.

Does the sentence include the word "tragic"?
a. yes b. no

3.

a. SSS, No Mismatch: The article by the editor of the newspaper was so difficult to understand.
b. SPS, N2 Mismatch: The article by the editors of the newspaper was so difficult to understand.
c. SSP, N3 Mismatch: The article by the editor of the newspapers was so difficult to understand.
d. SPP, Total Mismatch: The article by the editors of the newspapers was so difficult to understand.

Does the sentence include the word "difficult"?
a. yes b. no

4.

a. SSS, No Mismatch: The daughter of the author of the book was pleased with the Nobel Prize.
b. SPS, N2 Mismatch: The daughter of the authors of the book was pleased with the Nobel Prize.
c. SSP, N3 Mismatch: The daughter of the author of the books was pleased with the Nobel Prize.

d. SPP, Total Mismatch: The daughter of the authors of the books was pleased with the Nobel Prize.

Does the sentence include the word "pleased"?

a. yes b. no

5.

a. SSS, No Mismatch: The design for the engine of the factory is very detailed and practical.

b. SPS, N2 Mismatch: The design for the engines of the factory is very detailed and practical.

c. SSP, N3 Mismatch: The design for the engine of the factories is very detailed and practical.

d. SPP, Total Mismatch: The design for the engines of the factories is very detailed and practical.

Does the sentence include the word "practical"?

a. yes b. no

6.

a. SSS, No Mismatch: The payment for the actress of the movie was extremely big for this sector.

b. SPS, N2 Mismatch: The payment for the actresses of the movie was extremely big for this sector.

c. SSP, N3 Mismatch: The payment for the actress of the movies was extremely big for this sector.

d. SPP, Total Mismatch: The payment for the actresses of the movies was extremely big for this sector.

Does the sentence include the word "extremely "?

a. yes b. no

7.

a. SSS, No Mismatch: The discussion about the problem of the house is the main problem in marriages.

b. SPS, N2 Mismatch: The discussion about the problems of the house is the main problem in marriages.

c. SSP, N3 Mismatch: The discussion about the problem of the houses is the main problem in marriages.

d. SPP, Total Mismatch: The discussion about the problems of the houses is the main problem in marriages.

Does the sentence include the word "main"?

a. yes b. no

8.

a. SSS, No Mismatch: The idea behind the experiment of the scientist was sophisticated and very intelligent.

b. SPS, N2 Mismatch: The idea behind the experiments of the scientist was sophisticated and very intelligent.

c. SSP, N3 Mismatch: The idea behind the experiment of the scientists was sophisticated and very intelligent.

d. SPP, Total Mismatch: The idea behind the experiments of the scientists was sophisticated and very intelligent.

Does the sentence include the word "intelligent"?
a. yes b. no

9.

a. SSS, No Mismatch: The picture on the door of the room was beautiful with many details.
b. SPS, N2 Mismatch: The picture on the doors of the room was beautiful with many details.
c. SSP, N3 Mismatch: The picture on the door of the rooms was beautiful with many details.
d. SPP, Total Mismatch: The picture on the doors of the rooms was beautiful with many details.

Does the sentence include the word "beautiful"?
a. yes b. no

10.

a. SSS, No Mismatch: The kid near the toy of the cat was happy with her delicious cookies.
b. SPS, N2 Mismatch: The kid near the toys of the cat was happy with her delicious cookies.
c. SSP, N3 Mismatch: The kid near the toy of the cats was happy with her delicious cookies.
d. SPP, Total Mismatch: The kid near the toys of the cats was happy with her delicious cookies.

Does the sentence include the word "delicious"?
a. yes b. no

11.

a. SSS, No Mismatch: The daughter of the editor of the magazine was worried about the exams.
b. SPS, N2 Mismatch: The daughter of the editors of the magazine was worried about the exams.
c. SSP, N3 Mismatch: The daughter of the editor of the magazines was worried about the exams.
d. SPP, Total Mismatch: The daughter of the editors of the magazines was worried about the exams.

Does the sentence include the word "exams"?
a. yes b. no

12.

a. SSS, No Mismatch: The gift for the son of the visitor was expensive and very interesting.
b. SPS, N2 Mismatch: The gift for the sons of the visitor was expensive and very interesting.
c. SSP, N3 Mismatch: The gift for the son of the visitors was expensive and very interesting.
d. SPP, Total Mismatch: The gift for the sons of the visitors was expensive and very interesting.

Does the sentence include the word "expensive"?
a. yes b. no

13.

a. SSS, No Mismatch: The announcement by the principal of the school is impossible to hear or understand.
b. SPS, N2 Mismatch: The announcement by the principals of the school is impossible to hear or understand.
c. SSP, N3 Mismatch: The announcement by the principal of the schools is impossible to hear or understand.
d. SPP, Total Mismatch: The announcement by the principals of the schools is impossible to hear or understand.

Does the sentence include the word "listen"?
a. yes b. no

14.

a. SSS, No Mismatch: The meal for the guest of the parent was ready before she came.
b. SPS, N2 Mismatch: The meal for the guests of the parent was ready before she came.
c. SSP, N3 Mismatch: The meal for the guest of the parents was ready before she came.
d. SPP, Total Mismatch: The meal for the guests of the parents was ready before she came.

Does the sentence include the word "unprepared"?
a. yes b. no

15.

a. SSS, No Mismatch: The reward for the winner of the competition is important and very high.
b. SPS, N2 Mismatch: The reward for the winners of the competition is important and very high.
c. SSP, N3 Mismatch: The reward for the winner of competitions is important and very high.
d. SPP, Total Mismatch: The reward for the winners of the competitions is important and very high.

Does the sentence include the word "small"?
a. yes b. no

16.

a. SSS, No Mismatch: The gramophone near the photo of the student is nostalgic and quite beautiful.
b. SPS, N2 Mismatch: The gramophone near the photos of the student is nostalgic and quite beautiful.
c. SSP, N3 Mismatch: The gramophone near the photo of the students is nostalgic and quite beautiful.
d. SPP, Total Mismatch: The gramophone near the photos of the students is nostalgic and quite beautiful.

Does the sentence include the word "flowers"?
a. yes b. no

17.

a. SSS, No Mismatch: The warning on the entrance of the platform is hard to see and read.
b. SPS, N2 Mismatch: The warning on the entrances of the platform is hard to see and read.
c. SSP, N3 Mismatch: The warning on the entrance of the platforms is hard to see and read.
d. SPP, Total Mismatch: The warning on the entrances of the platforms is hard to see and read.

Does the sentence include the word "understand"?
a. yes b. no

18.

a. SSS, No Mismatch: The recipe by the cook of the restaurant is very delicious and healthy.
b. SPS, N2 Mismatch: The recipe by the cooks of the restaurant is very delicious and healthy.
c. SSP, N3 Mismatch: The recipe by the cook of the restaurants is very delicious and healthy.
d. SPP, Total Mismatch: The recipe by the cooks of the restaurants is very delicious and healthy.

Does the sentence include the word "tasty"?
a. yes b. no

19.

a. SSS, No Mismatch: The prescription by the doctor of the hospital was accurate and therefore lifesaving.
b. SPS, N2 Mismatch: The prescription by the doctors of the hospital was accurate and therefore lifesaving.
c. SSP, N3 Mismatch: The prescription by the doctor of the hospitals was accurate and therefore lifesaving.
d. SPP, Total Mismatch: The prescription by the doctors of the hospitals was accurate and therefore lifesaving.

Does the sentence include the word "nurse"?
a. yes b. no

20.

a. SSS, No Mismatch: The advertising by the producer of the movie is informative for this field.
b. SPS, N2 Mismatch: The advertising by the producers of the movie is informative for this field.
c. SSP, N3 Mismatch: The advertising by the producer of the movies is informative for this field.
d. SPP, Total Mismatch: The advertising by the producers of the movies is informative for this field.

Does the sentence include the word "arrogant"?
a. yes b. no

21.

a. SSS, No Mismatch: The letter from the cousin of my girlfriend was full of hatred and anger.

b. SPS, N2 Mismatch: The letter from the cousins of my girlfriend was full of hatred and anger.
c. SSP, N3 Mismatch: The letter from the cousin of my girlfriends was full of hatred and anger.
d. SPP, Total Mismatch: The letter from the cousins of my girlfriends was full of hatred and anger.

Does the sentence include the word "love"?
a. yes b. no

22.

a. SSS, No Mismatch: The drink for the guest of the innkeeper is juicy and rich in flavor.
b. SPS, N2 Mismatch: The drink for the guests of the innkeeper is juicy and rich in flavor.
c. SSP, N3 Mismatch: The drink for the guest of the innkeepers is juicy and rich in flavor.
d. SPP, Total Mismatch: The drink for the guests of the innkeepers is juicy and rich in flavor.

Does the sentence include the word "red"?
a. yes b. no

23.

a. SSS, No Mismatch: The decision by the manager of the company is extremely important for profit.
b. SPS, N2 Mismatch: The decision by the managers of the company is extremely important for profit.
c. SSP, N3 Mismatch: The decision by the manager of the companies is extremely important for profit.
d. SPP, Total Mismatch: The decision by the managers of the companies is extremely important for profit.

Does the sentence include the word "trivial"?
a. yes b. no

24.

a. SSS, No Mismatch: The article by the researcher of the university was well-written and professional.
b. SPS, N2 Mismatch: The article by the researchers of the university was well-written and professional.
c. SSP, N3 Mismatch: The article by the researcher of the universities was well-written and professional.
d. SPP, Total Mismatch: The article by the researchers of the universities was well-written and professional.

Does the sentence include the word "complicated"?
a. yes b. no

APPENDIX C

ITEMS AND QUESTIONS USED IN EYE-TRACKING EXPERIMENT 2

1.

a. PPP, No Mismatch: The cakes for the guests of the daughters were very difficult to prepare.
b. PSP, N2 Mismatch: The cakes for one guest of the daughters were very difficult to prepare.
c. PPS, N3 Mismatch: The cakes for the guests of one daughter were very difficult to prepare.
d. PSS, Total Mismatch: The cakes for one guest of one daughter were very difficult to prepare.

Does the sentence include the word "prepare"?
a. yes b. no

2.

a. PPP, No Mismatch: The reviews for the movies of the actors were harsh but still honest.
b. PSP, N2 Mismatch: The reviews for one movie of the actors were harsh but still honest.
c. PPS, N3 Mismatch: The reviews for the movies of one actor were harsh but still honest.
d. PSS, Total Mismatch: The reviews for one movie of one actor were harsh but still honest.

Does the sentence include the word "harsh"?
a. yes b. no

3.

a. PPP, No Mismatch: The birds near the flowers of the trees are beautiful and singing happily.
b. PSP, N2 Mismatch: The birds near one flower of the trees are beautiful and singing happily.
c. PPS, N3 Mismatch: The birds near the flowers of one tree are beautiful and singing happily.
d. PSS, Total Mismatch: The birds near one flower of one tree are beautiful and singing happily.

Does the sentence include the word "singing"?
a. yes b. no

4.

a. PPP, No Mismatch: The boys with the posters of the actresses were happy in the movie premiere.
b. PSP, N2 Mismatch: The boys with one poster of the actresses were happy in the movie premiere.
c. PPS, N3 Mismatch: The boys with the posters of one actress were happy in the movie premiere.
d. PSS, Total Mismatch: The boys with one poster of one actress were happy in the movie premiere.

Does the sentence include the word "happy"?
a. yes b. no

5.

a. PPP, No Mismatch: The paintings near the guards of the castles are ancient and very valuable.
b. PSP, N2 Mismatch: The paintings near one guard of the castles are ancient and very valuable.
c. PPS, N3 Mismatch: The paintings near the guards of one castle are ancient and very valuable.
d. PSS, Total Mismatch: The paintings near one guard of one castle are ancient and very valuable.

Does the sentence include the word "valuable"?
a. yes b. no

6.

a. PPP, No Mismatch: The lambs with the farmers of the farms were tall and extremely fat.
b. PSP, N2 Mismatch: The lambs with one farmer of the farms were tall and extremely fat.
c. PPS, N3 Mismatch: The lambs with the farmers of one farm were tall and extremely fat.
d. PSS, Total Mismatch: The lambs with one farmer of one farm were tall and extremely fat.

Does the sentence include the word "tall"?
a. yes b. no

7.

a. PPP, No Mismatch: The lamps near the paintings of the lakes were priceless and timeless antiques.
b. PSP, N2 Mismatch: The lamps near one painting of the lakes were priceless and timeless antiques.
c. PPS, N3 Mismatch: The lamps near the paintings of one lake were priceless and timeless antiques.
d. PSS, Total Mismatch: The lamps near one painting of one lake were priceless and timeless antiques.

Does the sentence include the word "priceless"?
a. yes b. no

8.

a. PPP, No Mismatch: The results of the experiments of the researchers are very promising in the field.
b. PSP, N2 Mismatch: The results of one experiment of the researchers are very promising in the field.
c. PPS, N3 Mismatch: The results of the experiments of one researcher are very promising in the field.
d. PSS, Total Mismatch: The results of one experiment of one researcher are very promising in the field.

Does the sentence include the word "promising"?
a. yes b. no

9.

a. PPP, No Mismatch: The buses to the towns of the festivals are quite fun and very comfortable.
b. PSP, N2 Mismatch: The buses to one town of the festivals are quite fun and very comfortable.
c. PPS, N3 Mismatch: The buses to the towns of one festival are quite fun and very comfortable.
d. PSS, Total Mismatch: The buses to one town of one festival are quite fun and very comfortable.

Does the sentence include the word "fun"?
a. yes b. no

10.

a. PPP, No Mismatch: The friends of the publishers of the newspapers are very happy after marriage.
b. PSP, N2 Mismatch: The friends of one publisher of the newspapers are very happy after marriage.
c. PPS, N3 Mismatch: The friends of the publishers of one newspaper are very happy after marriage.
d. PSS, Total Mismatch: The friends of one publisher of one newspaper are very happy after marriage.

Does the sentence include the word "marriage"?
a. yes b. no

11.

a. PPP, No Mismatch: The ponds near the cottages of the doctors are huge with many ducks.
b. PSP, N2 Mismatch: The ponds near one cottage of the doctors are huge with many ducks.
c. PPS, N3 Mismatch: The ponds near the cottages of one doctor are huge with many ducks.
d. PSS, Total Mismatch: The ponds near one cottage of one doctor are huge with many ducks.

Does the sentence include the word "many"?
a. yes b. no

12.

a. PPP, No Mismatch: The shops near the entrances of the malls were full of mice and insects.
b. PSP, N2 Mismatch: The shops near one entrance of the malls were full of mice and insects.
c. PPS, N3 Mismatch: The shops near the entrances of one mall were full of mice and insects.
d. PSS, Total Mismatch: The shops near one entrance of one mall were full of mice and insects.

Does the sentence include the word "mice"?
a. yes b. no

13.

a. PPP, No Mismatch: The schools near the gardens of the houses are very spacious and green.
b. PSP, N2 Mismatch: The schools near one garden of the houses are very spacious and green.
c. PPS, N3 Mismatch: The schools near the gardens of one house are very spacious and green.
d. PSS, Total Mismatch: The schools near one garden of one house are very spacious and green.

Does the sentence include the word "big"?
a. yes b. no

14.

a. PPP, No Mismatch: The tours for the mosques of the cities were very long and tiring.
b. PSP, N2 Mismatch: The tours for one mosque of the cities were very long and tiring.
c. PPS, N3 Mismatch: The tours for the mosques of one city were very long and tiring.
d. PSS, Total Mismatch: The tours for one mosque of one city were very long and tiring.

Does the sentence include the word "exhausting"?
a. yes b. no

15.

a. PPP, No Mismatch: The rewards for the winners of the races were too big to reject.
b. PSP, N2 Mismatch: The rewards for one winner of the races were too big to reject.
c. PPS, N3 Mismatch: The rewards for the winners of one race were too big to reject.
d. PSS, Total Mismatch: The rewards for one winner of one race were too big to reject.

Does the sentence include the word "huge"?
a. yes b. no

16.

a. PPP, No Mismatch: The journeys through the villages of the countries were expensive and tiring to take.
b. PSP, N2 Mismatch: The journeys through one village of the countries were expensive and tiring to take.
c. PPS, N3 Mismatch: The journeys through the villages of one country were expensive and tiring to take.
d. PSS, Total Mismatch: The journeys through one village of one country were expensive and tiring to take.

Does the sentence include the word "boring"?
a. yes b. no

17.

a. PPP, No Mismatch: The statues in the exhibitions of the sculptors are bizarre and very frightening.

b. PSP, N2 Mismatch: The statues in one exhibition of the sculptors are bizarre and very frightening.
c. PPS, N3 Mismatch: The statues in the exhibitions of one sculptor are bizarre and very frightening.
d. PSS, Total Mismatch: The statues in one exhibition of one sculptor are bizarre and very frightening.

Does the sentence include the word "aesthetic"?
a. yes b. no

18.

a. PPP, No Mismatch: The museums with the pictures of the painters are expensive and hard to enter.
b. PSP, N2 Mismatch: The museums with one picture of the painters are expensive and hard to enter.
c. PPS, N3 Mismatch: The museums with the pictures of one painter are expensive and hard to enter.
d. PSS, Total Mismatch: The museums with one picture of one painter are expensive and hard to enter.

Does the sentence include the word "cheap"?
a. yes b. no

19.

a. PPP, No Mismatch: The lessons about the founders of the firms are boring but sometimes informative.
b. PSP, N2 Mismatch: The lessons about one founder of the firms are boring but sometimes informative.
c. PPS, N3 Mismatch: The lessons about the founders of one firm are boring but sometimes informative.
d. PSS, Total Mismatch: The lessons about one founder of one firm are boring but sometimes informative.

Does the sentence include the word "short"?
a. yes b. no

20.

a. PPP, No Mismatch: The toys for the sons of the teachers are very entertaining to play with.
b. PSP, N2 Mismatch: The toys for one son of the teachers are very entertaining to play with.
c. PPS, N3 Mismatch: The toys for the sons of one teacher are very entertaining to play with.
d. PSS, Total Mismatch: The toys for one son of one teacher are very entertaining to play with.

Does the sentence include the word "break"?
a. yes b. no

21.

a. PPP, No Mismatch: The benefits for the managers of the companies are continuous and quite motivating.
b. PSP, N2 Mismatch: The benefits for one manager of the companies are continuous and quite motivating.

c. PPS, N3 Mismatch: The benefits for the managers of one company are continuous and quite motivating.
d. PSS, Total Mismatch: The benefits for one manager of one company are continuous and quite motivating.

Does the sentence include the word "long"?
a. yes b. no

22.

a. PPP, No Mismatch: The symbols on the keys of the gates were rusty from years of use.
b. PSP, N2 Mismatch: The symbols on one key of the gates were rusty from years of use.
c. PPS, N3 Mismatch: The symbols on the keys of one gate were rusty from years of use.
d. PSS, Total Mismatch: The symbols on one key of one gate were rusty from years of use.

Does the sentence include the word "shiny"?
a. yes b. no

23.

a. PPP, No Mismatch: The manuals by the engineers of the fridges are hard to read without glasses.
b. PSP, N2 Mismatch: The manuals by one engineer of the fridges are hard to read without glasses.
c. PPS, N3 Mismatch: The manuals by the engineers of one fridge are hard to read without glasses.
d. PSS, Total Mismatch: The manuals by one engineer of one fridge are hard to read without glasses.

Does the sentence include the word "lenses"?
a. yes b. no

24.

a. PPP, No Mismatch: The settings for the films of the directors are artistic and quite expensive.
b. PSP, N2 Mismatch: The settings for one film of the directors are artistic and quite expensive.
c. PPS, N3 Mismatch: The settings for the films of one director are artistic and quite expensive.
d. PSS, Total Mismatch: The settings for one film of one director are artistic and quite expensive.

Does the sentence include the word "dull"?
a. yes b. no

APPENDIX D

ITEMS USED IN OFFLINE SENTENCE COMPLETION TEST

1.

a. SSS, No Mismatch: The advertisement about the house of the estate-agent _____ interesting to look at.
b. SPS, N2 Mismatch: The advertisement about the houses of the estate-agent _____ interesting to look at.
c. SSP, N3 Mismatch: The advertisement about the house of the estate-agents _____ interesting to a look at.
d. SPP, Total Mismatch: The advertisement about the houses of the estate-agents _____interesting to look at.

2.

a. SSS, No Mismatch: The announcement from the founder of the club _____ tragic and made everyone anxious.
b. SPS, N2 Mismatch: The announcement from the founders of the club _____ tragic and made everyone anxious.
c. SSP, N3 Mismatch: The announcement from the founder of the clubs _____ tragic and made everyone anxious.
d. SPP, Total Mismatch: The announcement from the founders of the clubs _____ tragic and made everyone anxious.

3.

a. SSS, No Mismatch: The article by the editor of the newspaper _____ so difficult to understand.
b. SPS, N2 Mismatch: The article by the editors of the newspaper _____ so difficult to understand.
c. SSP, N3 Mismatch: The article by the editor of the newspapers _____ so difficult to understand.
d. SPP, Total Mismatch: The article by the editors of the newspapers _____ so difficult to understand.

4.

a. SSS, No Mismatch: The daughter of the author of the book _____ pleased with the Nobel Prize.
b. SPS, N2 Mismatch: The daughter of the authors of the book _____ pleased with the Nobel Prize.
c. SSP, N3 Mismatch: The daughter of the author of the books _____ pleased with the Nobel Prize.
d. SPP, Total Mismatch: The daughter of the authors of the books _____ pleased with the Nobel Prize.

5.

a. SSS, No Mismatch: The design for the engine of the factory _____ very detailed and practical.
b. SPS, N2 Mismatch: The design for the engines of the factory _____ very detailed and practical.
c. SSP, N3 Mismatch: The design for the engine of the factories _____ very detailed and practical.
d. SPP, Total Mismatch: The design for the engines of the factories _____ very detailed and practical.

6.

a. SSS, No Mismatch: The payment for the actress of the movie _____ extremely big for this sector.
b. SPS, N2 Mismatch: The payment for the actresses of the movie _____ extremely big for this sector.
c. SSP, N3 Mismatch: The payment for the actress of the movies _____ extremely big for this sector.
d. SPP, Total Mismatch: The payment for the actresses of the movies _____ extremely big for this sector.

7.

a. SSS, No Mismatch: The discussion about the problem of the house _____ the main problem in marriages.
b. SPS, N2 Mismatch: The discussion about the problems of the house _____ the main problem in marriages.
c. SSP, N3 Mismatch: The discussion about the problem of the houses _____ the main problem in marriages.
d. SPP, Total Mismatch: The discussion about the problems of the houses _____ the main problem in marriages.

8.

a. SSS, No Mismatch: The idea behind the experiment of the scientist _____ sophisticated and very intelligent.
b. SPS, N2 Mismatch: The idea behind the experiments of the scientist _____ sophisticated and very intelligent.
c. SSP, N3 Mismatch: The idea behind the experiment of the scientists _____ sophisticated and very intelligent.
d. SPP, Total Mismatch: The idea behind the experiments of the scientists _____ sophisticated and very intelligent.

9.

a. SSS, No Mismatch: The picture on the door of the room _____ beautiful with many details.
b. SPS, N2 Mismatch: The picture on the doors of the room _____ beautiful with many details.

c. SSP, N3 Mismatch: The picture on the door of the rooms _____ beautiful with many details.
d. SPP, Total Mismatch: The picture on the doors of the rooms _____ beautiful with many details.

10.
a. SSS, No Mismatch: The kid near the toy of the cat _____ happy with her delicious cookies.
b. SPS, N2 Mismatch: The kid near the toys of the cat _____ happy with her delicious cookies.
c. SSP, N3 Mismatch: The kid near the toy of the cats _____ happy with her delicious cookies.
d. SPP, Total Mismatch: The kid near the toys of the cats _____ happy with her delicious cookies.

11.
a. SSS, No Mismatch: The daughter of the editor of the magazine _____ worried about the exams.
b. SPS, N2 Mismatch: The daughter of the editors of the magazine _____ worried about the exams.
c. SSP, N3 Mismatch: The daughter of the editor of the magazines _____ worried about the exams.
d. SPP, Total Mismatch: The daughter of the editors of the magazines _____ worried about the exams.

12.
a. SSS, No Mismatch: The gift for the son of the visitor _____ expensive and very interesting.
b. SPS, N2 Mismatch: The gift for the sons of the visitor _____ expensive and very interesting.
c. SSP, N3 Mismatch: The gift for the son of the visitors _____ expensive and very interesting.
d. SPP, Total Mismatch: The gift for the sons of the visitors _____ expensive and very interesting.

13.
a. SSS, No Mismatch: The announcement by the principal of the school _____ impossible to hear or understand.
b. SPS, N2 Mismatch: The announcement by the principals of the school _____ impossible to hear or understand.
c. SSP, N3 Mismatch: The announcement by the principal of the schools _____ impossible to hear or understand.
d. SPP, Total Mismatch: The announcement by the principals of the schools _____ impossible to hear or understand.

14.

a. SSS, No Mismatch: The meal for the guest of the parent _____ ready before she came.
b. SPS, N2 Mismatch: The meal for the guests of the parent _____ ready before she came.
c. SSP, N3 Mismatch: The meal for the guest of the parents _____ ready before she came.
d. SPP, Total Mismatch: The meal for the guests of the parents _____ ready before she came.

15.

a. SSS, No Mismatch: The reward for the winner of the competition _____ important and very high.
b. SPS, N2 Mismatch: The reward for the winners of the competition _____ important and very high.
c. SSP, N3 Mismatch: The reward for the winner of competitions _____ important and very high.
d. SPP, Total Mismatch: The reward for the winners of the competitions _____ important and very high.

16.

a. SSS, No Mismatch: The gramophone near the photo of the student _____ nostalgic and quite beautiful.
b. SPS, N2 Mismatch: The gramophone near the photos of the student _____ nostalgic and quite beautiful.
c. SSP, N3 Mismatch: The gramophone near the photo of the students _____ nostalgic and quite beautiful.
d. SPP, Total Mismatch: The gramophone near the photos of the students _____ nostalgic and quite beautiful.

17.

a. SSS, No Mismatch: The warning on the entrance of the platform _____ hard to see and read.
b. SPS, N2 Mismatch: The warning on the entrances of the platform _____ hard to see and read.
c. SSP, N3 Mismatch: The warning on the entrance of the platforms _____ hard to see and read.
d. SPP, Total Mismatch: The warning on the entrances of the platforms _____ hard to see and read.

18.

a. SSS, No Mismatch: The recipe by the cook of the restaurant _____ very delicious and healthy.
b. SPS, N2 Mismatch: The recipe by the cooks of the restaurant _____ very delicious and healthy.

c. SSP, N3 Mismatch: The recipe by the cook of the restaurants _____ very delicious and healthy.
d. SPP, Total Mismatch: The recipe by the cooks of the restaurants _____ very delicious and healthy.

19.

a. SSS, No Mismatch: The prescription by the doctor of the hospital _____ accurate and therefore lifesaving.
b. SPS, N2 Mismatch: The prescription by the doctors of the hospital _____ accurate and therefore lifesaving.
c. SSP, N3 Mismatch: The prescription by the doctor of the hospitals _____ accurate and therefore lifesaving.
d. SPP, Total Mismatch: The prescription by the doctors of the hospitals _____ accurate and therefore lifesaving.

20.

a. SSS, No Mismatch: The advertising by the producer of the movie _____ informative for this field.
b. SPS, N2 Mismatch: The advertising by the producers of the movie _____ informative for this field.
c. SSP, N3 Mismatch: The advertising by the producer of the movies _____ informative for this field.
d. SPP, Total Mismatch: The advertising by the producers of the movies _____ informative for this field.

21.

a. SSS, No Mismatch: The letter from the cousin of my girlfriend _____ full of hatred and anger.
b. SPS, N2 Mismatch: The letter from the cousins of my girlfriend _____ full of hatred and anger.
c. SSP, N3 Mismatch: The letter from the cousin of my girlfriends _____ full of hatred and anger.
d. SPP, Total Mismatch: The letter from the cousins of my girlfriends _____ full of hatred and anger.

22.

a. SSS, No Mismatch: The drink for the guest of the innkeeper _____ juicy and rich in flavor.
b. SPS, N2 Mismatch: The drink for the guests of the innkeeper _____ juicy and rich in flavor.
c. SSP, N3 Mismatch: The drink for the guest of the innkeepers _____ juicy and rich in flavor.
d. SPP, Total Mismatch: The drink for the guests of the innkeepers _____ juicy and rich in flavor.

23.

a. SSS, No Mismatch: The decision by the manager of the company _____ extremely important for profit.
b. SPS, N2 Mismatch: The decision by the managers of the company _____ extremely important for profit.
c. SSP, N3 Mismatch: The decision by the manager of the companies _____ extremely important for profit.
d. SPP, Total Mismatch: The decision by the managers of the companies _____ extremely important for profit.

24.

a. SSS, No Mismatch: The article by the researcher of the university _____ well-written and professional.
b. SPS, N2 Mismatch: The article by the researchers of the university _____ well-written and professional.
c. SSP, N3 Mismatch: The article by the researcher of the universities _____ well-written and professional.
d. SPP, Total Mismatch: The article by the researchers of the universities _____ well-written and professional.

25.

a. PPP, No Mismatch: The cakes for the guests of the daughters _____ very difficult to prepare.
b. PSP, N2 Mismatch: The cakes for one guest of the daughters _____ very difficult to prepare.
c. PPS, N3 Mismatch: The cakes for the guests of one daughter _____ very difficult to prepare.
d. PSS, Total Mismatch: The cakes for one guest of one daughter _____ very difficult to prepare.

26.

a. PPP, No Mismatch: The reviews for the movies of the actors _____ harsh but still honest.
b. PSP, N2 Mismatch: The reviews for one movie of the actors _____ harsh but still honest.
c. PPS, N3 Mismatch: The reviews for the movies of one actor _____ harsh but still honest.
d. PSS, Total Mismatch: The reviews for one movie of one actor _____ harsh but still honest.

27.

a. PPP, No Mismatch: The birds near the flowers of the trees _____ beautiful and singing happily.
b. PSP, N2 Mismatch: The birds near one flower of the trees _____ beautiful and singing happily.
c. PPS, N3 Mismatch: The birds near the flowers of one tree _____ beautiful and singing happily.

d. PSS, Total Mismatch: The birds near one flower of one tree _____ beautiful and singing happily.

28.

a. PPP, No Mismatch: The boys with the posters of the actresses _____ happy in the movie premiere.
b. PSP, N2 Mismatch: The boys with one poster of the actresses _____ happy in the movie premiere.
c. PPS, N3 Mismatch: The boys with the posters of one actress _____ happy in the movie premiere.
d. PSS, Total Mismatch: The boys with one poster of one actress _____ happy in the movie premiere.

29.

a. PPP, No Mismatch: The paintings near the guards of the castles _____ ancient and very valuable.
b. PSP, N2 Mismatch: The paintings near one guard of the castles _____ ancient and very valuable.
c. PPS, N3 Mismatch: The paintings near the guards of one castle _____ ancient and very valuable.
d. PSS, Total Mismatch: The paintings near one guard of one castle _____ ancient and very valuable.

30.

a. PPP, No Mismatch: The lambs with the farmers of the farms _____ tall and extremely fat.
b. PSP, N2 Mismatch: The lambs with one farmer of the farms _____ tall and extremely fat.
c. PPS, N3 Mismatch: The lambs with the farmers of one farm _____ tall and extremely fat.
d. PSS, Total Mismatch: The lambs with one farmer of one farm _____ tall and extremely fat.

31.

a. PPP, No Mismatch: The lamps near the paintings of the lakes _____ priceless and timeless antiques.
b. PSP, N2 Mismatch: The lamps near one painting of the lakes _____ priceless and timeless antiques.
c. PPS, N3 Mismatch: The lamps near the paintings of one lake _____ priceless and timeless antiques.
d. PSS, Total Mismatch: The lamps near one painting of one lake _____ priceless and timeless antiques.

32.

a. PPP, No Mismatch: The results of the experiments of the researchers _____ very promising in the field.
b. PSP, N2 Mismatch: The results of one experiment of the researchers _____ very promising in the field.
c. PPS, N3 Mismatch: The results of the experiments of one researcher _____ very promising in the field.
d. PSS, Total Mismatch: The results of one experiment of one researcher _____ very promising in the field.

33.

a. PPP, No Mismatch: The buses to the towns of the festivals _____ quite fun and very comfortable.
b. PSP, N2 Mismatch: The buses to one town of the festivals _____ quite fun and very comfortable.
c. PPS, N3 Mismatch: The buses to the towns of one festival _____ quite fun and very comfortable.
d. PSS, Total Mismatch: The buses to one town of one festival _____ quite fun and very comfortable.

34.

a. PPP, No Mismatch: The friends of the publishers of the newspapers _____ very happy after marriage.
b. PSP, N2 Mismatch: The friends of one publisher of the newspapers _____ very happy after marriage.
c. PPS, N3 Mismatch: The friends of the publishers of one newspaper _____ very happy after marriage.
d. PSS, Total Mismatch: The friends of one publisher of one newspaper _____ very happy after marriage.

35.

a. PPP, No Mismatch: The ponds near the cottages of the doctors _____ huge with many ducks.
b. PSP, N2 Mismatch: The ponds near one cottage of the doctors _____ huge with many ducks.
c. PPS, N3 Mismatch: The ponds near the cottages of one doctor _____ huge with many ducks.
d. PSS, Total Mismatch: The ponds near one cottage of one doctor _____ huge with many ducks.

36.

a. PPP, No Mismatch: The shops near the entrances of the malls _____ full of mice and insects.
b. PSP, N2 Mismatch: The shops near one entrance of the malls _____ full of mice and insects.

c. PPS, N3 Mismatch: The shops near the entrances of one mall _____ full of mice and insects.
d. PSS, Total Mismatch: The shops near one entrance of one mall _____ full of mice and insects.

37.

a. PPP, No Mismatch: The schools near the gardens of the houses _____ very spacious and green.
b. PSP, N2 Mismatch: The schools near one garden of the houses _____ very spacious and green.
c. PPS, N3 Mismatch: The schools near the gardens of one house _____ very spacious and green.
d. PSS, Total Mismatch: The schools near one garden of one house _____ very spacious and green.

38.

a. PPP, No Mismatch: The tours for the mosques of the cities _____ very long and tiring.
b. PSP, N2 Mismatch: The tours for one mosque of the cities _____ very long and tiring.
c. PPS, N3 Mismatch: The tours for the mosques of one city _____ very long and tiring.
d. PSS, Total Mismatch: The tours for one mosque of one city _____ very long and tiring.

39.

a. PPP, No Mismatch: The rewards for the winners of the races _____ too big to reject.
b. PSP, N2 Mismatch: The rewards for one winner of the races _____ too big to reject.
c. PPS, N3 Mismatch: The rewards for the winners of one race _____ too big to reject.
d. PSS, Total Mismatch: The rewards for one winner of one race _____ too big to reject.

40.

a. PPP, No Mismatch: The journeys through the villages of the countries _____ expensive and tiring to take.
b. PSP, N2 Mismatch: The journeys through one village of the countries _____ expensive and tiring to take.
c. PPS, N3 Mismatch: The journeys through the villages of one country _____ expensive and tiring to take.
d. PSS, Total Mismatch: The journeys through one village of one country _____ expensive and tiring to take.

41.

a. PPP, No Mismatch: The statues in the exhibitions of the sculptors _____ bizarre and very frightening.
b. PSP, N2 Mismatch: The statues in one exhibition of the sculptors _____ bizarre and very frightening.
c. PPS, N3 Mismatch: The statues in the exhibitions of one sculptor _____ bizarre and very frightening.
d. PSS, Total Mismatch: The statues in one exhibition of one sculptor _____ bizarre and very frightening.

42.

a. PPP, No Mismatch: The museums with the pictures of the painters _____ expensive and hard to enter.
b. PSP, N2 Mismatch: The museums with one picture of the painters _____ expensive and hard to enter.
c. PPS, N3 Mismatch: The museums with the pictures of one painter _____ expensive and hard to enter.
d. PSS, Total Mismatch: The museums with one picture of one painter _____ expensive and hard to enter.

43.

a. PPP, No Mismatch: The lessons about the founders of the firms _____ boring but sometimes informative.
b. PSP, N2 Mismatch: The lessons about one founder of the firms _____ boring but sometimes informative.
c. PPS, N3 Mismatch: The lessons about the founders of one firm _____ boring but sometimes informative.
d. PSS, Total Mismatch: The lessons about one founder of one firm _____ boring but sometimes informative.

44.

a. PPP, No Mismatch: The toys for the sons of the teachers _____ very entertaining to play with.
b. PSP, N2 Mismatch: The toys for one son of the teachers _____ very entertaining to play with.
c. PPS, N3 Mismatch: The toys for the sons of one teacher _____ very entertaining to play with.
d. PSS, Total Mismatch: The toys for one son of one teacher _____ very entertaining to play with.

45.

a. PPP, No Mismatch: The benefits for the managers of the companies _____ continuous and quite motivating.
b. PSP, N2 Mismatch: The benefits for one manager of the companies _____ continuous and quite motivating.

c. PPS, N3 Mismatch: The benefits for the managers of one company _____ continuous and quite motivating.
d. PSS, Total Mismatch: The benefits for one manager of one company _____ continuous and quite motivating.

46.

a. PPP, No Mismatch: The symbols on the keys of the gates _____ rusty from years of use.
b. PSP, N2 Mismatch: The symbols on one key of the gates _____ rusty from years of use.
c. PPS, N3 Mismatch: The symbols on the keys of one gate _____ rusty from years of use.
d. PSS, Total Mismatch: The symbols on one key of one gate _____ rusty from years of use.

47.

a. PPP, No Mismatch: The manuals by the engineers of the fridges _____ hard to read without glasses.
b. PSP, N2 Mismatch: The manuals by one engineer of the fridges _____ hard to read without glasses.
c. PPS, N3 Mismatch: The manuals by the engineers of one fridge _____ hard to read without glasses.
d. PSS, Total Mismatch: The manuals by one engineer of one fridge _____ hard to read without glasses.

48.

a. PPP, No Mismatch: The settings for the films of the directors _____ artistic and quite expensive.
b. PSP, N2 Mismatch: The settings for one film of the directors _____ artistic and quite expensive.
c. PPS, N3 Mismatch: The settings for the films of one director _____ artistic and quite expensive.
d. PSS, Total Mismatch: The settings for one film of one director _____ artistic and quite expensive.

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